PARASITES OF SOME FISHES IN MANITOBA

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ABSTRACT

The intestinal helminths of *Perca flavescens* (Mitchill) and *Stizostedion vitreum vitreum* (Mitchill) are recorded. Twelve species of helminths, five cestodes, three trematodes, three nematodes, and one acanthocephalan are reported from eighty fish examined. No new species are described. A number of new locality and host records are reported.

Triaenophorus crassus infestation in *Salvelinus namaycush* (Walbaum) is recorded. One hundred and two *Salvelinus namaycush* were examined for cysts of *Triaenophorus crassus*. Unencysted plerocercoids of *Triaenophorus crassus* in *Salvelinus namaycush* are reported.

Synoptic tables and maps of distribution of parasites reported from fishes in Manitoba are included.

A note on host-parasite relationships and ecology of the parasite fauna of *Perca flavescens* and *Stizostedion vitreum vitreum* is presented.

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INTRODUCTION

This project was undertaken primarily to contribute to our knowledge of the parasite fauna of freshwater fishes in Manitoba, and to review the existing literature on this subject. The survey was conducted with a view to preparing a list of parasites of Manitoba fishes, and to report on the ecology and host-parasite relationships of some fishes and their parasites.

Fish parasites of Manitoba are still imperfectly known and much remains to be learned before any form of fisheries management is possible for their control. Many fish parasites are important as they are able to utilize man as the final host. A number of parasitic worms can be acquired by man eating raw or improperly cooked fish. Two species of fish parasites known to occur naturally in man, the broad tapeworm *Dibothriocephalus latus* (=*Diphyllobothrium latum*) and the liver fluke *Metorchis conjunctus*, have been found in Manitoba.

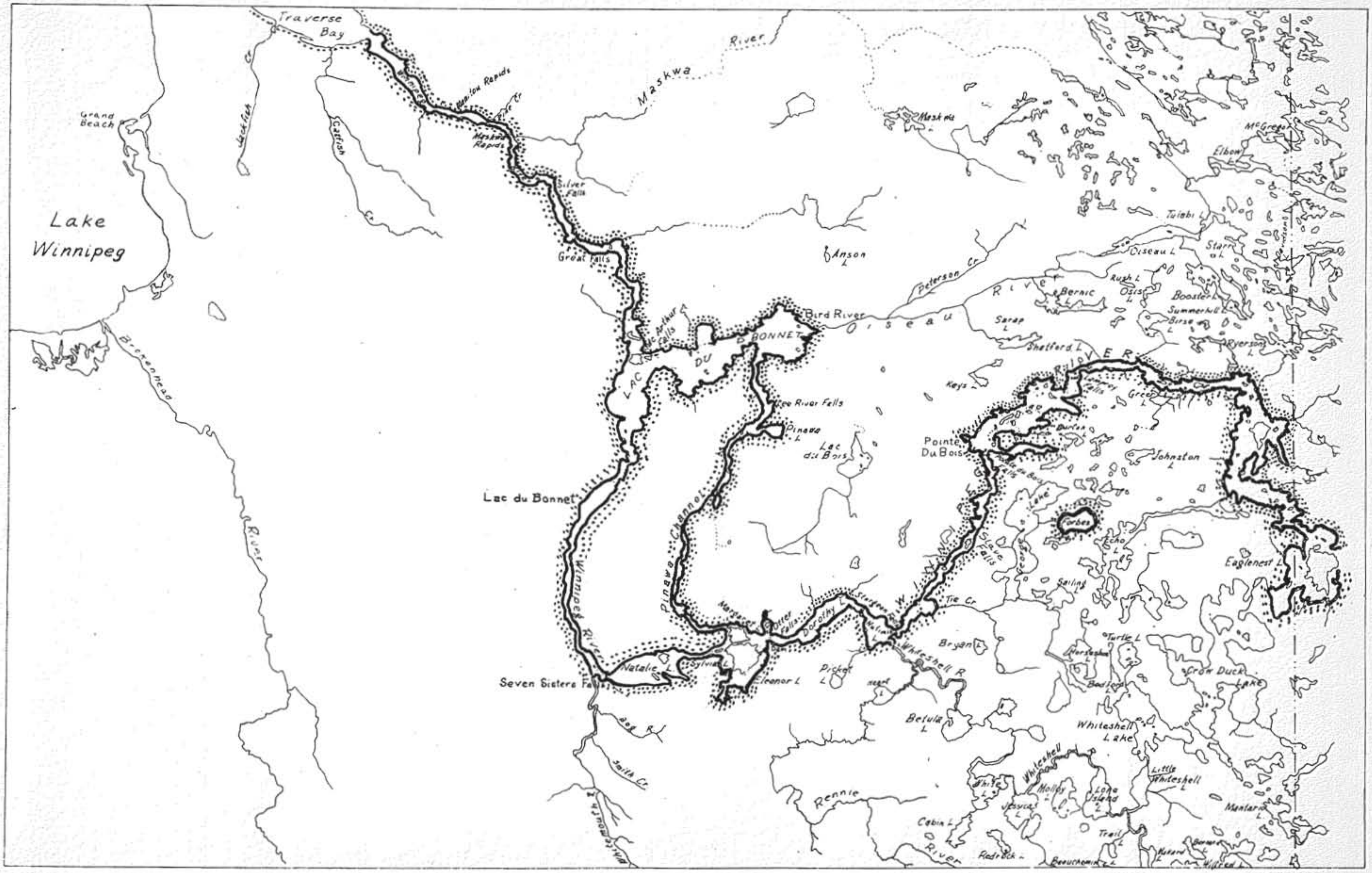
Several fish parasites are of commercial importance because of their effect upon the marketability of fish. One of the most troublesome of these is the plerocercoid larva of *Triaenophorus crassus*. The adult of this tapeworm lives in the intestine of the northern pike *Esox lucius* in which site it is relatively unimportant, but the plerocercoids occur in the flesh of whitefishes, (Coregonidae). This larval form is so abundant in coregonids in Canadian lakes of the Prairie Provinces that the United States Food and Drug Administration bars importation of heavily infected fish from this region. This resulted in such heavy losses to commercial fisheries that the Canadian government sponsored a program to attempt control of this parasite (63).

For the sport fisherman, the greatest importance of fish parasites is their effect on his aesthetic senses. Among the most objectionable fish parasites from the standpoint of the angler are the larval flukes (often called "grubs") which occur in the flesh and viscera of fishes. Aside from making the fish less desirable to the fisherman many of these parasites may cause considerable damage to the fish.

A better understanding of the diseases of fish, particularly those caused by animal parasites, is essential to a fish management program. The study of these organisms is an important phase of any management program and should therefore be continued. Otto (71) states, "To know the parasite completely we must know more than its taxonomy, morphology, and life cycle, fundamental as these are.....An understanding of the ecology of a parasite and the resulting parasitism requires an appreciation of many facets, including the ecology of the host and how parasite and host influence each other....The future offers opportunities unlimited to the ecologically minded parasitologist".

Material for the present study was collected during two summers. In the summer of 1959, the writer examined 102 lake trout from Forbes Lake for Triaenophorus. The degree of infection, the types of encysted and non-encysted plerocercoids found, and the influence of Triaenophorus infection on the growth of lake trout have been studied. This material was collected while the writer was employed by the Manitoba Fisheries Branch. In 1961, while employed as a biologist for the Department of Health, Province of Manitoba, the writer conducted a pollution survey on the Winnipeg River. During this time 80 fish of two species were examined for intestinal helminths. Twelve species were found of which there were five cestodes, three trematodes, three nematodes, and one acanthocephalan. Their distribution in Manitoba and Canada is reported, and the relationship of these parasites to their hosts is described. Forbes Lake and the Winnipeg River are shown in Map 1.

Map 1 Forbes Lake and the Winnipeg River.



WINNIPEG RIVER,

Lake Winnipeg to Ontario boundary.

5 0 5 Miles

5 0 5 Kilometers

HISTORICAL REVIEW

Information on the fish parasites of Manitoba is widely scattered in technical journals and reports of the Fisheries Research Board and of other organizations. Though there is little information on the ectoparasites of fishes the literature concerning their endoparasites is considerable and sufficient to justify a brief historical review.

The beginnings of parasitological research on fishes in Manitoba date back to Magath (53) who demonstrated experimentally that fishes from Lake Winnipeg and from some lakes in Minnesota are infected with the larvae of Dibothriocephalus latus Linn. 1758 [1]. The identity of these larvae from Manitoba fishes had never been studied experimentally prior to the publication of Magath's paper. In a later paper (54) Magath discussed the growth rate of larvae in the definitive host and gave some suggestions for the eradication of this tapeworm.

Nicholson (67) described a human infection with D. latus acquired from Manitoba fish. He demonstrated by feeding experiments that 20% of Esox lucius and two of the seven Stizostedion vitreum from Lake Winnipeg and Lake Manitoba were infected with larvae of this tapeworm. A parasite tentatively identified as Triaenophorus

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1. Dibothriocephalus latus was included in the genus Diphyllobothrium Lühe 1910 (cited from Wardle and McLeod, (103)), but the original nomenclature has been retained in the present treatment in accordance with the restrictions described by Wardle and McLeod.

nodulosus (Pallas), was collected from the pike (Esox lucius). Nicholson also recorded the incidence of D. latus in man in Winnipeg and its possible mode of spread.

Vergeer (94) stressed the importance of Lakes Winnipeg, Winnipegosis and Manitoba as sources of infection with D. latus in the United States. Later (95) he studied the intensity and extensity of infestation of fish in these and some other Canadian lakes and suggested some control measures.

In a paper on D. latus in Esox lucius from Lake Winnipeg, Nicholson (69) has discussed the seasonal variation in the rate of infestation. He found that summer caught pike contained many plerocercoids of D. latus in contrast to winter caught fish which showed only scanty infestation. Larvae from winter caught fish were small and frequently motionless, while those from the summer caught fish were large and active. He suggested that D. latus infection of Esox is probably a seasonal event occurring in the early summer. Nicholson also found that few adult tapeworms developed when dogs were fed larvae from winter caught fish, while 60% of the larvae from summer caught fish developed to adults.

Wardle (100) studied the influence of temperature, digestive juices and of physiological salines on the plerocercoids of D. latus. His material from Lake Winnipeg and Lake Winnipegosis included the following hosts: Esox lucius, Perca flavescens, Stizostedion vitreum, S. canadense and Lota lota maculosa.

At the request of the Biological Board of Canada, Bajkov investigated the Dibothriocephalus latus problem in Manitoba. His report (4) contains a description of the life-cycle of this tapeworm and its distribution in both commercially and non-commercially fished lakes of this province. He has recorded plerocercoids of D. latus from five species of Manitoban fishes; namely: Esox lucius, Stizostedion vitreum, Stizostedion canadense, Perca flavescens, and Lota lota maculosa. Living plerocercoids obtained from the four first mentioned species were fed to dogs and developed into adult tapeworms. The plerocercoids obtained from Lota lota maculosa did not develop into adults.

Bajkov reviews the geographical distribution of this circumpolar parasite and, in particular, the areas on the American continent from which D. latus has been reported. "D. latum is distributed throughout all the Great Lakes system, the Upper Mississippi Basin, extending possibly to Nebraska, Lake Nipigon, Lake of the Woods, practically all of the small lakes and streams of the Northern United States, Ontario and Manitoba. It is very common in Lakes Winnipeg, Manitoba, Winnipegosis and other smaller lakes of the province of Manitoba. It is very abundant in all eastern and western tributaries of Lake Winnipeg, in the Nelson River, also practically in all lakes of Northern Manitoba (The Pas district)". Bajkov rejects the theory that D. latus had been introduced to the American continent from Europe. He suggests that this is a native parasite occurring both in the eastern and western hemispheres.

He studied the life cycle of D. latus by feeding dogs.

It was shown that the optimum temperature for the eggs to hatch is between 26°C and 27°C. Experiments carried on at the Lake Winnipeg Biological Station in 1931 showed that sunshine is very favorable for the hatching of D. latus eggs. Eggs obtained from dog feces were exposed to sun rays, and the percentage of hatching was as high as 95%. It was also demonstrated that eggs washed repeatedly (10 times) were more viable than unwashed eggs. Bajkov suggests that the life span of the plerocercoid is less than one year.

Wardle, Gotschall and Horder (102) studied experimentally the influence of D. latus on serum calcium, plasma phosphorus, haemoglobin content, and blood counts in dogs. No significant changes in blood calcium and phosphorus were found. However, the infestation resulted in a reduction in both red cell counts and in haemoglobin content. A marked leucocytosis was observed.

A report by Harvey (30), on file at the Manitoba Provincial Fisheries Branch, contains a study of D. latus in fishes of Lake Wellman in the Duck Mountain Forest Reserve. This lake was first surveyed by McLeod (55). He netted 18 walleyed pike (Stizostedion vitreum) and found 94% of these fish infected with plerocercoids, averaging six per fish. Lake Wellman was re-surveyed in August of 1951 by Prof. R. K. Stewart-Hay of the University of Manitoba (82). Following detailed examinations of 20 walleyed pike, Prof. Stewart-Hay reported 95% infected with Dibothriocephalus plerocercoids, an average of nine plerocercoids per fish.

Harvey (30) reports the results of an investigation of the D. latus life cycle at Wellman Lake. Special emphasis was given to a possible means of interrupting the life cycle and reducing or eliminating the parasite infestation from the lake. Of the 77 walleyed pike examined by Harvey (1955), 40% were infected with plerocercoids. Harvey has pointed out that Diaptomus oregonensis is probably the first intermediate host in Lake Wellman while second intermediate hosts are Stizostedion vitreum, Esox lucius, and occasionally Perca flavescens. The known distribution of this parasite in Manitoba is shown in Map 2, Table A.

One of the most thoroughly investigated fish parasites in the province of Manitoba is Triaenophorus. Three species of this genus are known to occur in Canada: T. crassus Forel, T. nodulosus (Pallas) and T. stizostedionis Miller, all present in Manitoba. Only T. crassus Forel is of great economic importance. Its plerocercoids occur in the muscles of Coregonidae, where their presence is aesthetically objectionable.

The economical importance of this parasite was recognized in 1932, when inspectors refused to allow heavily infected fish to enter the United States. The rejection of shipments had such a serious effect upon the whitefish industry in the Prairie Provinces and Ontario that the Dominion Government, at the request of the Prairie Provinces, appointed the Prairie Provinces Fisheries Investigation Committee. An important result of this Committee's report was the establishment of the Station of the Fisheries Research Board of Canada at Winnipeg. Since this time, a great deal of research on this parasite has been undertaken.

The first investigators of Triaenophorus in Manitoba were

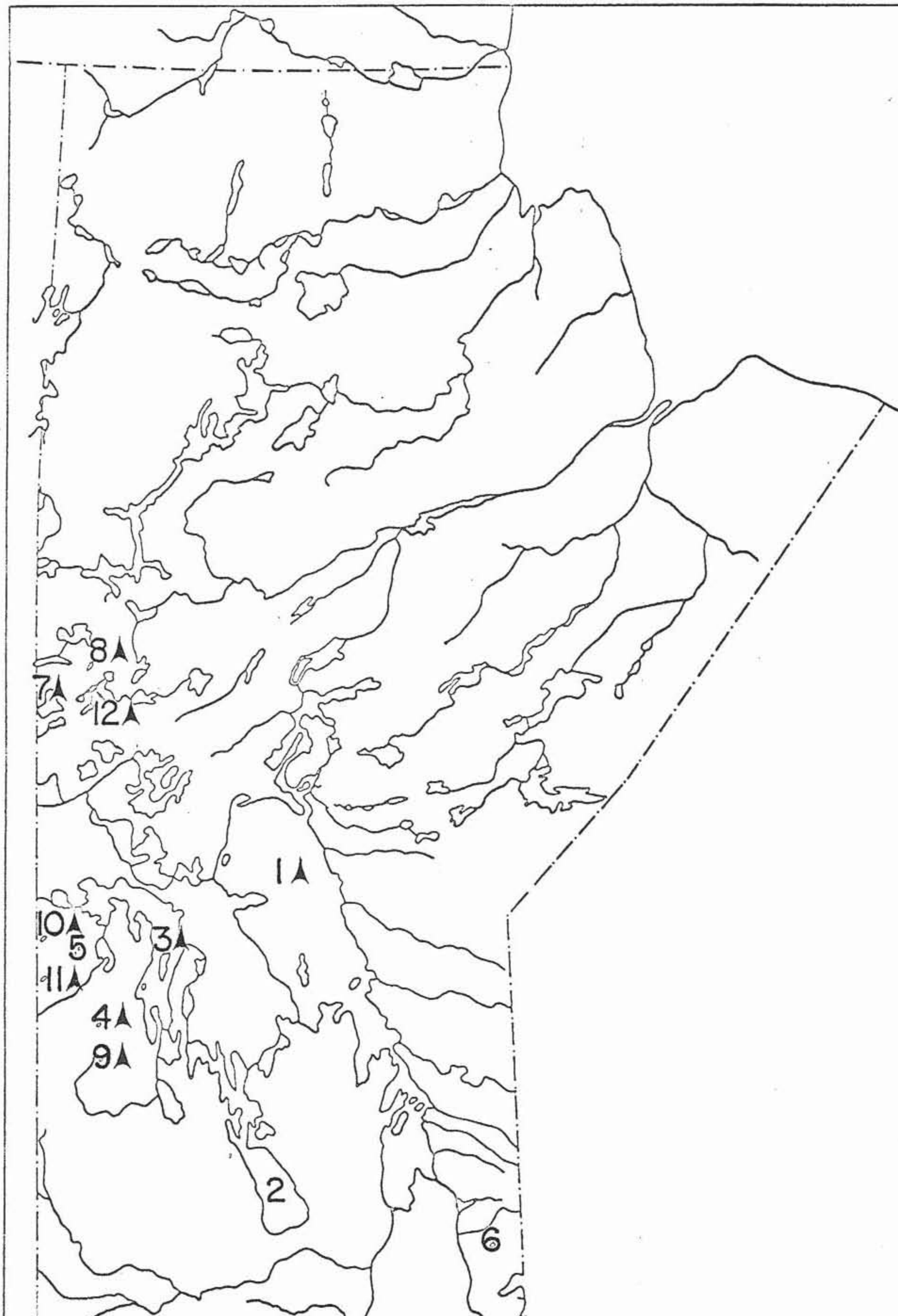
Map 2 Known distribution of Dibothriocephalus in Manitoba

Legend

1. Lake Winnipeg
2. Lake Manitoba
3. Lake Winnipegosis
4. Lake Wellman
5. North Steeprock Lake, South Steeprock Lake and Bell Lake
6. Burton Lake
7. Lake Athapapuskow
8. Heming Lake
9. Childs Lake
10. Armit Lake
11. Pickerel Lake
12. Lake Second Cranberry

1-8 Dibothriocephalus latus

▲ Dibothriocephalus sp.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Newton, Nicholson, and Wardle. Nicholson (68) found Triaenophorus in the flesh of the tullibee (Leucichthys) and has related it to the adult form in the intestine of the pike (Esox lucius), a predator on young fishes. His attempts to infect dogs were unsuccessful. In his experiments he used larvae from Leucichthys nigripinnis and L. tullibee from Lake Winnipeg, and from Coregonus clupeaformis, from Kississing Lake.

Newton (66) reported Triaenophorus from Manitoba lakes (Winnipeg, Winnipegosis, Manitoba, Dauphin, St. Martin, and a number of lakes in the Pas district) as T. tricuspidatus Bloch, 1779. Approximately 7,000 fish of the following species were examined: Esox lucius, Coregonus clupeaformis, Leucichthys tullibee, L. zenithicus, L. nipigon, L. nigripinnis, Perca flavescens, Stizostedion vitreum, Stizostedion canadense, Lota lota maculosa, Hiodon chrysopsis, Catostomus catostomus, Catostomus commersoni, Ictalurus punctatus and Ameiurus nebulosus. The survey area ranged from south of Lake Winnipeg to lakes some distance north along the Hudson Bay railway and from the east of Manitoba to the western boundary.

Newton described the incidence of Triaenophorus tricuspidatus in Coregonus and Leucichthys species in the larger lakes in Manitoba. In Lake Winnipeg 45% of the Coregonus and 60% of the Leucichthys spp. were infected in June, while the infestation rate dropped to 30-40% for both genera in July and continued to decline until January. 96 whitefish (Coregonus) were examined from Lake Winnipegosis, only three of which were infected-- one parasite being found in each fish. The Leucichthys showed a much higher rate of infection. Of all the fish examined from Lake Manitoba, none were infected with *T. tricuspidatus*. Similarly, 12 *Leucichthys* from Lake Dauphin were found to be free from infection. Of the 15 *Coregonus* from Lake St. Martin examined, only one parasite was found in each of five infected individuals. A total of 26 small lakes in The Pas district were examined. Fish from 6 of these lakes were found to be free from infection.

Newton describes the morphology of the encysted plerocercoid collected from various species of *Leucichthys* and from *Coregonus clupeaformis* and he describes the structure of the adult parasite found in pike. A short note on the life cycle of *T. tricuspidatus* is also included in his paper.

Wardle (99), in his survey of the cestodes of fishes from the Hudson Bay Drainage System, found both *T. crassus* and *T. nodulosus*, but recorded both species as varieties of *T. tricuspidatus*, namely, *T. t.* morpha *megadentatus* and *T. t.* morpha *microdentatus*. This identification was corrected by Ekbaum (21), who, in comparing the Canadian material to the European, has shown that the North American cestodes were *T. crassus* and *T. nodulosus*. In 1937 (22) she studied experimentally the maturation and hatching of the eggs of *T. crassus* from fishes from Matlock and Gimli on Lake Winnipeg and from several localities in Ontario. She has observed egg formation in *T. crassus* during February. The eggs were fully developed and ready to hatch in May. Newton (66) failed to confirm Ekbaum's findings. He found mature eggs in the uterus in February. Contrary to Ekbaum's findings he did not observe sexual development during May and August. Newton's measurements of the coracidia differ from those of Ekbaum.

In 1945 the Fisheries Research Board of Canada began an experiment at Heming Lake, Manitoba, in an attempt to reduce the pike population and thus to improve the quality of the whitefish (Coregonus clupeaformis) which were heavily infected with T. crassus plerocercoids. This 588-acre lake is situated in Precambrian country about 80 miles north of The Pas. Dr. K. H. Doan of the Central Research Station of the Fisheries Research Board of Canada directed the pike control here. Since 1950 this work has been continued by Dr. G. H. Lawler. Since the beginning of this project a number of publications on the biology of Triaenophorus have appeared. These include studies on its intermediate hosts, its geographical distribution, methods of control, and correlation of infestation rate with limnological data.

One of the first of these reports, that of Arnason (2), describes the infection rate of Cyclops bicuspidatus with Triaenophorus procercoids in Heming Lake. The 1949 annual report of the Central Fisheries Research Station describes the attempts by Doan (17), and Kennedy and Doan (39), to interrupt the life cycle of Triaenophorus at Heming Lake by destroying the pike population. Netting and poisoning were the techniques employed in the eradication of these fish. In the same report, Oakland (70) has published a statistical study of whitefish infestation from Lake Winnipeg. The purpose of his study was to determine the most satisfactory sampling method for the programme of pre-inspection of whitefish for export. Tables were prepared to guide inspectors in their examinations for Triaenophorus. Doan (17) summarizes the results of investigations at the Heming Lake Station to control the Triaenophorus in central Canada.

Watson and Lawler (104) recorded the incidence of *Triaenophorus* procercoids in *Cyclops bicuspidatus* at Heming Lake on the basis of 4 years sampling (1952-1956). They point out that these data may prove useful in predicting rates of incidence of *Triaenophorus* infestation in fishes. Similar studies on eggs, coracidia and plerocercoids of *Triaenophorus* at Heming Lake are reported by Lawler (43). Samples of eggs and coracidia of *T. crassus* and *T. nodulosus* were measured. The results were generally in agreement with those obtained by investigators in other regions, e.g. Miller (59). Low temperatures retarded the development of the parasites and the hatching of the eggs. Experimental infections of several copepod hosts with eggs and coracidia of *Triaenophorus* showed *C. bicuspidatus* to be the susceptible host in Heming Lake. The growth of procercoids in the copepod host was observed to be slower than previously reported, and Lawler attributes this to the effect of low temperatures. Naturally infected *Cyclops bicuspidatus* developed larger procercoids than artificially infected copepods of the same species. The possibility that some of the procercoids found in *Cyclops* might be *Dibothriocephalus latus* was discussed.

The geographical distribution and the hosts of *Triaenophorus* in North America are reviewed by Lawler and Scott (46). On the basis of the literature and of personal communications they list 32 species of fish as hosts to this parasite. "In North America the known range of *Triaenophorus* lies between 42 N latitude (Indiana, U.S.A.), northward to 67 N latitude (Great Bear Lake, Northwest Territories, Canada) and from the lower St. Lawrence River north-westerly to Alaska. The most southerly record is for the State of Indiana and, although it has not been reported to occur in North Dakota, Illinois or Ohio, the presence of the genus in neighboring states suggests that it will be found as a result of further work." Lawler and Scott suggest that temperature may be the most important physical factor affecting the distribution of Triaenophorus. They point out that Esox lucius is the key biotic factor influencing the distribution of T. crassus and T. nodulosus. "The pike is one of the few true freshwater fishes in the Arctic and its tolerance for cold probably enabled it to cross a late Siberian-Alaskan land bridge and enter America."

In 1952 Lawler (42) reported a new North American host for T. nodulosus. A plerocercoid of this pseudophyllidean cestode was found encysted in the liver of a Slimy Sculpin, Cottus cognatus at Heming Lake, Manitoba. Only one of the forty-eight fish of this species examined had this parasite, however, and the indications are that it should be regarded as an accidental host.

Lawler and Watson (47) conducted limnological studies of Heming Lake, and the adjacent Home and Wapun lakes. These were undertaken to determine relationships between the physical and chemical characteristics of the lake and the life history of Triaenophorus. Since this history is dependent on at least two fish hosts, particular attention was given to the ecological factors which govern the production and survival of these fishes. Other factors considered were; geology of the country, morphometry of the lake, temperature of the water, oxygen content, hydrogen-ion concentration, mineral content, transparency, abundance of phyto-and zooplankton, and bottom fauna. This survey provided helpful information on the ecological factors influencing the life cycle of Triaenophorus. Lawler and Watson report nine species of cestodes from eleven species of fish from these lakes.

Lawler (44) reviews the research on the biology and control of this parasite at Heming Lake. He stresses the complexity of the Triaenophorus problem, but points out that a decrease in the percentage of Cyclops bicuspidatus infected, and a reduction in abundance of adult worms in pike show that the control measures were at least partially effective.

Watson and Price (106) reported the results of experimental infections of cyclopids from various localities, chiefly from the vicinity of Toronto, Ontario, and from Heming Lake, Manitoba. These authors placed uninfected cyclopids in contact with viable coracidia and examined them later for the presence of procercoids. The following cyclopids from Heming Lake have been infected with T. crassus: Microcyclops varicans rubellus, Ectocyclops phaleratus, Cyclops bicuspidatus thomasi, C. brevispinosus. Those infected with T. nodulosus were: C. bicuspidatus thomasi, C. brevispinosus, and Eucyclops speratus.

Lawler (45) described the results of three years research on Triaenophorus at Heming Lake. Intensive fishing effort has resulted in a marked decrease in the proportion of older year classes in the pike population. The predominance of young small pike in the catch at Heming Lake enhances the possibility of eradicating T. crassus, as small pike are less liable to consume infected whitefish. He points out that there has been a drastic decline in the infection level in whitefish since 1945. Lawler states that "the T. crassus population in Heming Lake is extinct." A constant decline in the number of T. crassus cysts found in the whitefish population and the cisco population at

Heming Lake has been apparent since 1945; no cysts were found in the 1960 fish samples. Even more convincing evidence that T. crassus has been reduced in Heming Lake is the decrease in the number of adult worms in the gut of the pike. For the past three years Lawler has not found a single T. crassus in the pike intestines. He states that "as no infections were found in either pike, whitefish or ciscoes in 1960, it is highly improbable that there will be any change in the parasite population in 1961". Lawler states that "it has been demonstrated conclusively that an intensive fishery for pike will bring about a decrease in the number of cysts of the tapeworm".

Watson and Lawler (105) published the results of their studies on the eggs and procercoids of Triaenophorus. Eggs in samples taken at Heming Lake averaged 0.05 by 0.03 mm. Observations on the hatching of the eggs indicate that most eggs contain live embryos. Most eggs are hatched within 3 or 4 days after hatching commences. Low oxygen tension in the water and low temperatures delay the onset of hatching. The hatched coracidia live for 24 to 28 hours depending on the temperature of the water and the length of time they have been stored. Watson and Lawler examined populations of Cyclops in shallow water areas of Heming Lake to determine the annual level of infection with procercoids. This level was about 1% over the years 1953-1959. Samples collected inshore were found to be more heavily infected than those from deeper water, and samples from the middle of the lake were almost invariably uninfected.

Miller (63) has published a review of the Triaenophorus problem in Canada. The biology of this parasite and a summary of studies on Triaenophorus by the Fisheries Research Board are included in this report.

In 1952, Keleher (38) studied the infestation of Lake Winnipeg ciscoes (Leucichthys sp.) by T. crassus and used parasitological data in an attempt to clarify the existing classification of these fishes. He suggests that species of Leucichthys differ in their degree of infestation with T. crassus.

The emphasis of most parasitological studies in Manitoba has been on the fishes as intermediate hosts. However, adult parasites of fishes have also been studied. Wardle (99) surveyed the cestodes of several thousand fishes belonging to 30 species from the Hudson Bay drainage system and the larger lakes of Manitoba and Saskatchewan. Ten species of adult cestodes and three species of cestode larvae were recorded. All thirteen species, including one new species, Proteocephalus luciopercae, were reported from Manitoba.

Wardle (101) published a comprehensive report on the incidence of endoparasitic helminths in Canadian animals. He reports one adult cestodarian, 53 adult Cestoda and 24 larval Cestoda known to occur in Canadian animals. The majority of the Cestoda are Dibothriocephaloidea and Taenioidea. An attempt is made to evaluate the economic significance of the cestodes of the area.

Ekbaum (20) has recorded two species of Eubothrium from Manitoba: E. rugosum Batsch, 1786 from Lota lota maculosa in Lake Winnipeg, and E. salvelini Schrank, 1781 from Cristivomer (=Salvelinus) namaycush from Clear Lake. Map 3 and Table C show the known distribution of Eubothrium in Manitoba.

Map 3 Known distribution of *Eubothrium* in Manitoba.

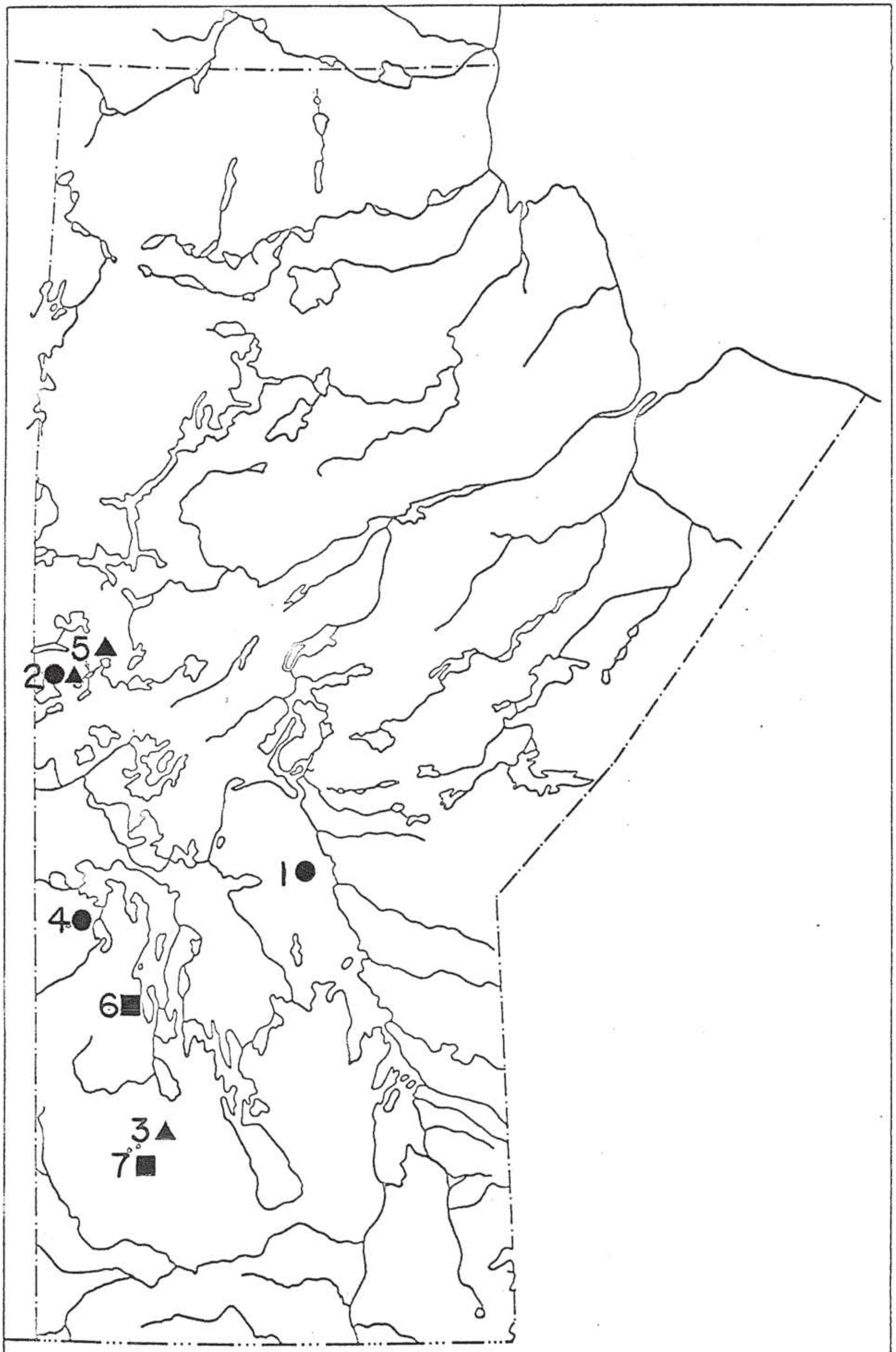
Legend

1. Lake Winnipeg
2. Lake Athapapuskow
3. Clear Lake
4. Lake North Steeprock
5. Lake Second Cranberry
6. Lake Wellman
7. Lake Groschak

● *Eubothrium rugosum*

■ *Eubothrium salvelini*

▲ *Eubothrium* sp.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In 1933 Smedley studied nematodes from Canadian marine and freshwater fishes. She reviewed methods of studying nematodes and described a new method of preparing material for sectioning, and a new triple stain. She also described a new species of nematode, Raphidascaris canadensis from Esox lucius and reported its presence in Lakes Winnipeg, Winnipegosis, and lakes in The Pas district. Smedley (79) reports Cystidicola stigmatura (Leidy, 1886), Ward and Magath, 1916, from the swim-bladder of Coregonus clupeaformis from Lake Winnipeg, and Jackfish and Murray Lakes, Manitoba. This is the first report of this nematode from western Canada.

In a M.Sc. thesis, Little (49) records four species of Proteocephalus and one of Bothriocephalus from seven species of fish from Manitoba. P. stizostedionis Hunter and Bangham, 1933 is synonymised with P. luciopercae Wardle, 1932.

Allen and Wardle (1) found opisthorchid trematodes, which they described as a new species Parametorchis manitobensis, in the liver of dogs near Cormorant Lake, north east of The Pas. The dogs were fed Catostomus commersoni, but no larval trematodes were found upon examining 60 fishes of this species. Cameron (10) has synonymised P. manitobensis with Metorchis conjunctus and has shown experimentally that C. commersoni does serve as second intermediate host of this trematode in Canada. Subsequent observations show that this parasite is rather widespread in dogs in outlying areas of Manitoba.

Evans (24) reports the finding of 36 specimens of Amphimerus pseudofelineus in cats fed Catostomus commersoni from Oak Point, Lake Manitoba. This is the first Canadian record for this parasite and the first record of its secondary intermediate host for the world. In an M.Sc. thesis, W. S. Evans (25) reports two species of liver flukes, Metorchis conjunctus and Amphimerus pseudofelineus from fish in Manitoba. Feeding experiments involving Catostomus commersoni and Perca flavescens from Black River, Lake Winnipeg, produced specimens of Metorchis conjunctus. This is the first record of Perca flavescens serving as an intermediate host of Metorchis conjunctus. He also discusses the variability of characters used for the separation of the mammalian species of Metorchis.

In conclusion, brief mention has to be made of parasites collected in the course of biological studies of Manitoba lakes. The majority of these surveys were conducted by Dr. J. A. McLeod and the late Professor R. K. Stewart-Hay of the University of Manitoba. Reports of their investigations are on file at the Manitoba Fisheries Branch. The investigations were conducted primarily to evaluate the productivity of the lakes, and in the first place to determine fish production. The parasites comprised only a small part of the material collected and were not subjected to critical examination. Only the larger parasites were collected with little mention made of the small trematodes, larval cestodes, and smaller nematodes. They have also reported species of parasitic copepods - Map 4, Table J. The parasites identified are included in synoptic tables of fish parasites in Manitoba. (See Appendix, Tables A - J.)

Map 4 Known distribution of parasitic Copepoda in Manitoba

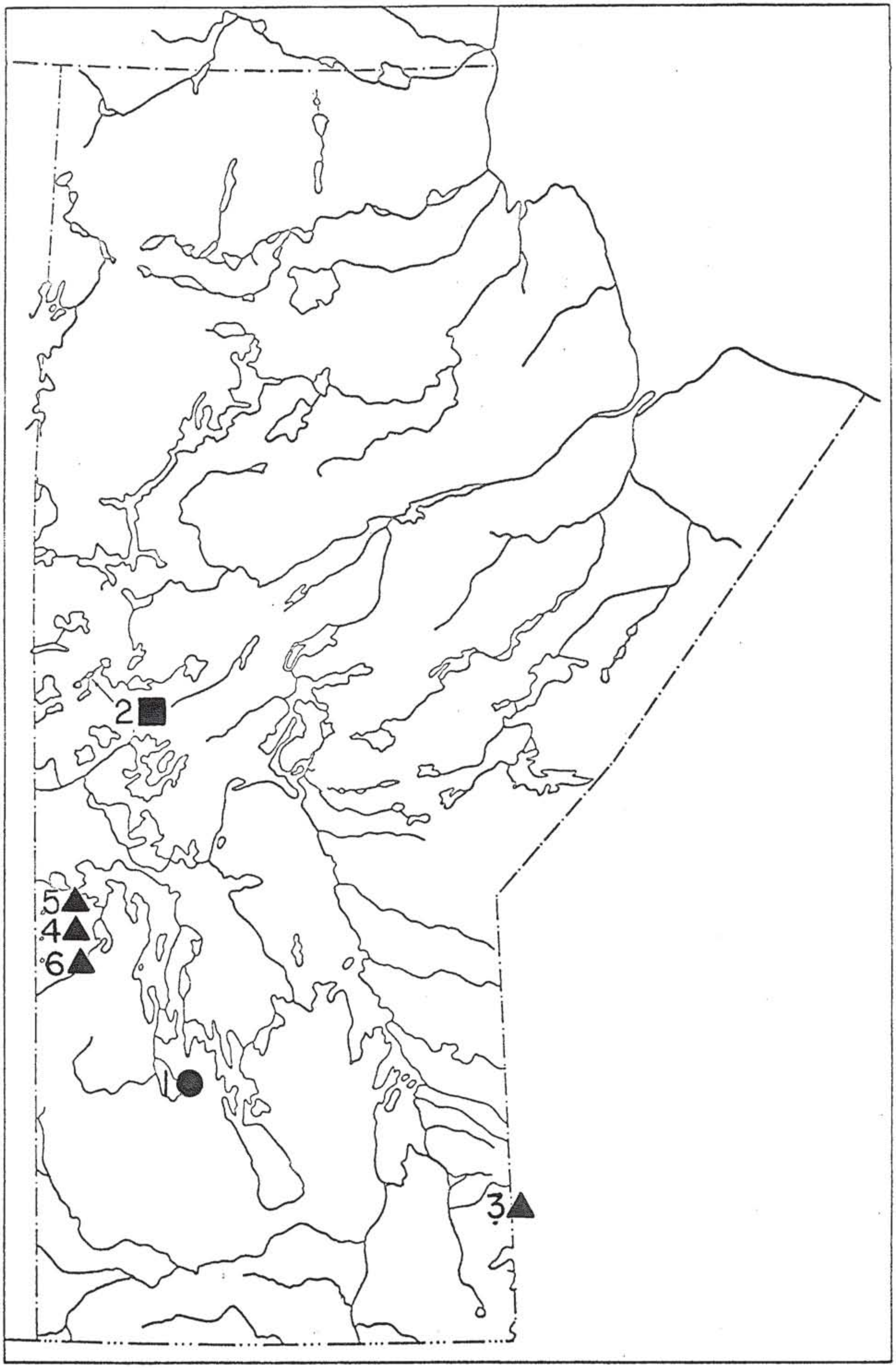
Legend

1. Lake Dauphin
2. Lake Second Cranberry
3. Lake Caddy
4. Lake Pickerel
5. Armit Lake
6. Whitefish Lake

● *Argulus stizostethi*

■ *Salmincola* sp.

▲ *Ergasilus* sp.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MATERIALS AND METHODS

Collection of hosts:

Material for this project was obtained in 1959 and 1961. The writer examined lake trout (*Salvelinus namaycush*) from Forbes Lake, Manitoba, for *Triaenophorus* during the summer of 1959. Pike-perch (*Stizostedion vitreum vitreum*) and yellow perch (*Perca flavescens*) from the Winnipeg River, Manitoba, were examined for intestinal helminths during the summer of 1961. Fish were caught in gill nets. A standard gang of nets of the following mesh sizes were employed for each net set: 1", 2", 3", $3\frac{3}{4}$", 4", $4\frac{1}{4}$", $4\frac{3}{4}$", and 5".

Sex, age, length, weight, locality of net set, and date were recorded for each individual examined. The length of the fish was recorded to the nearest one-eighth of an inch, and weights to the nearest ounce. Sex was determined by examination of the gonads. In cases where sex identification was impossible, the fish was reported as immature. The age of the host was determined on the basis of examination of scales.

Collection of parasites:

(a) *Triaenophorus in lake trout*: All fish were examined for parasites inhabiting the flesh. The muscle of each fish was stripped away from the body (filleted) and examined by cutting it obliquely into very thin strips. The skin was removed from the muscle in order to locate parasites situated immediately beneath the skin. *Triaenophorus* cysts and plerocercoids were counted, and the cysts were recorded according to their size and shape. Free and encysted

Triaenophorus plerocercoids were preserved in 70% alcohol.

(b) Intestinal helminths of pikeperch and yellow perch: The collection of parasites from these fishes was limited to the recovery of intestinal cestodes, trematodes, nematodes, and acanthocephala. Finding the larger parasites was relatively easy. The intestine, stomach, and pyloric ceca were cut open and immersed in a quart sealer filled with physiological saline solution. The sealer was shaken and the contents allowed to settle. The cleared portion containing mucus and partially digested material was poured off. This process was repeated a number of times replacing the decanted liquid each time with fresh solution. The parasites, being heavier than the mucus and intestinal debris, settled to the bottom of the sealer and were concentrated in the remaining fluid. This fluid was then examined in a Petri dish with the aid of a binocular microscope, and the parasites collected. Prolonged examination of the settled residue was necessary in some cases to collect the smaller trematodes.

Fixation:

The worms were washed in physiological saline to remove any remaining mucus prior to fixation. Trematodes were placed in tap water and allowed to die. This caused most specimens to relax and release their eggs. This is highly desirable as an egg-filled uterus usually obscures much of the anatomy. Following relaxation the trematodes were fixed in hot 10% formalin.

Cestodes, after being freed of mucus, were placed in tap water until they no longer responded to stimuli. They were then stretched only slightly, compressed between two glass slides, and fixed with hot 10% formalin. Some of the larger cestodes were fixed in a Petri dish by pipetting hot 10% formalin onto them.

Acanthocephalans were allowed to die in tap water. The specimens were able to invert the proboscis for a short time, but usually the proboscis remained extended. They were fixed in hot 10% formalin.

Large nematodes were dropped into hot 10% formalin solution which caused the worms to straighten out. To prevent smaller more delicate nematodes from shrivelling they were fixed in cold 10% formalin.

Staining:

Trematodes and cestodes were stained in Gower's carmine. This is an excellent stain, especially for trematodes. The internal organs are coloured a deep red and can easily be differentiated from one another. Harris' haematoxylin stain also proved satisfactory for cestodes. Following staining, the cestodes and trematodes were dehydrated in a graded series of alcohols, cleared in xylene and mounted in permount. The reagents employed in the clearing process had a decided "shrinking" effect on the smaller more delicate trematodes.

Acanthocephalans were subjected to carmine and haematoxylin stains but reacted poorly to both. Acanthocephala and nematodes were cleared in lactic acid. They wrinkled and shrivelled when first subjected to this reagent, but after two or three days in lactic acid, they expanded so that the principal organs were clearly visible.

Photography:

Photographic techniques varied depending on the nature of the mounted material. A technique used recently by Wm. Evans in trematode studies was employed in photographing some of the cestodes and larger trematodes. The mounted specimen was projected under a bioscope or 35mm. enlarger onto a sheet of F3 Kodak photographic paper. This, when developed and fixed, produced a negative print of the specimen.

Photomicrography was used for small trematodes and cestode larvae. Line drawings using camera lucida and microscope were used to show detailed anatomical structure.

TAXONOMY AND CLASSIFICATION

LIST OF HELMINTHS FOUND BY THE WRITER

CESTODA

Family Triaenophoridae Loennberg, 1889

Genus *Triaenophorus* Rudolphi, 1793

1. *Triaenophorus stizostedionis* Miller, 1945
2. *Triaenophorus crassus* Forel, 1868

Family Bothriocephalidae Blanchard, 1849

Genus *Bothriocephalus* Rudolphi, 1808

3. *Bothriocephalus cuspidatus* Cooper, 1917
4. *Bothriocephalus* sp.

Family Proteocephalidae La Rue, 1914

Genus *Proteocephalus* Weinland, 1858

5. *Proteocephalus luciopercae* Wardle, 1932
6. *Proteocephalus* spp.

TREMATODA

Family Cryptogonimidae Ciurea, 1933

Genus *Centrovarium* Stafford, 1904

7. *Centrovarium lobotes* (MacCallum, 1895) Stafford, 1904

Family Bucephalidae Poche, 1907

Genus *Bucephaloides* Hopkins, 1954

8. *Bucephaloides pusilla* (Stafford, 1904) Hopkins, 1954

Family Allocreadiidae Stossich, 1903

Genus *Crepidostomum* Braun, 1900

9. *Crepidostomum cooperi* Hopkins, 1931

NEMATODA

Family Rhabdochonidae Skrjabin, 1946

Genus *Rhabdochona* Railliet, 1916

10. *Rhabdochona cascadilla* Wigdor, 1918

Genus *Spinitectus* Fourment, 1883

11. *Spinitectus* sp.

Family Heterocheilidae Railliet et Henry, 1915

Genus *Raphidascaris* Railliet et Henry, 1915

12. *Raphidascaris canadensis* Smedley, 1933

ACANTHOCEPHALA

Family Neoechinorhynchidae Hamann, 1892

Genus *Neoechinorhynchus* Hamann, 1905

13. *Neoechinorhynchus cylindratus* VanCleave, 1913

FISH PARASITES KNOWN TO OCCUR IN MANITOBA

CESTODA

Family Triaenophoridae Loennberg, 1889

Genus *Triaenophorus* Rudolphi, 1793

1. *Triaenophorus crassus* Forel, 1868
2. *Triaenophorus nodulosus* (Pallas, 1781) Rudolphi, 1819
3. *Triaenophorus stizostedionis* Miller, 1945
4. *Triaenophorus* sp.

Family Diphyllobothriidae Lühe, 1910

Genus *Dibothriocephalus* Lühe, 1899

5. *Dibothriocephalus latus* (Linnaeus, 1758) Wardle and McLeod, 1952
6. *Dibothriocephalus* sp.

Genus *Ligula* Bloch, 1782

7. *Ligula intestinalis* (Linnaeus, 1758)
8. *Ligula* sp.

Genus *Schistocephalus* Creplin, 1829

9. *Schistocephalus solidus* (Mueller, 1776)
10. *Schistocephalus* sp.

Family Bothriocephalidae Blanchard, 1849

Genus *Bothriocephalus* Rudolphi, 1808

11. *Bothriocephalus cuspidatus* Cooper, 1917
12. *Bothriocephalus* sp.

Family Amphicotylidae Ariola, 1899

Genus Eubothrium Nybelin, 1922

13. Eubothrium rugosum (Batsch, 1786)

14. Eubothrium salvelini (Schrank, 1790)

15. Eubothrium sp.

Family Caryophyllaeidae Leuckart, 1878

Genus Glaridacris Cooper, 1920

16. Glaridacris catostomi Cooper, 1920

17. Glaridacris sp.

Genus Spartoides Hunter, 1929

18. Spartoides wardi Hunter, 1929

Family Cyathocephalidae Nybelin, 1922

Genus Cyathocephalus Kessler, 1868

19. Cyathocephalus truncatus (Pallas, 1781)

Family Proteocephalidae La Rue, 1911

Genus Corallobothrium Fritsch, 1886

20. Corallobothrium fimbriatum Essex, 1927

Genus Proteocephalus Weinland, 1858

21. Proteocephalus luciopercae Wardle, 1932

22. Proteocephalus pinguis La Rue, 1911

23. Proteocephalus laruei Faust, 1920

24. Proteocephalus singularis La Rue, 1911

25. Proteocephalus coregoni Wardle, 1932

26. Proteocephalus pusillus Ward, 1910

27. Proteocephalus sp.

TREMATODA

Family Opisthorchiidae Braun, 1901

Genus Metorchis Loose, 1899

28. Metorchis conjunctus (Cobbold, 1860) Loose, 1899 - metacerariae

Genus Amphimerus Barker, 1911

29. Amphimerus pseudofelineus (Ward, 1901) Barker, 1911 - metacercariae

Family Clinostomidae Lühe, 1901

Genus Clinostomum Leidy, 1856

30. Clinostomum marginatum (Rudolphi, 1819) - metacercariae

31. Clinostomum sp. - metacercariae

Family Cryptogonimidae Ciurea, 1933

Genus Centrovarium Stafford, 1904

32. Centrovarium lobotes (MacCallum, 1895) Stafford, 1904

Family Bucephalidae Poche, 1907

Genus Bucephaloides Hopkins, 1954

33. Bucephaloides pusilla (Stafford, 1904) Hopkins, 1954

Family Allocreadiidae Stossich, 1903

Genus Crepidostomum Braun, 1900

34. Crepidostomum cooperi Hopkins, 1931

NEMATODA

Family Heterocheilidae Raillet et Henry, 1915

Genus *Raphidascaris* Raillet et Henry, 1915

35. *Raphidascaris canadensis* Smedley, 1933

36. *Raphidascaris* sp.

Family Rhabdochonidae Skrjabin, 1946

Genus *Rhabdochona* Railliet, 1916

37. *Rhabdochona cascadilla* Wigdor, 1918

Genus *Cystidicola* Fischer, 1798

38. *Cystidicola stigmatura* (Leidy, 1886)

Genus *Spinitectus* Fourment, 1883

39. *Spinitectus* sp.

ACANTHOCEPHALA

Family Neoechinorhynchidae Hamann, 1892

Genus *Neoechinorhynchus* Stiles and Hassall, 1905

(=Neorhynchus, Hamann, 1892) VanCleave, 1913

40. *Neoechinorhynchus cylindratus* Van Cleave, 1913

41. *Neoechinorhynchus crassus* Van Cleave, 1919

42. *Neoechinorhynchus* sp.

Genus *Tanaorhamphus* Ward, 1918

43. *Tanaorhamphus* sp.

Family Echinorhynchidae Hamann, 1892

Genus *Echinorhynchus* Zoega, 1776

44. *Echinorhynchus coregoni* Linkins, 1919

Genus *Pomphorhynchus* Monticelli, 1905

45. *Pomphorhynchus bulbocolli* Linkins, 1919

46. *Pomphorhynchus* sp.

COPEPODA

Family Ergasilidae Nordmann, 1832

Genus *Ergasilus* Nordmann, 1832

47. Ergasilus sp.

Family Lernaeopodidae Edwards, 1840

Genus *Salmincola* Wilson, 1915

48. *Salmincola* sp.

Family Argulidae Muller, 1785

Genus *Argulus* Muller, 1785

49. *Argulus stizostethi* Kellicott, 1880

Notes on Cestodes

Family Triaenophoridae, Loennberg, 1889

Genus Triaenophorus, Rudolphi, 1793

Triaenophorus stizostedionis Miller, 1945

Records from Manitoba:

Definitive Host: Stizostedion vitreum---Lake Second Cranberry - Stewart-Hay, (86); Heming Lake - Lawler, (41); Lake Dauphin (sub-adult specimens) - Stewart-Hay, (81).

Second Intermediate Hosts: Percopsis omiscomaycus---Heming Lake - Lawler, (41). Cottus cognatus gracilis---Heming Lake - Lawler, 1953 (unpub.). Map 5, Table B, show Triaenophorus distribution in Manitoba.

Other Canadian Records:

Northwest Territories:

Definitive Host: Stizostedion vitreum---Great Slave Lake - Rawson, (73).

Ontario:

Definitive Host: Stizostedion vitreum---Lake Superior (sub-adult) - Miller, (61); Lake Huron and Manitoulin Island - Bangham, (6).

Alberta:

Definitive Host: Stizostedion vitreum---Lesser Slave Lake - Miller, (61).

Second Intermediate Host: Percopsis omiscomaycus---Lesser Slave Lake - Miller, (61).

Author's Findings

Triaenophorus stizostedionis was found in 6 of the 28 yellow pikeperch (*Stizostedion vitreum*) from the Winnipeg River. Four specimens from the intestine of a single pikeperch represented the heaviest infestation encountered. All *Triaenophorus* examined were immature.

Measurements of Specimens

Measurements of the scolex hooks of 5 preserved specimens comprised the basis for identification. Stained and mounted material proved unsatisfactory for the examination of the hooks. The longest worm measured was 85 mm. long; the shortest 22 mm. The scoleces of most of the worms were small and expanded, the bothria being quite conspicuous (Fig. 1). The scolex hook consists of a basal plate embedded in the scolex and three prongs attached to this plate. The average width of the basal plate is 148μ, its depth (anterior to posterior) 20μ, and the average length of the marginal prong - 56μ, Table 1 .

Species Identification

T. stizostedionis was identified on the basis of the shape and size of the scolex hooks (Fig. 3). The scolex hooks of our specimens agree in detail with Miller's description (61), "The scolex hooks of *T. stizostedionis* are characteristic. Each consists of a narrow, curved basal plate, which bears three prongs. The median prong is stout and, with the basal plate, is embedded in the tissue of the scolex. The fourth projection, characteristic of *T. nodulosus*

Map 5 Known distribution of *Triaenophorus* in Manitoba

Legend

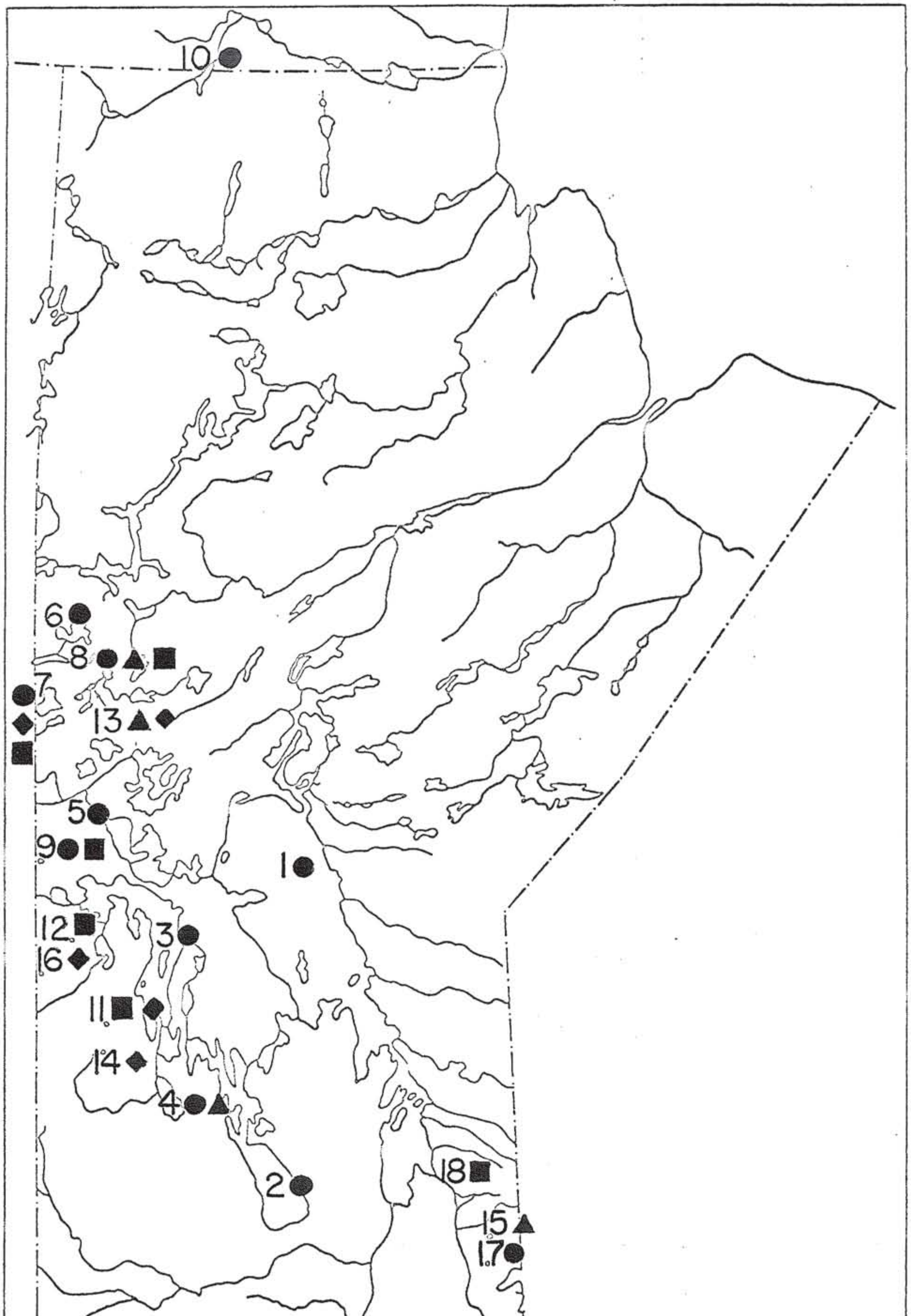
1. Lake Winnipeg
2. Lake Manitoba
3. Lake Winnipegosis
4. Lake Dauphin
5. Lakes in The Pas District
6. Lake Kississing
7. Lake Athapapuskow
8. Heming Lake
9. Armit Lake
10. Lake Nueltin (Manitoba-Northwest Territories Boundary)
11. Lake Wellman
12. South Steeprock Lake
13. Lake Second Cranberry
14. Childs Lake
15. Burton Lake
16. Pickerel Lake
17. Forbes Lake
18. Winnipeg River

● *Triaenophorus crassus*

■ *Triaenophorus nodulosus*

▲ *Triaenophorus stizostedionis*

◆ *Triaenophorus* sp.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is lacking." Dimensions of the scolex hooks of T. stizostedionis are compared to Miller's measurements in Table 1.

The presence of a Y-shaped protuberance on the middle surface of each hook of T. stizostedionis confirmed the identification. Miller (61) states, "This protuberance is alone sufficient to distinguish T. stizostedionis from T. crassus and T. nodulosus." The scolex and scolex hook of T. stizostedionis (Figs. 1 and 3) are compared to those of T. crassus (Figs. 2 and 4).

PLATE I

Fig. 1 Scolex of *Triaenophorus stizostedionis*. X28

Fig. 2 Scolex of *Triaenophorus crassus*. X26

Fig. 3 Camera lucida drawing of a scolex hook of *T. stizostedionis*. Lateral surface. X308 The dotted line represents a portion of the hook that is visible only in preserved specimens.

Fig. 4 Camera lucida drawing of a scolex hook of *T. crassus*. Surficial view. X167

FIG. 1

FIG. 2

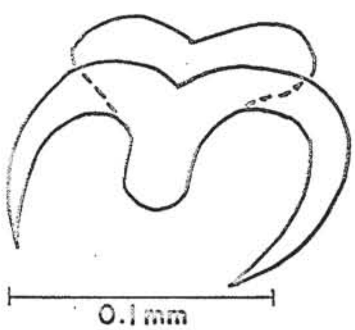


FIG. 3

FIG. 4

TABLE 1

Our measurements of the scolex hooks of *T. stizostedionis* (μ) compared to Miller's measurements

	Width of basal plate	Depth of basal plate (Ant-Post.)	Length of Marginal prong	Author
T. stizostedionis	150(123-198)	28(22-23)	68(48-77)	Miller, (61)
T. stizostedionis	148(117-182)	20(19-21)	56(42-70)	Present Paper

Discussion

Two species of Triaenophorus have been reported from Stizostedion vitreum in North America.

1. Triaenophorus nodulosus:

   Cooper (16) - Lake Michigan, U.S.A.

   VanCleave and Mueller (93) - Oneida Lake, New York, U.S.A.

   Bangham and Hunter (8) - Lake Erie - report Triaenophorus sp. not T. nodulosus as Lawler and Scott (46) have stated.

2. Triaenophorus stizostedionis:

   Miller (61) - Lesser Slave Lake, Alberta.

   Bangham, 1952 - Lake Erie (Lawler and Scott, (46) pers. comm.).

   Stewart-Hay (81) - Lake Dauphin, Manitoba.

   Stewart-Hay (86) - Lake Second Cranberry, Manitoba.

   Lawler (41) - Heming Lake, Manitoba.

   Rawson (73) - Great Slave Lake, N.W.T.

   Miller (61) - Lake Superior.

The author suggests that T. nodulosus reported by Van Cleave and Mueller (93), and T. nodulosus recorded from S. vitreum prior to 1945 are T. stizostedionis Miller, 1945. The views of the writer are based on the following facts:

1. Immature T. nodulosus in S. vitreum from Lake Michigan reported by Cooper (16), and similar parasites found in S. vitreum from Lake Superior are regarded by Miller (61) as T. stizostedionis.
2. Although T. nodulosus is known to occur in lakes harboring S. vitreum, e.g. Lesser Slave Lake, Great Slave Lake and Lake

Erie, it has not been reported in the pikeperch from these waters.

3. Records of T. nodulosus in pikeperch agree with our findings of T. stizostedionis in pikeperch; e.g. VanCleave and Mueller (93) report immature T. nodulosus in pikeperch from Oneida Lake. They state, "the only host in which it has been found in the Oneida Lake fauna is the pikeperch..... Thirteen immature T. nodulosus in the intestine of a single pikeperch is the heaviest infestation encountered."

   Specimens of T. stizostedionis from pikeperch in the Winnipeg River were immature and few in number (not more than four worms per fish).

4. All the records of T. nodulosus in pikeperch appeared before the description of T. stizostedionis by Miller in 1945.

Family Bothriocephalidae Blanchard, 1849

Genus Bothriocephalus Rudolphi, 1808

Bothriocephalus cuspidatus Cooper, 1917

Records from Manitoba:

Definitive Hosts: Stizostedion vitreum, Esox lucius, and Cristivomer namaycush---Lakes Wellman, Snow, Dauphin, Glad, Whitefish, Childs, Pickerel, Athapapuskow, and Mossy River - Little, (49). Stizostedion vitreum---Lake Wellman, Lake Dauphin - Stewart-Hay, (81) (82); Pickerel Lake - Stewart-Hay, (84); Lake Athapapuskow - Stewart-Hay, (87); Salvelinus (Cristivomer) namaycush---Childs Lake - Stewart-Hay, (83). The known distribution of this parasite in Manitoba is shown in Map 6, Table D.

Other Canadian Records:

Ontario:

Definitive Hosts: Stizostedion vitreum---Flat Rock Lake - Cooper, (16); Giants Tomb Id., Georgian Bay, Lake Huron - Cooper, (16); Lake Huron and Manitoulin Island - Bangham, (6); Stizostedion canadense---Lake Huron and Manitoulin Island - Bangham, (6).

Hudson Bay Drainage System:

Definitive Hosts: Stizostedion vitreum, Stizostedion canadense, Amphiodon alosoides, Hiodon tergisus, Esox lucius, Perca flavescens, and Leucichthys sp. - Wardle, (99).

Map 6 Known distribution of Bothriocephalus and Ligula in Manitoba.

Legend

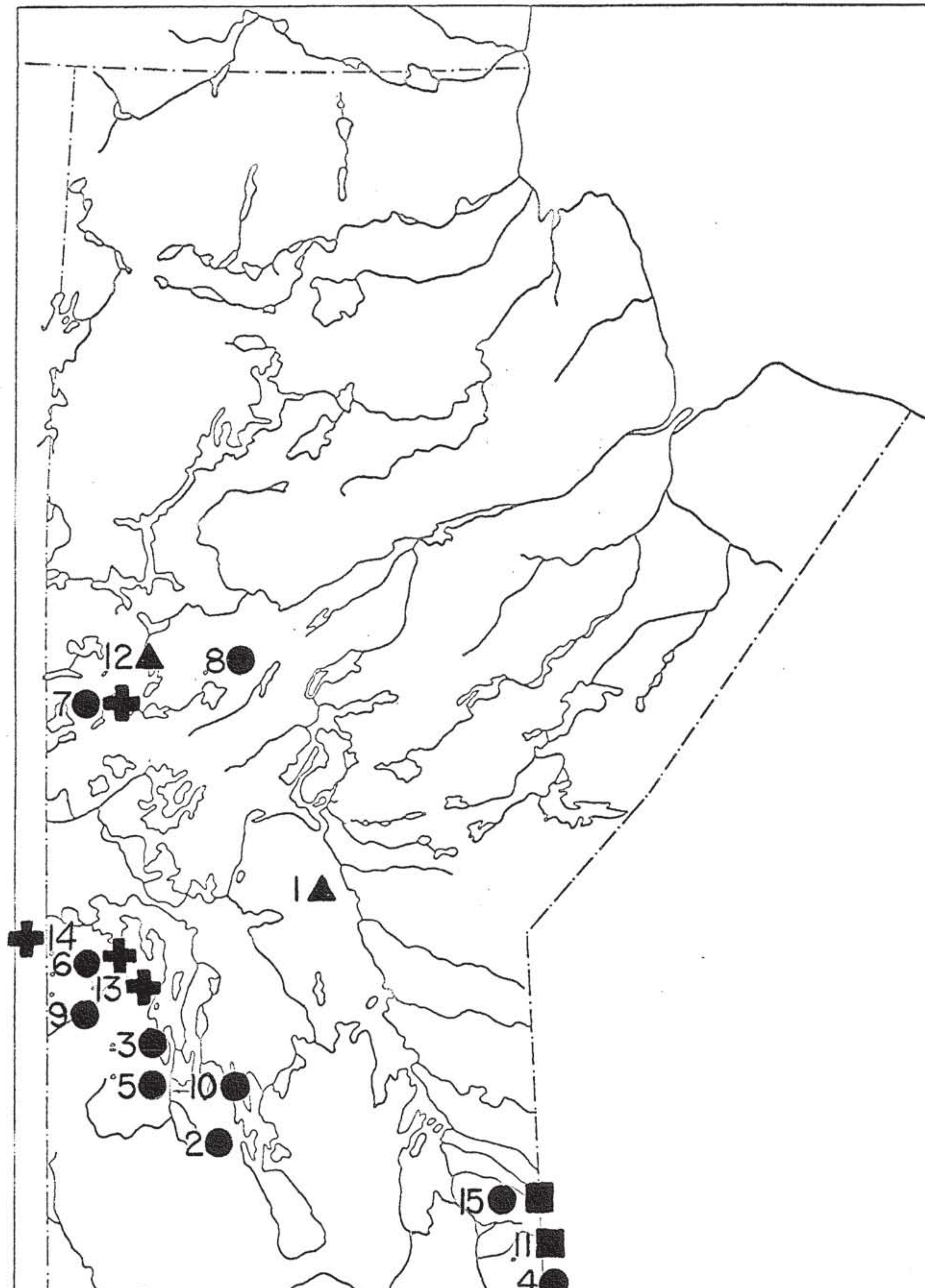
1. Lake Winnipeg
2. Lake Dauphin
3. Lake Wellman and Glad Lake
4. Lake Caddy
5. Lake Childs
6. Lake Pickerel
7. Lake Athapapuskow
8. Lake Snow
9. Whitefish Lake
10. Mossey River
11. Lake Burton
12. Lake Heming
13. South Steeprock Lake and North Steeprock Lake
14. Armit Lake
15. Winnipeg River
16. Hunt Lake

● Bothriocephalus cuspidatus

■ Bothriocephalus sp.

▲ Ligula intestinalus

✚ Ligula sp.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Quebec:

Definitive Host: Stizostedion vitreum---Baskatong Reservoir,, Gatineau River - Worley and Bangham (113).

Author's Findings

21 of 28 (75%) Stizostedion vitreum from the Winnipeg River were found to be infected with Bothriocephalus cuspidatus. Large numbers of adult B. cuspidatus (up to 40 per fish) were collected from the intestinal caeca and intestine of S. vitreum.

Measurements of Specimens

Specimens were medium sized, the longest measuring 140 mm. Wardle and McLeod (103) state that this species rarely exceeds 150 mm. in length. All the specimens conform to the description of B. cuspidatus Cooper, 1917. The measurements cited are based on the examination of 10 adult worms. Relaxed specimens exhibit the characteristic large scolex with long narrow bothria, and bluntly rounded apex (Fig. 5). Scoleces were 3.0 mm. long, 1.2 mm. wide at the middle, and 2.5 mm. posteriorly. The genital pore could easily be seen in the anterior third of the proglottis. Proglottids were usually wider than long (Fig. 6). Our measurements are similar to those reported by other authors Table 2. The testes, 50-60 in each proglottis, are large and spherical, averaging 65 μ in diameter. The ovaries appear as thin strips in the posterior portion of the segment. Gravid proglottids are shown in (Fig. 7).

TABLE 2

Comparison of my measurements of *Bothriocephalus cuspidatus* with those of other authors (in mm.)

Author	Longest specimens	Scolex width	Scolex length	Egg width	Egg length	Testes length	Testes number
Cooper (16)	180	1.0(mid.) 2.5(post.)	3.3	0.042-0.045	0.062-0.066	0.060	50-60
Wardle (99)	150	0.33	1.0		0.040-0.050	0.060-0.070	50
Little (49)	150	0.4	1.1	-	-	-	50
Present Paper	150	1.2(mid.) 2.5(post.)	3.0	-	0.042-0.051	0.065	50-60

PLATE II

Fig. 5 Scolex of *Bothriocephalus cuspidatus*. X46

Fig. 6 Immature proglottids of *B. cuspidatus*. X24

Fig. 7 Gravid proglottids of *B. cuspidatus*. X24

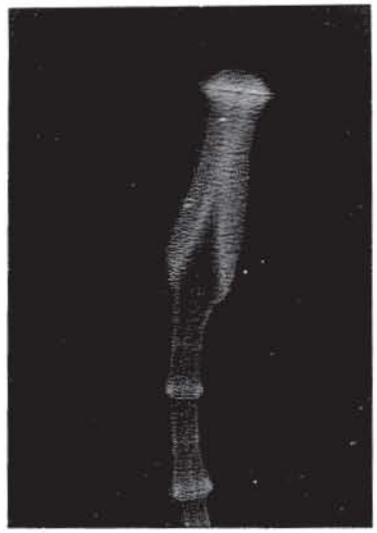


FIG. 5

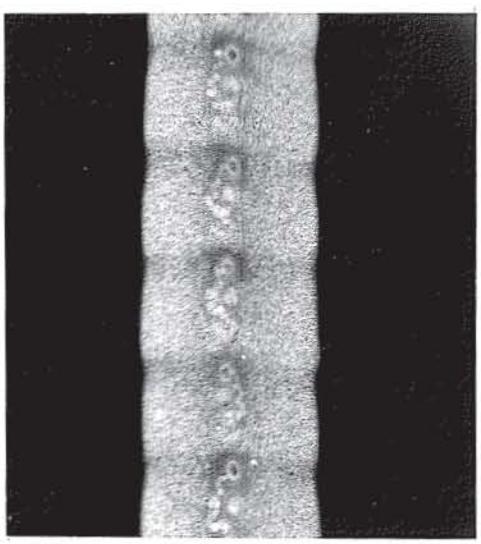


FIG. 6

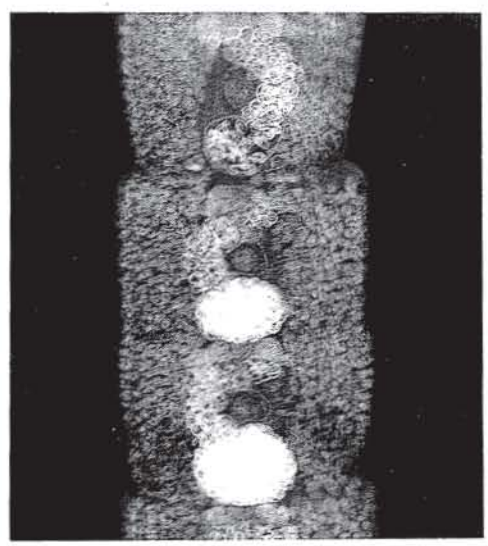


FIG. 7

Discussion

The most noticeable peculiarity of B. cuspidatus infestation in the pikeperch was the large numbers of worms present in the intestine and pyloric cascae. The intestine of the infected fish contained, on an average, 30-40 adult specimens. The pyloric caeca of some pikeperch appeared to be "plugged" with B. cuspidatus. Other investigators have reported large numbers of this parasite in S. vitreum, (Essex, (23), Van Cleave and Mueller, (93)). Essex suggests an explanation for this heavy intestinal load of B. cuspidatus in pikeperch, "An examination of the stomach contents of 20 S. vitreum showed large numbers of copepods regardless of the size of the fish... ....these copepods may have gained entrance by either of two ways: (1) by being strained out of the water and ingested directly by the fish; or (2) by being ingested by small fish which are known to feed largely on plankton, these small fish whose stomachs contain quantities of copepods, being in turn swallowed by larger fish. The digestion of the small fish would liberate the copepods in the stomach of the large fish. Copepods infected with the procercoids of B. cuspidatus would thus be transferred to the larger fish. This may explain why the adult S. vitreum which is primarily piscivorous, usually harbors a large number of B. cuspidatus."

There are no records of a second intermediate host for this parasite. Essex (23) states, "The structure of the procercoid and a study of the food of Stizostedion vitreum indicates that a second intermediate host is rather improbable."

Bothriocephalus sp.

An unidentified species of Bothriocephalus larva was collected from the intestine of yellow perch from the Winnipeg River. As these consisted of a scolex and a few proglottids no attempt has been made to classify the parasites to species.

Author's Findings

13 of 52 (26.9%) Perca flavescens from the Winnipeg River were infected with an unidentified species of Bothriocephalus. All specimens were immature. The worms were very small, consisting of a fully developed scolex and a few segments (Fig. 8A). Sometimes only a scolex was present. Twenty specimens measured were from 1.3 mm. to 3.5 mm. long. Eight worms was the heaviest infestation encountered.

Discussion

Unidentified species of Bothriocephalus have been reported in Perca flavescens from a number of localities. Cooper (16) reports larval specimens collected by Dr. A. S. Pearse from lakes in Wisconsin, U.S.A. Immature Bothriocephalus sp. were found in yellow perch from Burton Lake, Manitoba, by Stewart-Hay (85). Bangham (5) found immature specimens in P. flavescens from lakes in Algonquin Park, Ontario, and Bangham and Venard (9) record similar findings in this host for the same area. Bangham (6) collected immature Bothriocephalus sp. from P. flavescens in Lake Huron and Manitoulin Island waters, Ontario.

According to VanCleave and Mueller (93), unidentified Bothriocephalus spp. have been found in the digestive tract of a number of fish, none of which appear suitable as the final host.

They state, "Larval stages of Bothriocephalus, which seem to be passed in hosts unsuited to bring the worms to sexual maturity, have been found in a number of fish, as follows: Lepibema chrysops, Esox lucius, E. niger, Catostomus commersonni, Eupomotis gibbosus, Ambloplites rupestris and Leucosomus corporalis. These hosts seem to have no significance in the life cycle of the tapeworms, and since the determination of the species on the basis of the scolex alone is difficult, no attempt has been made to give specific identifications of these specimens......The larvae (scoleces with a few rudimentary proglottids) are found in the intestine of a large number of fishes, but they do not mature. Occasionally in the yellow perch these young worms make a slight approach toward sexual activity, but it is obvious that even in this closely related host conditions are unfavorable, for most of the worms remain undeveloped and even the largest individuals are not flourishing."

Wardle (99) and Wardle and McLeod (103) report Bothriocephalus cuspidatus from Perca flavescens, and point out that this parasite is relatively uncommon in this host.

PLATE III

Fig. 8 A-*Bothriocephalus* sp. larva. X45

B-*Proteocephalus* sp. larva. X36

C-*Proteocephalus* sp. larva. X44

Note the vestigial sucker

at the tip of the scolex.

A B C

FIG. 8

Family Proteocephalidae LaRue, 1914

Subfamily Proteocephalinae Mola, 1929

Genus Proteocephalus Weinland, 1858

Proteocephalus luciopercae Wardle, 1932

Records from Manitoba:

Definitive Hosts: Stizostedion vitreum---Lake Winnipeg - Wardle, (99), Little, (49); Lake Dauphin - Little, (49), Stewart-Hay,(81); Lake Pickerel - Stewart-Hay, (84); Lake Wellman - (subadults) Stewart-Hay, (82); Lake Second Cranberry - Stewart-Hay, (86); Heming Lake - Little, (49), Lawler and Watson, (47); Lake Athapapuskow - Stewart-Hay, (87). Stizostedion canadense---Lake Winnipeg - Wardle, (99), Little, (49); Lake Dauphin - Little, (49). Map 7 and Table E show the known distribution of Proteocephalus in Manitoba.

Other Canadian Records:

Saskatchewan:

Definitive Hosts: Stizostedion vitreum---Lake Waskesiu - Little, (49), Wardle, (99). Stizostedion canadense---Lake Waskesiu - Little, (49), Wardle, (99).

Quebec:

Definitive Hosts: Stizostedion vitreum---Baskatong Reservoir, Gatineau River - Worley and Bangham, (113). Esox lucius---Lac Petite Jaune, Ruis Côte Jaune, Baskatong Reservoir, Gatineau River - Worley and Bangham, (113).

Map 7 Known distribution of Proteocephalus in Manitoba

Legend

1. Lake Winnipeg
2. Lake Manitoba
3. Lake Winnipegosis
4. Lake Dauphin
5. North Steeprock Lake, South Steeprock Lake and Bell Lake
6. Lake Burton
7. Lake Athapapuskow
8. Lake Heming
9. Lake Armit
10. Lake Wellman
11. Lake Pickerel
12. Lake Second Cranberry
13. Lake South Indian
14. Lake Caddy
15. Lake Groschak
16. Snow Lake
17. Winnipeg River

● Proteocephalus luciopercae

▲ Proteocephalus pinguis

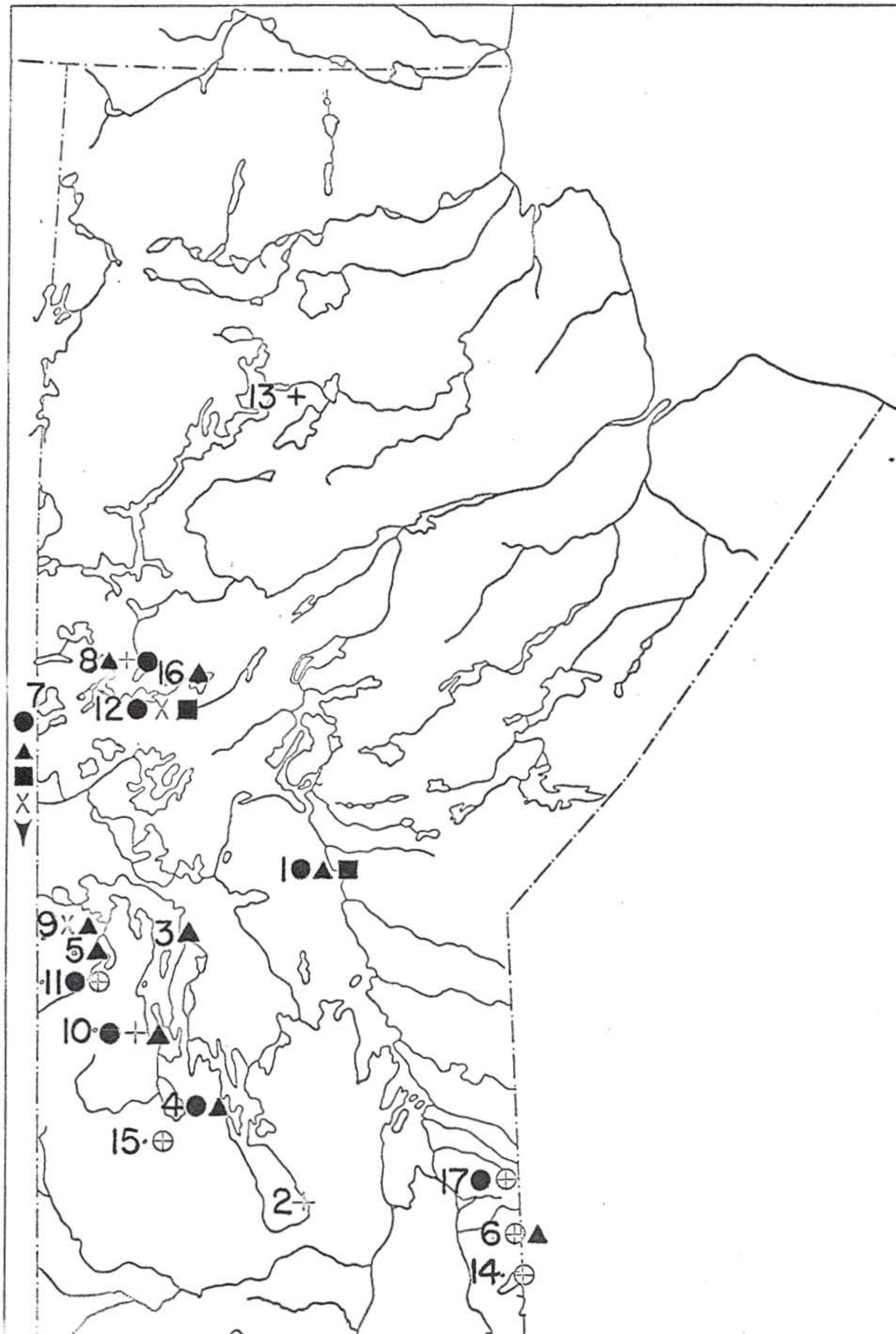
■ Proteocephalus laruei

+ Proteocephalus singularis

X Proteocephalus coregoni

Y Proteocephalus pusillus

⊕ Proteocephalus sp.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Ontario:

Definitive Host: Stizostedion vitreum---Lake Huron and Manitoulin Island - Bangham, (6).

Author's Findings:

12 of 28 (42.8%) Stizostedion vitreum from the Winnipeg River were infected with Proteocephalus luciopercae. Most were mature, medium sized specimens. They were located in the intestine and pyloric caecae. 10-20 worms were usually present in one fish. 27 P. luciopercae from an individual host was the heaviest infestation encountered.

Measurements of Specimens

The largest specimen was 175 mm. long. Wardle (99) and Little (49) report specimens 250 mm. long. Most of the worms were 100-150 mm. long. The scoleces were small and subrectangular. Our measurements of the relaxed scoleces are close to those reported by Wardle (99), see Table 3. Segments of mature individuals are normally wider than long, the gravid proglottids being nearly square. Measurements of my material (based on a total of 10 specimens) are compared to other findings, Table 3.

Species Identification

The genital pore is situated in the lateral anterior half of the proglottis and opens irregularly to the left and right in adjacent proglottids. The testes, 80-100 per segment, average 50 mm. in diameter. The vas deferens is coiled and straightens only before entering the cirrus pouch. Ovaries are bilobed, oval and situated

TABLE 3

Comparison of my measurements of *Proteocephalus luciopercae* with those of other authors (in mm.)

Author	Length of specimens	Proglottid width	Proglottid length	Scolex width	Scolex length	Diameter of acetabula	Testes number	Testes diameter
Wardle (99)	250	2.0	0.6	0.1	0.165	0.065	80-100	0.050
Hunter & Bangham (36)	102-186	1.7-3.5 1.2-4.1	0.19-0.47(mature) 0.51-1.2 (gravid)	0.28	0.13	0.06-0.12	90-125	0.032-0.061
Little (49)	250	1.5-2.0	0.5-0.6	-	-	-	80-100	-
Present Paper	175	1.3-2.9	0.5-0.8	0.1-0.34	0.12-2.4	0.090	80-90	0.040-0.050

at the posterior end of the proglottis. The uterus is typically four lobed, (Fig.10). The apex of the scolex of P. luciopercae, prolonged as a conical pseudo-rostellum, is an outstanding characteristic of this species, (Fig. 9).

Discussion

Prior to 1932 no proteocephalid had been reported from Stizostedion vitreum. A new species, Proteocephalus luciopercae, was described by Wardle, (99) from Stizostedion vitreum and Stizostedion canadense in Lake Winnipeg, Manitoba, and Lake Waskesiu, Saskatchewan. Hunter and Bangham (36) describe a new species P. stizostethi from S. vitreum in Lake Erie. Little (49) in an unpublished M.Sc. thesis suggests that P. luciopercae and P. stizostethi are synonymous, the last name being the junior synonym. Little (49) states, "Pickerel intestines examined yielded proteocephalan forms that fitted both the description of Wardle's luciopercae and Hunter and Bangham's stizostethi. As some of the original material used by Wardle in his description was available, a re-examination of this material was undertaken in conjunction with the material which had been freshly mounted. It was apparent after this examination that variations that existed between stizostethi and luciopercae could be traced to maturity or individual variation caused principally by the killing and fixing technique." The writer agrees with Little, and consequently, all reports of P. stizostethi from Canada are regarded as records of P. luciopercae.

PLATE IV

Fig. 9 Scolex of Proteocephalus luciopercae. X123

Fig. 10 Camera lucida drawing of P. luciopercae proglottid. X47

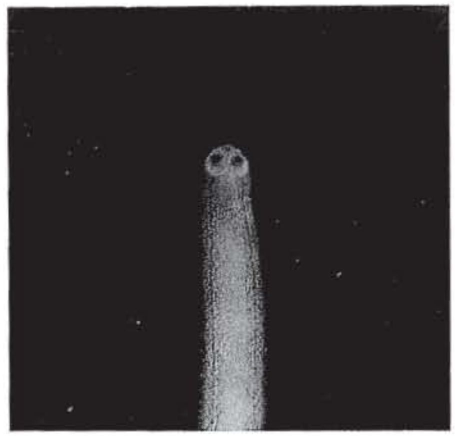
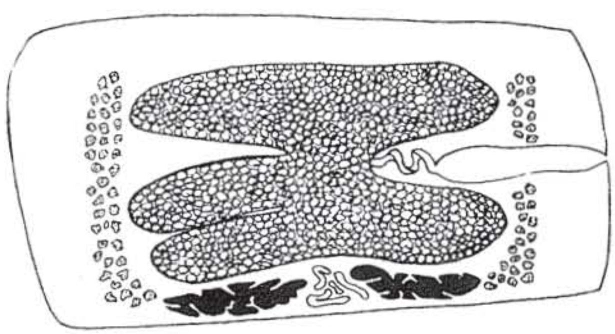


FIG. 9



FIG, 10

Proteocephalus sp.

The writer found two unidentified species of *Proteocephalus* in *Perca flavescens* from the Winnipeg River. These were small immature larval forms which could not be positively identified.

Author's Findings

19 of 52 (36.5%) *Perca flavescens* from the Winnipeg River were infected with immature *Proteocephalus* spp. Two species of *Proteocephalus* larvae could be distinguished by the presence or absence of a fifth vestigial sucker. Most of the larval forms found in the intestine lacked the vestigial sucker at the tip of the scolex (Fig. 8, B). A few smaller larvae, however, possessed a distinct vestigial sucker (Fig. 8, C). The larval *Proteocephalus* lacking the fifth sucker measured 1.1-2.3 mm. in length, whereas the smaller forms with the apical sucker measured only 0.5-0.9 mm.

Discussion

Most of the larval *Proteocephalus* collected from the yellow perch consisted of a scolex only. Some of the larger specimens, however, did exhibit some proglottis formation. It is impossible to identify specimens of this size, and only the probable generic diagnosis is given. VanCleave and Mueller (93) found larval *Proteocephalus* in fish from Oneida Lake, N.Y. They state, "young post-larval *Proteocephalus* are frequently encountered in the intestines of fishes. Most of the larvae are encountered in fish hosts evidently incapable of bringing them to maturity. All fish feeding upon copepods must occasionally take in these larvae, and the infestation becomes significant only when the combination of host and larvae happens to be biologically appropriate."

The distribution of other cestodes reported from fish in Manitoba is shown in Map 8 and Table F.

Map 8 Known distribution of other Cestoda in Manitoba fishes.

Legend

1. Lake Winnipeg
2. Lake Dauphin
3. Lake Athapapuskow
4. Lake Heming
5. Lake Armit
6. Lake Whitefish

● *Glaridacris catostomi*

■ *Glaridacris sp.*

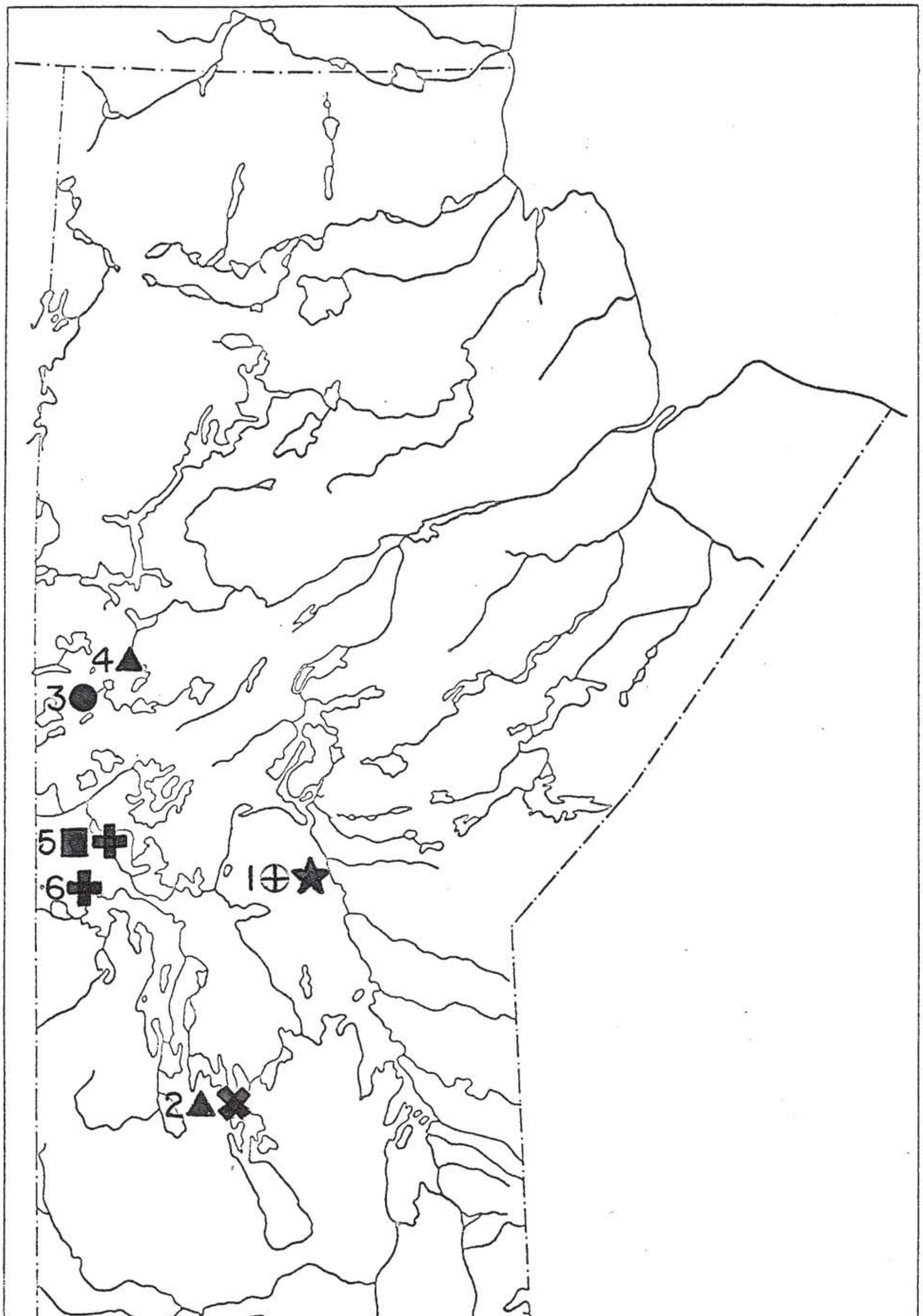
▲ *Schistocephalus solidus*

✚ *Schistocephalus* sp.

⊕ *Cyathocephalus truncatus*

★ *Corallobothrium fimbriatum*

✖ *Sparttoides wardi*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Notes on Trematodes

Family Cryptogonimidae Ciurea, 1933

Subfamily Cryptogoniminae Ward, 1917

Genus *Centrovarium* Stafford, 1904

Centrovarium lobotes, (MacCallum, 1895) Stafford, 1904

Records from Manitoba:

Definitive Host: *Stizostedion vitreum*---Lake Dauphin - Stewart-Hay, (81). The distribution of fish trematodes in Manitoba is shown in Map 9 and Table G.

Other Canadian Records:

Ontario:

Definitive Hosts: *Ambloplites rupestris*---Go-Home Bay, Lake Huron - Cooper, (15); Ward and Whipple, (98). *Ameiurus nebulosus*---South Bay, Lake Huron - Bangham, (6). *Stizostedion canadense*---South Bay, Lake Huron - Bangham, (6). *Stizostedion vitreum*---Ward and Whipple, (98); Lake Erie and Grand River - MacCallum, (52). *Anguilla chrysopa*---Ward and Whipple, (98); Lake Erie and Grand River - MacCallum, (52). *Esox lucius*---Ward and Whipple, (98). *Perca flavescens*---Lake Erie and Grand River - MacCallum, (52).

Second Intermediate Hosts: *Notropis volucellus*---South Bay, Lake Huron and Mindemoya Lake - Bangham, (6). *Hyborhynchus notatus*---Mindemoya Lake, Lily Lake, and South Bay, Lake Huron - Bangham, (6).

Map 9 Known distribution of *Trematoda* in Manitoba fishes

Legend

1. Lake Burton
2. Lake Wellman
3. Lake Cormorant
4. Lake Dauphin
5. Lake Winnipeg
6. Lake Manitoba
7. Lake Caribou
8. Lake Wallace
9. Shoal Lake
10. Winnipeg River

● *Metorchis conjunctus* (metacercaria)

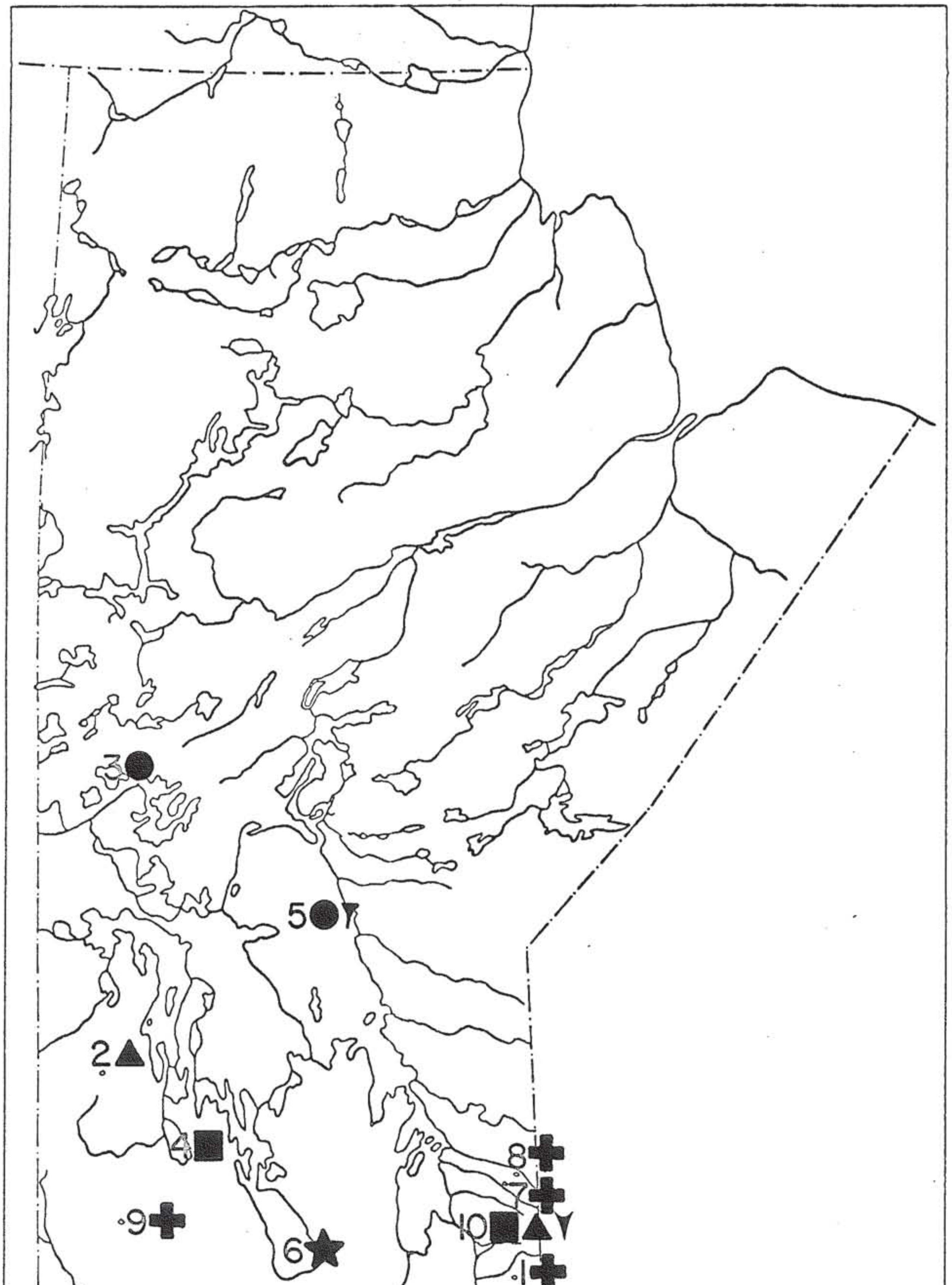
■ *Centrovarium lobotes*

▲ *Crepidostomum cooperi*

✚ *Clinostomum marginatum* (metacercaria)

★ *Amphimerus pseudofelineus* (metacercaria)

Y *Bucephaloides pusilla*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Quebec:

Definitive Hosts: Esox lucius---St. Lawrence watershed - Lyster, (50); Montreal fish markets - Stafford, (80). Ambloplites rupestris---St. Lawrence watershed - Lyster, (50). Stizostedion vitreum---St. Lawrence watershed - Lyster, (50); Montreal fish markets - Stafford, (80). Ameiurus nebulosus---St. Lawrence watershed-Lyster, (50).

Author's Findings

2 of 28 (7.1%) Stizostedion vitreum from the Winnipeg River were infected with Centrovarium lobotes. One specimen was found in each fish. The worms are of moderate size, white to light brown, and very fragile. They show little activity when removed from the gut of the host.

Measurements of Specimens

Only one of the worms was fixed in a relaxed condition (Fig.12). This specimen is 1.9 mm. long and 0.724 mm. wide at its maximum width. The terminal sucker is spherical, 0.184 mm. in diameter. There is a short pre-pharynx, a small pharynx, and an esophagus about the same length as the pharynx (0.920 mm.). The acetabulum is almost the same size as the terminal sucker and measures 0.195 mm. It is situated about one-third the body length from the anterior end. The uteri of both specimens contained large numbers of light brown eggs which averaged 0.030 mm. wide and 0.062 mm.long.

PLATE V

Fig. 11 Camera lucida drawing of *Centrovarium lobotes*. X32

Fig. 12 Gravid *Centrovarium lobotes*. X32

FIG. 11

FIG. 12

The rosette-shaped ovary is situated in the middle of the body. The two testes are arranged one on either side of the body posterior to the ovary. Our measurements are compared to measurements of other authors in Table 4.

Species Identification

Centrovarium lobotes is the sole species of this genus. Stafford (80) established the genus Centrovarium with type C. lobotes (Distomum lobotes MacCallum, 1895). This parasite is distinguished from other Cryptogoniminae by the short ceca, the possession of a non-bipartite acetabulum, and the position of the vitellaria in dorso-lateral fields between the bifurcation of the intestine and anterior to the testes (Fig.11).

Discussion

This report constitutes the second record of C. lobotes in Manitoba. Stewart-Hay (81) has reported 7 specimens of C. lobotes from 4 Stizostedion vitreum in Lake Dauphin.

This parasite is apparently restricted to North American freshwater fishes. It has been reported by Bangham and Hunter (8) in Percopsis omiscomaycus, Stizostedion canadense griseum, Stizostedion vitreum, Stizostedion glaucum, Micropterus dolomieu, and Esox vermiculatus from Lake Erie. Hunter (35) found metacercariae of C. lobotes encysted in the body cavity, flesh, between the myotomes, and in the eye sockets of Hyborhynchus notatus and Notropis cornutus from Sucker Brook, near Waddington, New York, U.S.A. Hunter (35) and Hunter and Hunter (37) have experimentally infected Micropterus dolomieu

TABLE 4

Comparison of my measurements of Centrovarium lobotes with those of other authors (all measurements in mm.)

Author	Number of Specimens	Length	Width	Diameter of Terminal Sucker	Diameter of Acetabulum	Pharynx length	Egg measurements
MacCallum (52)	-	1-3	-	-	-	-	-
Stafford (80)	4	1.6-2.3	-	-	-	-	0.03 x 0.13
Cooper (15)	-	2.35	0.71	0.154	0.187	0.102	-
VanCleave & Mueller(93)	11	2.0	-	-	-	-	0.015 x 0.032 0.008 x 0.017
Present Paper	2	1.9	0.724	0.184	0.195	0.920	0.030 x 0.062

with C. lobotes metacercariae. They have recorded C. lobotes metacercariae in Percopsis omiscomaycus from Lake Erie and Lake Champlain watersheds, Hyborhynchus notatus from Lake Champlain and St. Lawrence watersheds, Notropis deliciosus stramineus and N. bifrenatus from Lake Champlain, and N. cornutus frontalis and N. heterolepis from the St. Lawrence River and its watersheds. VanCleave and Mueller (93) have found metacercariae of C. lobotes in Percopsis omiscomaycus and young or mature worms in Perca flavescens, Stizostedion vitreum, Micropterus dolomieu, and Ameiurus natalis from Oneida Lake, New York.

The distribution of Centrovarium lobotes in Manitoba fishes is shown in Map 9.

Family Bucephalidae Poche, 1907

Subfamily Prosorhynchinae Nicoll, 1914

Genus Bucephaloides Hopkins, 1954

Synonyms: Bucephalopsis Diesing, 1855

Prosorhynchoides Dolfus, 1929

Bucephaloides pusilla (Stafford, 1904) Hopkins, 1954

Synonyms: Gasterostomum pusillum Stafford, 1904

Bucephalus pusilla Woodhead, 1930

Bucephalopsis pusilla VanCleave and Mueller, 1934

Bucephalopsis arcuatus (Linton, 1900) Nagaty, 1937

Bucephalopsis pusilla Lyster, 1939

Bucephalus pusillus Bangham and Hunter, 1939

Records from Manitoba:

Definitive Host: Stizostedion vitreum---Lake Winnipeg - Woodhead, (112).

Other Canadian Records:

Quebec:

Definitive Host: Stizostedion vitreum---St. Lawrence watershed - Lyster, (50), Montreal fish markets - Stafford, (80).

Ontario:

Definitive Host: Stizostedion vitreum---Mindemoya Lake, Windfall Lake, South Bay, Lake Huron - Bangham, (6).

Author's Findings

20 of 28 (71.4%) Stizostedion vitreum from the Winnipeg River were infected with Bucephaloides pusilla. The worms were found in the

ceca and intestine, a single host sometimes harbouring over 100 of these parasites. The worms were very active upon removal from the host, the cephalic sucker frequently extended forward. The living worms were nearly opaque, appearing snowy-white against a dark background. Many specimens contained eggs (Fig.13).

Measurements of Specimens

40 specimens were studied. Measurements of 20 preserved and 20 stained and mounted worms comprised the basis for the identification of this species. Our measurements of preserved specimens are slightly larger than the measurements by VanCleave and Mueller (93), and Woodhead, (112). Preserved specimens averaged 0.862 mm. long by 0.188 mm. wide. These measurements are close to those of Lyster (50). Measurements of the mounted material, however, coincided with those reported by VanCleave and Mueller, and Woodhead. Twenty mounted B. pusilla averaged 0.590 mm. long and 0.123 mm. wide. Preserved worms were longer and wider than mounted ones, Table 5. The shrinking was obviously caused by the dehydration and clearing of these fragile trematodes.

The morphology of the specimens is typical of B. pusilla, (Fig.14). Measurements of our specimens conform to the measurements of other authors, Table 6. Relaxed worms are cylindrical with the cephalic sucker directed forward and averaging 0.092 mm. in both diameters. The ventral sucker (extended in some specimens and retracted in others) is smaller measuring 0.039 x 0.042 mm. The gut is about 0.14 mm. long, small, oval, and dorsal to the pharynx which is 0.038 mm. in diameter and situated in the middle of the body.

TABLE 5

Comparison of measurements (in mm.) of mounted and unmounted specimens of *Bucephaloides pusilla* from *Stizostedion vitreum*

	Length	Width
Preserved specimens	0.862(0.636-1.080)	0.188(0.155-0.252)
Mounted Specimens	0.590(0.468-0.732)	0.123(0.072-0.192)

PLATE VI

Fig. 13 Gravid specimen of Bucephaloides pusilla. X67

Fig. 14 Camera lucida drawing of B. pusilla. X134

FIG. 13

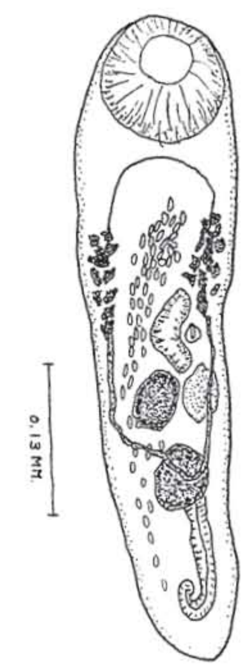


FIG. 14

The two testes are situated one in front of the other in the posterior part of the body and average 0.057 mm. in diameter. The single ovary measures 0.046 mm. in diameter and is situated between the gut and the anterior testis. The eggs are small, oval, and numerous, and average 0.02 x 0.03 mm. Bead-like vitellaria are found anterior and lateral to the intestine.

The distribution of B. pusilla in Manitoba is shown in Map 9.

Discussion

Bucephaloides pusilla was first reported by Woodhead (112) from Stizostedion vitreum in Lake Winnipeg, Manitoba. Our specimens are slightly larger than those of Woodhead, Table 6. Only one worm of 115 examined by Woodhead contained eggs, whereas, 32 of 40 B. pusilla examined by the writer were gravid. The higher percentage of gravid worms in my material depends probably on the season; my material was collected in summer, June to August, whereas that of Woodhead was collected in March.

TABLE 6

Comparison of my measurements (in mm.) of Bucephaloides pusilla with those of other authors

Author	Number of specimens	Length	Width	Diameter of cephalic sucker	Diameter of acetabulum	Gut length	Diameter of pharynx	Diameter of testes	Diameter of ovary	Egg measurements
Stafford (80)	-	0.77 1.23(living worm)	0.35	0.154	-	-	-	-	-	0.035 x 0.025
Woodhead (112)	115	0.549	0.122	-	-	0.106	0.032	0.060	0.042	0.031 x 0.020
VanCleave & Mueller (93)	-	0.67	0.15							
Lyster (50)	-	0.8	0.25	0.112	0.040 x 0.048	0.22	-	-	-	-
Present Paper	40	0.590-0.862	0.188-0.123	0.092	0.039 x 0.042	0.14	0.038	0.057	0.046	0.02 x 0.03

Family Allocreadiidae Stossich, 1903

Subfamily Crepidostominae Yamaguti, 1958

Genus Crepidostomum Braun, 1900

Synonyms: Acrodactyla Stafford, 1904;

Stephanophiala Nicoll, 1909;

Acrolichanus Ward, 1917.

Crepidostomum cooperi Hopkins, 1931

Synonyms: Crepidostomum amblоplites Hopkins, 1931

Crepidostomum solidum VanCleave and Mueller, 1932

Crepidostomum fausti Hunninen and Hunter, 1933

Crepidostomum laureatum (Stafford, 1904) Miller, 1941

Records from Manitoba:

Definitive Host: Perca flavescens---Lake Wellman - Stewart-Hay, (82).

Other Canadian Records:

Ontario:

Definitive Hosts: Perca flavescens---Algonquin Park lakes - Bangham, (5), Bangham and Venard, (9); Lake Huron and Manitoulin Island - Bangham, (6), Go-Home Bay (Cooper, 1915) Hopkins (33). Prosopium quadrilaterale---Algonquin Park lakes - Bangham, (5), Lepomis gibbosus---Algonquin Park lakes - Bangham, (5), Bangham and Venard, (9); Lake Huron and Manitoulin Island - Bangham, (6). Coregonus clupeaformis---Algonquin Park lakes - Bangham, (5). Micropterus dolomieu---Lake Huron and

Manitoulin Island - Bangham, (6). Ambloplites rupestris---Lake Huron and Manitoulin Island - Bangham, (6).

Quebec:

Definitive Hosts: Salvelinus fontinalis---Laurentide Park lakes - Choquette, (11); Lake Commandant - Lyster, (51); Montreal fish markets - Stafford, (80); Appalachian lakes - Richardson, (76); Fourth Lake, Ross Lake, Lake Memphremagog, Lac des Sables, Grand Lac Long, private waters entering Grand Lac Long-Fantham and Porter, (27). Perca flavescens---Central St. Lawrence watershed - Lyster, (50); Lac des Sables - Fantham and Porter, (27). Micropterus dolomieu---Central St. Lawrence watershed - Lyster, (50). Catostomus commersoni---Fourth Lake, Ross Lake, Grand Lac Long - Fantham and Porter, (27).

Nova Scotia:

Definitive Hosts: Salvelinus fontinalis---Richardson, (76). Fundulus heteroclitus---freshwater streams near Halifax - Fantham and Porter, (27). Cyprinus carpio---streams near Halifax - Fantham and Porter, (27).

New Brunswick:

Definitive Host: Salvelinus fontinalis---Richardson, (76).

Prince Edward Island:

Definitive Host: Salvelinus fontinalis---Richardson, (76).

Labrador coast:

Definitive Host: Salvelinus fontinalis---Richardson, (76).

Author's Findings

Crepidostomum cooperi was the most abundant parasite of yellow perch in the Winnipeg River. 39 of 52 (75%) yellow perch were infected. It was not uncommon to find 40 to 50 specimens in the digestive tract of one fish. Specimens from different hosts, and even from the same host, exhibited marked variation in gross anatomy. Some of the worms were nearly square, others appeared rectangular. Many of our specimens are basically rectangular but taper to a point at the posterior end (Fig.15). 50 stained and mounted specimens constitute the material for study.

Measurements of Specimens

These worms are small, the largest 1.3 mm., most - 0.5 - 0.6 mm. long. The width varies with body shape, being greatest usually in the region of the ovary. The oral sucker averages 0.2 to 0.4 mm. in diameter; and is surrounded by six papillae which vary in length and shape. The lateral papillae are slightly longer than the median ones, blunt, short, slightly recurved, 0.025 to 0.065 mm. long. They vary in size and shape to such an extent that they cannot be used as a criterion for species identification as suggested by VanCleave and Mueller (93). A long pre-pharynx extends from the oral sucker to an oval pharynx which averages 0.06 mm. in diameter. A pair of conspicuous eye spots could be seen in some of the specimens just posterior to the pharynx. The esophagus is very short and is followed by the

PLATE VII

Fig. 15 Common body shape of Crepidostomum cooperi. X65

Fig. 16 Position of the genital pore in C. cooperi. X69

Fig. 17 Camera lucida drawing of C. cooperi to show arrangement of the internal organs. X95

Fig. 18 Variation in the size and shape of papillae of C. cooperi. X90

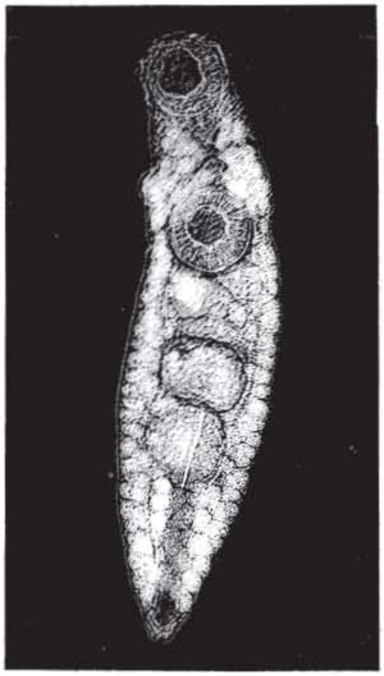


FIG. 15

FIG. 16

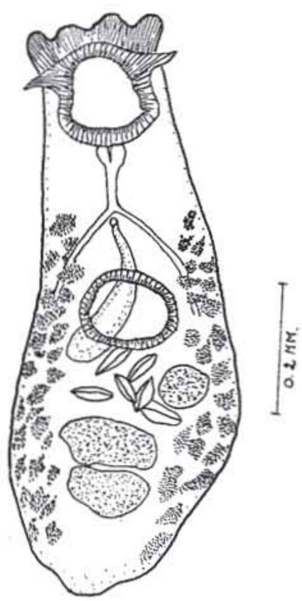


FIG. 17

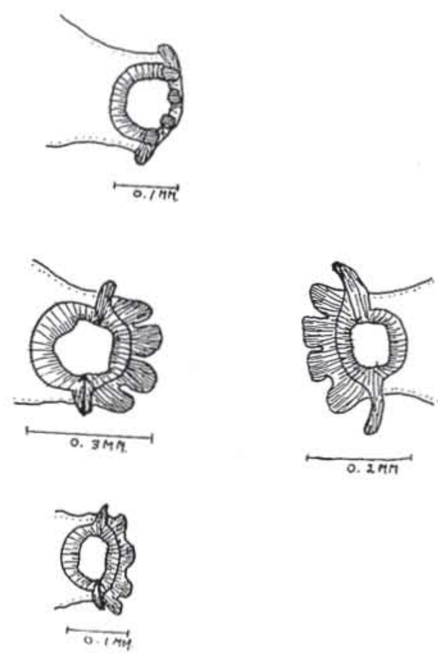


FIG. 18

intestinal ceca which extend to the posterior end of the body. The acetabulum is situated in the second quarter of the body and measures from 0.018 to 0.045 mm. in diameter.

The position of the genital pore is an important diagnostic feature of this species. Crepidostomum cooperi differs from C. isostomum, C. farionis, and C. vitellobum in that the latter species have the genital pore anterior to the bifurcation of the intestine, while in C. cooperi it is posterior. Fig.16 shows the median genital pore immediately anterior to the acetabulum and posterior to the bifurcation of the intestine.

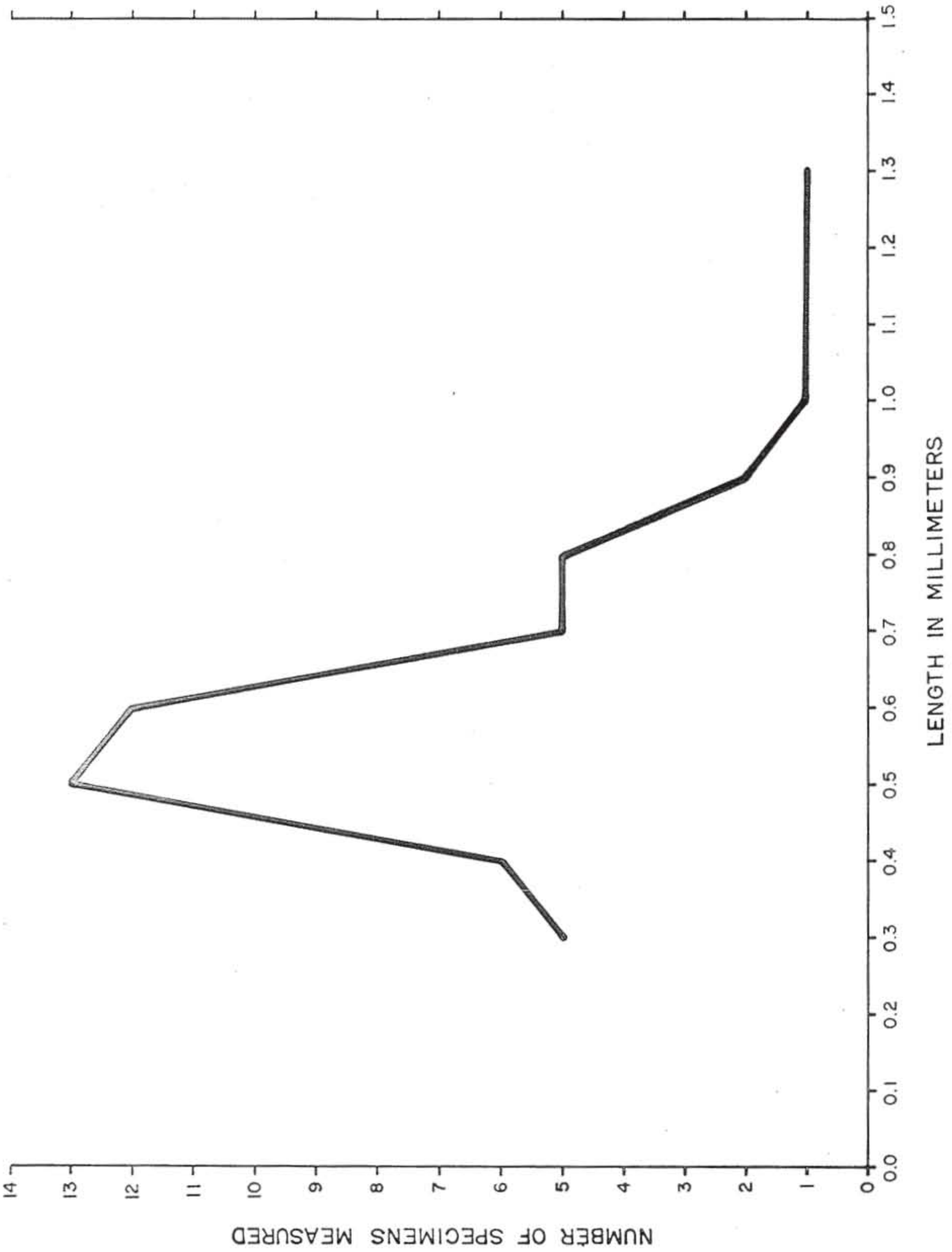
The reproductive organs are highly variable in size, shape, and position, depending on the body shape. They consist of two large spherical testes, tandem in position, and a single ovary situated anterior to the testes and slightly to the right of the acetabulum. The lateral body margin from the esophagus to the posterior end of the body are densely packed with vitellaria, (Fig.15). Some specimens contained eggs 0.035 to 0.070 mm. long by 0.042 to 0.052 mm. wide. Measurements of my material are compared to those of other authors in Table 7.

Discussion

Identification of species of Crepidostomum is difficult due to considerable individual variation. Thus the arrangement of internal organs of C. cooperi (Fig.17), even from the same host, varies greatly. To identify this species, 50 specimens were examined and measured. The most common body shape of the specimens from my material is shown in (Fig.15). Figure 18 illustrates the variations in the form of the oral papillae. The length of the oral papillae, particularly of the lateral ones, varies greatly. The variation of body length of 50 stained and mounted specimens is shown in(Fig. 19)

This is the second record of this species from Manitoba. Stewart-Hay (82) reported finding C. cooperi in Perca flavescens from Wellman Lake. He says, "Two perch examined had no intestinal tapeworms; one, however, had 30 immature flukes 0.2 to 0.6 mm. long. As far as could be determined, they were Crepidostomum, probably C. cooperi."

Fig. 19 Variation in body length of *Crepidostomum cooperi* based on 50 specimens.



LENGTH IN MILLIMETERS
NUMBER OF SPECIMENS MEASURED
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

FIG. 19

TABLE 7

Comparison of my measurements (in mm.) of *Crepidostomum cooperi* with measurements of other authors

Author	Number of specimens	Body Length	Diameter of oral sucker	Diameter of acetabulum	Diameter of pharynx	Diameter of testes	Diameter of ovary	Egg measurements
Hopkins (33)	10	0.39-0.86	0.15	0.16	0.050-0.060	0.13 0.15	-	0.050-0.060X 0.030-0.040
Hunninen & Hunter (34)	43	0.44-1.3	0.06-0.17X 0.1 -0.23	0.09-0.21X 0.12-0.23	0.040 x 0.080	0.05-0.26X 0.13-0.29 0.056-0.25X 0.12 -0.29	0.077X 0.122	0.055-0.072X 0.030-0.035
Lyster (51)	50	0.70-1.49	0.11-0.21X 0.14-0.25	0.14-0.28X 0.17-0.35	0.08 x 0.15	0.08-0.17X 0.15-0.18	0.7 X 0.14	0.056 X 0.084
Miller (57)	4	1.5 X 3.1	0.2 X 0.38	0.13 X 0.35	0.14 X 0.26	-	-	0.070-0.078X 0.042
Present Paper	50	0.3-1.3	0.2-0.4	0.018-0.045	0.06	-	-	0.035-0.070X 0.030-0.035

NOTES ON NEMATODES

Family Rhabdochonidae Skrjabin, 1946

Subfamily Rhabdochoninae Travassos, Artigas et Pereira, 1928

Genus Rhabdochona Railliet, 1916

Synonyms: Ichthyospirura, Skrjabin, 1917;

Pseudancyracanthus Skrjabin, 1923;

Pseudorhabdochona Liu et Wu, 1941.

Rhabdochona cascadilla Wigdor, 1918

Synonyms: Rhabdochona laurentiana (Lyster, 1940) Choquette, 1951.

Canadian Records:

British Columbia:

Definitive Hosts: Oncorhynchus nerka, Oncorhynchus nerka kennerlyi, Salmo clarki, Salmo gairdneri kamloops, Catostomus catostomus, Catostomus macrocheilus, Cyprinus carpio, Mylocheilus caurinus, Acrocheilus alutaceus, Couesius plumbeus greeni, Rhinichthys cataractae, Ptychocheilus oregonensis, and Richardsonius balteatus---Columbia and Fraser River drainages, and localities in the Skeena, Peace, Liard, and Skagit drainages - Bangham and Adams, (7).

Ontario:

Definitive Hosts: Semotilus atromaculatus---Algonquin Park lakes - Bangham, (5), Bangham and Venard, (9); Lake Huron and Manitoulin Island lakes - Bangham, (6).

Margariscus margarita nachtriebi---Algonquin Park lakes - Bangham, (5), Bangham and Venard, (9). Notropis cornutus---Algonquin Park lakes - Bangham, (5), Bangham and Venard, (9); Lake Huron and Manitoulin Island lakes - Bangham, (6). Chrosomus eos---Algonquin Park lakes - Bangham and Venard, (9). Leucosomas corporalis---Algonquin Park lakes - Bangham and Venard, (9). Hyborhynchus notatus---Algonquin Park lakes - Bangham and Venard, (9); Lake Huron and Manitoulin Island lakes - Bangham, (6). Micropterus domomieu---Algonquin Park lakes - Bangham and Venard, (9). Boleosoma n. nigrum---Lake Huron and Manitoulin Island lakes - Bangham, (6). Poecilichthys exilis---Lake Huron and Manitoulin Island lakes - Bangham, (6). Notropis h. hudsonius---Lake Huron and Manitoulin Island lakes - Bangham, (6).

Quebec:

Definitive Hosts: Catostomus commersonni---Lake Commandant - (Lyster, 1940) Choquette, (13). Salvelinus fontinalis---Laurentide Park lakes - Choquette, (11), (13). Catostomus catostomus, Semotilus a. atromaculatus, Margariscus margarita nachtriebi---locality not reported - Choquette, (13).

Author's Findings

Rhabdochona cascadilla was the most abundant species of nematode collected from Perca flavescens and Stizostedion vitreum in the Winnipeg River. 19 of 52 (36.5%) Perca flavescens and 2 of 28 (7.1%) S. vitreum were infected. It was not uncommon to find a yellow perch infected with 20 to 30 worms. One contained 42 adult R. cascadilla. The S. vitreum were only lightly infected; one contained 4, another - 7 specimens of this nematode. They were located in the intestine of the host. All the specimens were mature, many of the females contained eggs. Females were more abundant than males.

Measurements of Specimens

These nematodes are small and slender with a thin, smooth, unstriated cuticle. The following measurements are based on the examination of 5 females and 5 males. Males ranged from 3.62 to 5.50 mm. in length and had a maximum width of from 0.086 to 0.098 mm. Females are much larger, from 4.75 to 13.20 mm. long and average 0.135 mm. wide. The mouth is funnel-shaped and bears 14 anteriorly protruding teeth (Fig.20). The esophagus consists of an anterior muscular portion and a glandular, much longer, posterior portion. The total length of the esophagus was 1.109 to 3.127 mm. in the females and 0.997 to 1.301 mm. in the males. The nerve ring is 0.13 to 0.15 mm. from the anterior end in females and 0.12 - 0.14 mm. in males. The excretory pore is situated approximately 0.232 mm. from the anterior end of females and 0.197 mm. in males.

The tail of males is conical, subacute and recurved and averages 0.265 mm. in length (Fig.21). Seven or eight pairs of preanal papillae may be present, but their numbers vary (Choquette, (13). Two spicules are present, the right spicule averaging 0.105 mm., and the left one - 0.390 mm. in length. The tail of females is blunt

PLATE VIII

Fig. 20 Anterior end of *Rhabdochona cascadilla*.

Fig. 21 Left spicule and papillae of *R. cascadilla*.

Fig. 22 Posterior extremity of female *R. cascadilla*.

Fig. 23 Uterus of *R. cascadilla*.

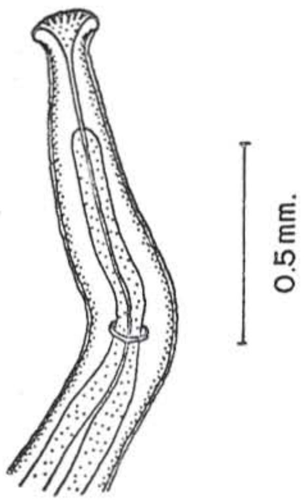


Fig. 20

Fig. 21

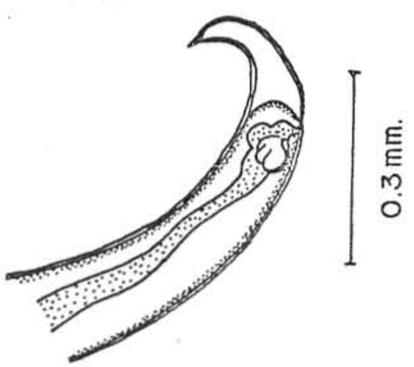


Fig. 22

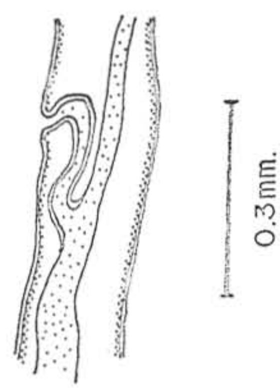


Fig. 23

and terminates in a spine-like process 0.202 to 0.285 mm. long (Fig.22). The uterus (Fig.23) contained eggs which measured 0.034 x 0.019 mm. and were not filamented. These measurements are compared to measurements by other authors in Table 8.

Discussion

This is the first report of Rhabdochona cascadilla from Manitoba, and the first report of R. cascadilla in Perca flavescens and Stizostedion vitreum in Canada. A new host record for this parasite is not unusual, however, as Choquette (13) states, "The host list is impressive, species of Rhabdochona having been recorded from 100 species of fish, from two undetermined species of fish, and from one crab." An unidentified species of Rhabdochona has been reported from Perca flavescens from Canada by Bangham (5) and Bangham and Venard (9). This was probably R. cascadilla.

Weller (107) described a new species of Rhabdochona, R. ovifilamenta from Perca flavescens from the Straits of Mackinac in Michigan, U.S.A. This species differs from R. cascadilla in possessing filamented eggs. The distribution of nematodes in fishes of Manitoba is shown in Map 10, and Table H.

TABLE 8

Comparison of measurements of *Rhabdochona cascadilla* in my material with measurements by other authors (in mm.)

Author	Sex	Length	Width	Esophagus total length	Distance of nerve ring from anterior extremity	Distance of excretory pore from anterior extremity	Length of tail	Spicule length right	Spicule length left	Egg Dimensions
Wigdor (111)	(M)	3.01-4.11	0.096-.104	0.24	0.115	-	-	-	0.04	
	(F)	6.8-9.28	0.096-.128	-	-	-	-	-	-	0.032 by 0.0.6
Lyster (51)	(M)	5.04	0.13	2.0	-	-	-	0.13	0.5	-
	(F)	8.3	0.15	2.0	-	-	-			
Gustafson (29)	(M)	2.18-5.76	0.085-.102	0.73-1.27	0.10-.12	0.15-.18	0.17-.25	0.065 to .95	0.333 to .383	
	(F)	3.9-7.5	0.116-.175	0.279-.447	0.102-.163	0.163-.210	0.16-.218			0.031-.038 by 0.019-.024
Choquette (13)	(M)	3.877-5.423	-	1.017-1.503	0.119-0.144	0.184-0.212	0.215-0.298	0.102 to 0.112	0.385 to 0.443	
	(F)	6.59-12.85	-	1.609-3.097	0.134-0.160	0.202-0.266	0.215-0.301			0.033-.034 by 0.017-0.018
Present Paper	(M)	3.62-5.50	0.086-.098	0.997-1.301	0.12-.14	0.197	0.265	0.105	0.390	
	(F)	4.75-13.20	0.135	1.109-3.127	0.13-.15	0.232	0.202-.285			0.034 by 0.019

M = Male; F = Female.

Map 10 Known distribution of *Nematoda* in Manitoba fishes

Legend

1. Lake Winnipeg
2. Lake Winnipegosis
3. Lakes in The Pas district
4. Lake Dauphin
5. Lake Caddy
6. Lake Burton
7. Lake Armit
8. Bell Lake, North Steeprock Lake, South Steeprock Lake
9. Lake Pickerel
10. Lake Athapapuskow
11. Lake Second Cranberry
12. Winnipeg River
13. Forbes Lake

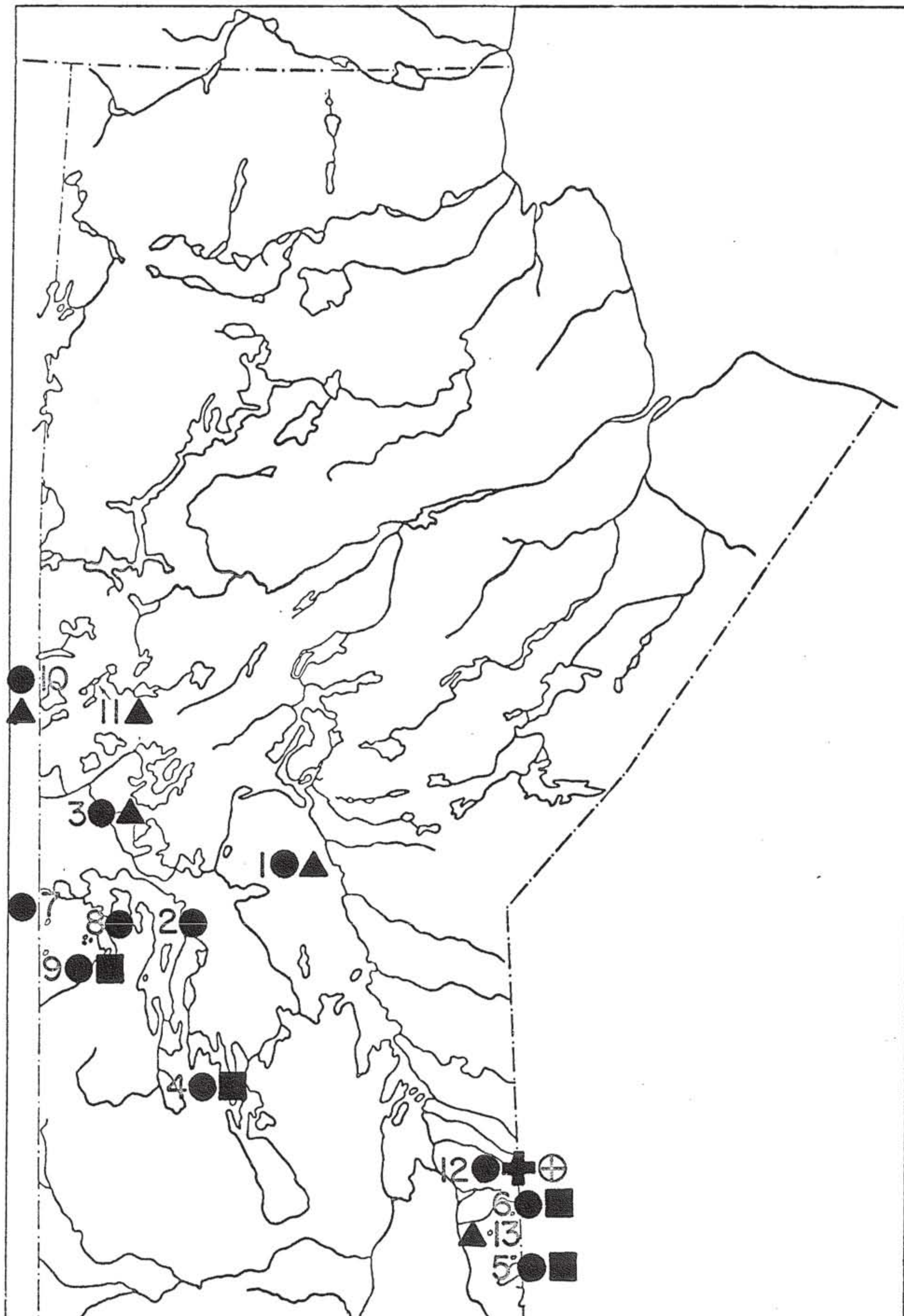
● *Raphidascaris canadensis*

■ *Raphidascaris* sp.

▲ *Cystidicola stigmatura*

✚ *Rhabdochona cascadilla*

⊕ *Spinitectus* sp.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Family Rhabdochonidae Skrjabin, 1946

Subfamily Spinitectinae Skrjabin, 1946

Genus Spinitectus Fourment, 1883

Synonyms: Goezia Zeder, 1800;
Cochlus Zeder, 1803;
Liorhynchus Rudolphi, 1801.

Spinitectus sp.

Author's Findings

Larvae of Spinitectus sp. were found in Perca flavescens and Stizostedion vitreum from the Winnipeg River. Eight of 52 (15.3%) yellow perch and 5 of 28 (17.8%) pikeperch were infected. The fish were lightly infected, the immature Spinitectus situated in the pyloric ceca and intestine. Nine specimens from the intestine of a single pikeperch was the heaviest infestation. Most of the infected fish yielded only 3 to 5 specimens.

Discussion

This is the first report of Spinitectus in fishes from Manitoba. Ten immature specimens measured from 4.0 to 6.3 mm. in length and were 0.046 to 0.103 mm. wide. They were easily identified as Spinitectus on the basis of the cylindrical, funnel-shaped buccal cavity, and, in particular, the spines on the cuticle. The cuticle is provided with a series of transverse rings which extend the full length of the worm. (Fig. 24, B.) Spines are attached to the posterior edge of each transverse ring. They are directed backward and decrease in size and number posteriorly. Adult features necessary for species identification were lacking.

PLATE IX

Fig. 24 A-Anterior end of *Spinitectus*.

B-Spined cuticle of *Spinitectus*.

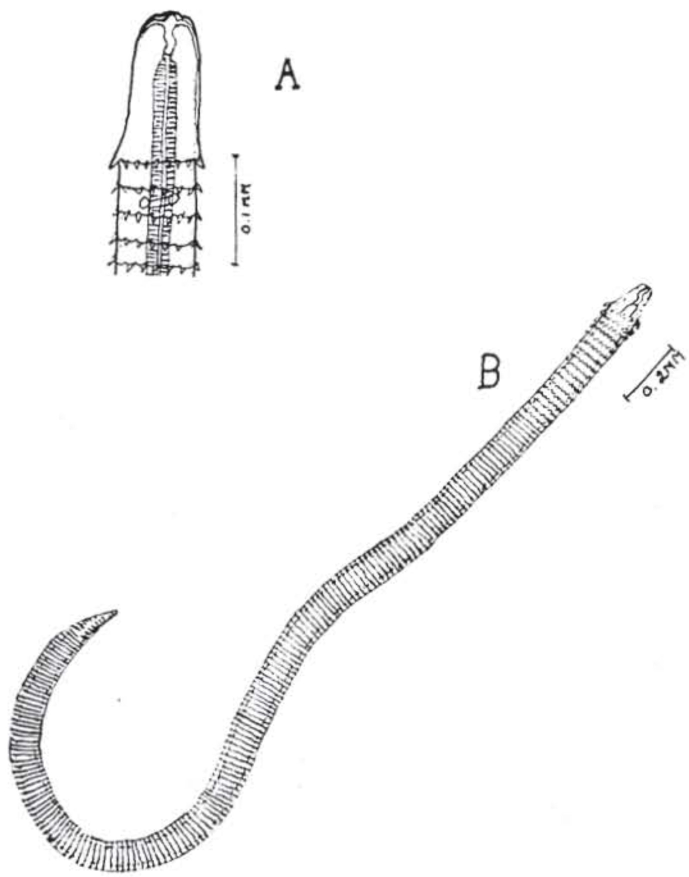


FIG. 24

Two species of Spinitectus have been recorded from fresh-water fishes in North America: S. gracilis Ward and Magath, 1917 and S. carolini Holl, 1926. The latter supposedly differs from the former in the presence of papillae which according to Ward and Magath (97) are lacking in S. gracilis. The two species of Spinitectus were redescribed by Mueller and VanCleave (65).

The Spinitectus from the yellow perch and pikeperch in the Winnipeg River can tentatively be identified as S. gracilis. The anterior ends of these specimens are well developed (Fig. 24, A). The shape of the oral capsule closely resembles drawings of the oral capsule of S. gracilis by Mueller and VanCleave (65). The oral capsule of S. gracilis is slightly bent, whereas that of S. carolini is straight. Also, tentative identification of this parasite is possible on the basis of its preferred habitat. VanCleave and Mueller (93) state, "Of the two lake species one is correlated with shallow water independent of bottom (S. carolini). The other is correlated with mud bottom independent of depth (S. gracilis)". Since most, if not all, the yellow perch and pikeperch from the Winnipeg River were obtained from net sets made inshore in areas of predominately mud and clay bottoms, it is probable that these immature Spinitectus are S. gracilis.

VanCleave and Mueller (93) report finding immature Spinitectus in Perca flavescens and Stizostedion vitreum from Oneida Lake, New York, U.S.A. They state: "Perca flavescens and Stizostedion vitreum carry immature Spinitectus in abundance.....That the worms never attain maturity in these fishes proves that they are incapable of serving as hosts." This is apparently untrue for other areas, however, as Bangham and Venard (9) and Bangham (6) found adult S. gracilis in Perca flavescens in Ontario, Canada.

Family Heterocheilidae Railliet et Henry, 1915

Subfamily Filocapsulariinae Yamaguti, 1961

Genus Raphidascaris Railliet et Henry, 1915

Raphidascaris canadensis Smedley, 1933

Records from Manitoba:

Definitive Hosts: Esox lucius---Lake Winnipeg - Smedley, (79); Lake Winnipegosis - Smedley, (79); Lakes in The Pas district - Smedley, (79); Caddy Lake - McLeod, (55); Lake Dauphin - Stewart-Hay, (81); Lake Burton, Lake Bell, North and South Steeprock lakes - Stewart-Hay, (84), (85); Lake Athapapuskow - Stewart-Hay, (87). Stizostedion vitreum---Pickerel Lake - Stewart-Hay, (84).

Other Canadian Records:

Quebec:

Definitive Host: Esox m. masquinongy---St. Lawrence watershed - Choquette, (12).

Author's Findings

Immature specimens of Raphidascaris canadensis were found in the intestine of 14 of 52 (26.9%) Perca flavescens from the Winnipeg River. This host was but lightly infected, 8 specimens was the heaviest infestation. Some of the hosts were infected with a single larval nematode.

Measurements of Specimens

Ten specimens of R. canadensis were measured. They ranged from 4.9 to 9.4 mm. in length and had an average maximum width of 0.092 mm. The cuticle had developed to a considerable thickness and was deeply striated. The striations were approximately 0.004 mm. apart. The anterior end was well developed showing large prominent lips. The posterior portion terminated in a sharp delicate pointed tail. Preanal papillae had begun to develop in some specimens. Other adult features were lacking. The immature specimens were compared to preserved and mounted adults of R. canadensis from a collection of Professor R. K. Stewart-Hay, University of Manitoba. The anterior region of our immature specimens was very similar to that of the adult specimens.

Discussion

Raphidascaris canadensis is distributed throughout western Canada (Smedley, (79). Adults are normally found in the intestine of Esox lucius where they reach a length of 50 mm. This parasite was first described by Smedley (79) on the basis of material from Esox lucius in Waskesiu and Sandy lakes, Saskatchewan, lakes Winnipeg and Winnipegosis, and various lakes in The Pas district, Manitoba.

The immature nematodes collected from Perca flavescens in the Winnipeg River are the pre-encystment larval stage in the life cycle of R. canadensis. Thomas (88) describes how minnows and perch may become infected by the hatched larvae of this parasite. R. canadensis lays its eggs in the intestine of the pike in the morula stage. After being passed by the host, at temperatures between 75 -80 F., the eggs become embryonated within eight hours. Following one molt in the egg, the larvae are infective to the bottom feeding minnows and perch.

The ingested larvae later become encysted in the mesenteries and liver of the perch.

This is the first report of R. canadensis from Perca flavescens in Manitoba and Canada. Stewart-Hay (85) reported Raphicascaris sp. from P. flavescens in Burton Lake, Manitoba. This was probably R. canadensis. The known distribution of R. canadensis and Raphidascaris sp. in Manitoba is shown in Map 10.

NOTES ON ACANTHOCEPHALA

Family Neoechinorhynchidae Hamann, 1892

Genus Neoechinorhynchus Stiles and Hassall, 1905

(=Neorhynchus Hamann, 1892) VanCleave, 1913

Neoechinorhynchus cylindratus VanCleave, 1913

Canadian Records:

Ontario:

Definitive Hosts: Micropterus dolomieu---Algonquin Park lakes - Bangham, (5), Bangham and Venard, (9); Lake Huron and Manitoulin Island lakes - Bangham, (6). Perca flavescens, Esox lucius, Huro salmoides, Lepomis gibbosus, Ambloplites rupestris, Pomoxis nigro-maculatus, Lota lota maculosa, Stizostedion vitreum, and Stizostedion canadense---Lake Huron and Manitoulin Island lakes - Bangham, (6).

Quebec:

Definitive Hosts: Esox m. masquinongy---St. Lawrence watershed - Choquette, (12). Catostomus commersonni---Lake Commandant - Lyster, (51). Salvelinus fontinalis---Lake Commandant - Lyster, (51).

Author's Findings

Neoechinorhynchus cylindratus was found in 21 of 28 (75%) S. vitreum from the Winnipeg River. Two specimens were collected from one of 52 Perca flavescens. Most of the pikeperch were infected with 5 to 20 worms. Twenty-six specimens collected from one pikeperch represents the heaviest individual infestation. Both adult and immature forms were present in our material. Many females contained large numbers of eggs in the pseudocoelom. The immature forms were smaller, terminating abruptly posteriorly. Many worms were found attached to the pyloric ceca and intestinal wall by the proboscis and were difficult to remove. Others were free in the intestinal contents.

Measurements of Specimens

Five males and 5 females constitute the material for study. Measurements of my specimens are in close agreement with findings of other authors (Table 9). Females measured 6.72 to 14.9 mm. with a maximum width of 0.46 to 0.76 mm. a short distance posterior to the proboscis (Fig. 25, C). Males were smaller - 4.94 to 10.9 mm. long by 0.46 to 0.67 mm. wide (Fig. 25, A). The proboscis of N. cylindratus is globular and slightly broader than long averaging 0.176 by 0.179 mm. (Fig. 25, B). The hooks on the proboscis are arranged in three circles of 6 hooks each; those of the distal circle have an average length of 0.069 mm., of the middle circle - 0.034 mm., and of the proximal circle - 0.020 mm. The two testes are of almost equal size, and measure 0.36 by 0.33 mm. The eggs are numerous and large, occupying most of the pseudocoelom, and average 0.046 by 0.018 mm. Five large subdermal nuclei in the mid-dorsal line of the body and one in the mid-ventral line were easily discernable.

Discussion

This is the first report of Neoechinorhynchus cylindratus

TABLE 9

Comparison of my measurements of *Neoechinorhynchus cylindratus* with measurements of other authors (in mm.)

Author	Length	Width	Proboscis Length	Proboscis Width	Length of Hooks distal	Length of Hooks middle	Length of Hooks proximal	Testes	Egg Dimensions
VanCleave(90)	10-15(F) 4.5-8.5(M)	0.7(F) 0.5-0.7(M)	0.150	0.172	0.079-.097	0.037	0.021-.025	-	0.049-.051 x 0.051-.021
Lyster(51)	5.1(F) 3.0-4.9(M) (excluding proboscis)	0.82(F) 0.6-.82(M)	0.53	0.12	0.4-.45	0.21	0.03	0.34 x 0.37	0.10-.12 x 0.07
Present Paper	6.72-14.9(F) 4.94-10.9(M)	0.46-.76(F) 0.46-.67(M)	0.176	0.179	0.069	0.034	0.020	0.33 x 0.36	

F = Female; M = Male.

PLATE X

Fig. 25 A-*Neoechinorhynchus cylindratus* male.

B-Proboscis and proboscis hooks of *N. cylindratus*.

C-*N.cylindratus* gravid female.

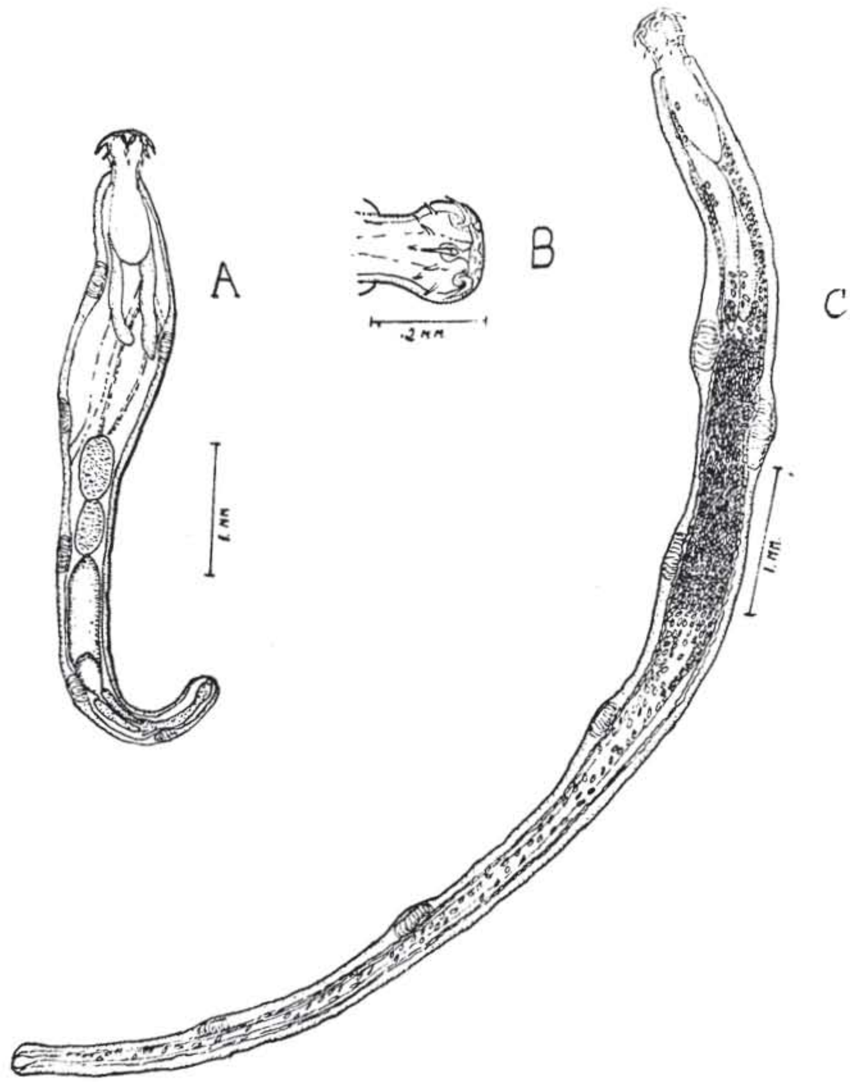


FIG. 25

from fish in Manitoba. Pikeperch from the Winnipeg River are heavily infected with this parasite. Yellow perch, however, seem to be unsuitable as the definitive host as only one of 52 perch contained two specimens. VanCleave (91) states, "Stizostedion vitreum is the most generally utilized host of N. cylindratus in Oneida Lake". In studying the fish parasites of Oneida Lake, VanCleave and Mueller (93) write, "The yellow perch frequently contains this parasite, but in the majority of cases only one or two individuals were present in each fish, and these were very often immature". They point out that, "Many species of fish could be listed as host of this parasite on the strength of one or a few instances of its occurrence. In a number of these hosts the adjustment is obviously imperfect, as indicated by the complete lack of gravid females".

The geographical distribution of this parasite, which seems to occur only in North America, was reviewed by Holloway (32). He states, "N. cylindratus has been reported from nine States (eight east of the Mississippi and Minnesota) and the Canadian province of Ontario". Holloway has apparently overlooked the reports of this acanthocephalan from fishes in Quebec by Lyster (51) and Choquette (12). The known distribution of Acanthocephala reported from Manitoba fishes is shown in Map 11 and Table 1.

The life history of N. cylindratus described by VanCleave (89) was reviewed by Ward (96) who found the largemouth bass Micropterus salmoides to be the natural definitive host, the bluegill Lepomis pallidus a transport host, and an ostracod Cyprina globula, the first intermediate host.

Map 11' Known distribution of *Acanthocephala* of Manitoba fishes.

Legend

1. Lake Dauphin
2. Lake Athapapuskow
3. Lake Second Cranberry
4. Lake Burton
5. Lake Pickerel
6. Lake Wellman
7. North Steeprock Lake and South Steeprock Lake
8. Lake Armit
9. Winnipeg River

■ *Neoechinorhynchus crassus*

★ *Neoechinorhynchus cylindratus*

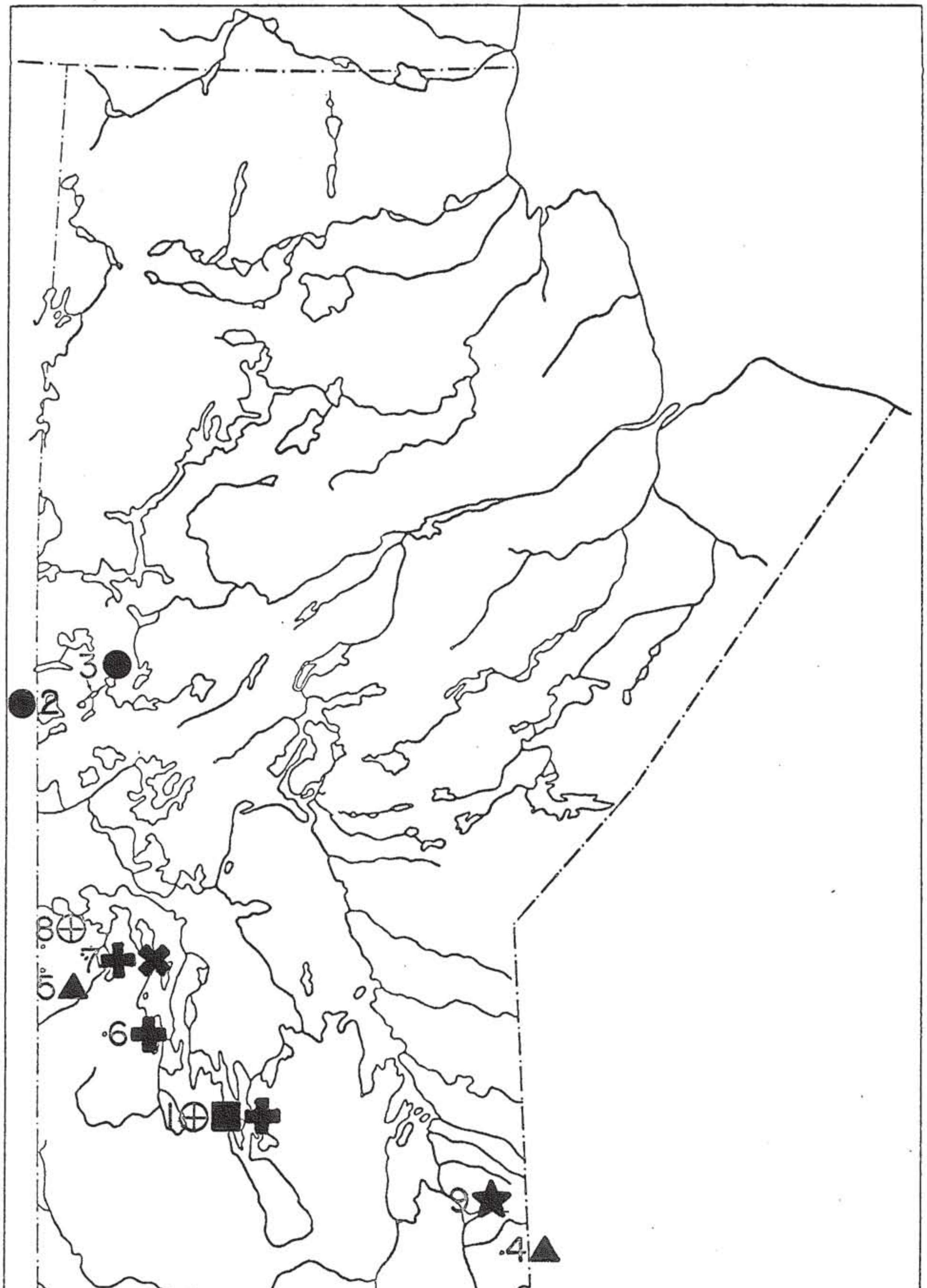
▲ *Neoechinorhynchus* sp.

✚ *Pomphorhynchus bulbocolli*

⊕ *Pomphorhynchus* sp.

● *Echinorhynchus coregoni*

✖ *Tanaorhamphus* sp.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TRIAENOPHORUS INFESTATION OF LAKE TROUT

Triaenophorus crassus Forel, 1868

Records from Manitoba:

Definitive Host: Esox lucius---Lake Winnipeg - Ekbaum, (22); Heming Lake - Lawler, (40), Lawler and Watson, (47); Lake Armit - Stewart-Hay, (84); Lake Athapapuskow - Stewart-Hay, (87).

Second Intermediate Hosts: Coregonus clupeaformis--- Lake Winnipeg - Newton, (66); Lake Athapapuskow - Nicholson, (68), Stewart-Hay (87); Lake Winnipegosis - Newton, (66); Heming Lake - Lawler, (40), Lawler and Watson, (47); Lake Dauphin - Newton, (66); Lake Kississing - Nicholson, (68); Lake St. Martin - Newton, (66); Nueltin Lake (Manitoba-Northwest Territories Boundary) - Federal Department of Fisheries (Lawler and Scott, (46); Lakes in The Pas district - Newton, (66). Leucichthys sp.---Lake Winnipeg - Nicholson, (68); Lake Manitoba - Keleher, J., (38); Heming Lake - Lawler, (40), Lawler and Watson, (47); Lakes in The Pas district - Newton, (66); Lake Athapapuskow - Stewart-Hay, (87). Salvelinus namaycush---Lake Athapapuskow - Stewart-Hay, (87). The distribution of T. crassus in Manitoba is shown in Map 5.

Other Canadian Records:

Northwest Territories:

Definitive Host: Esox lucius---Great Slave Lake - Rawson, (73; Great Bear Lake - Miller, (62).

Second Intermediate Hosts: Coregonus clupeaformis---Great Bear Lake - Miller, (62); Great Slave Lake - Rawson, (73). Leucichthys sp.---Great Bear Lake - Miller, (62); Great Slave Lake - Rawson, (62), (73). Thymallus signifer---Great Bear Lake - Miller, (62); Great Slave Lake - Rawson, (73). Salvelinus namaycush---Great Slave Lake - Rawson, (72), (73). Stenodus leucichthys---Great Slave Lake - Rawson, (72). Prosopium cylindraceum---Great Slave Lake - Rawson, (73).

Ontario:

Definitive Host: Esox lucius---Lake Nipissing - Fallis, MS, (26), Ekbaum, (22); Muskoka District and Georgian Bay, Lake Huron - Cooper, (16); Lake of the Woods - Ekbaum, (22); Moose Lake - Ekbaum, (22); Muskeg Lake - Welch, (108); South Bay, Lake Huron - (Bangham, 1952), Lawler & Scott, (46), Bangham (6).

Second Intermediate Hosts: Coregonus clupeaformis---Lake Nipigon - Welch, (109); South Bay, Lake Huron - (Bangham, 1952), Lawler & Scott, (46), Bangham, (6); Muskeg Lake - Welch, (109). Lota lota maculosa---Georgian Bay, Lake Huron - Cooper, (16). Leucichthys sp.---Lake Superior - Cooper, (16); Lake Nipissing - Fallis, MS, (26); Lake Nipigon - Welch, (109); South Bay, Lake Huron - (Bangham, 1952), Lawler & Scott, (46); Muskeg Lake - Welch, (108). Leucichthys artedi---

Manitoulin Island, Lake Huron - Bangham, (6);

Leucichthys hoyi---Lake Huron - Bangham, (6).

Petromyzon marinus---Manitoulin Island, Lake Huron - (Bangham, 1952), Lawler & Scott, (46), Bangham (6).

Alberta

Definitive Host: Esox lucius---Lesser Slave Lake - Miller, (58), (60); Baptiste and Square Lakes - Miller and Huston, MS, (64), Libin, (48).

Second Intermediate Hosts: Coregonus clupeaformis--- Lesser Slave Lake - Miller, (59), (60). Leucichthys sp.---Lesser Slave Lake - Miller, (60). Leucichthys tullibee---Lesser Slave Lake - Miller, (59). Prosopium oregonium---Lesser Slave Lake - Miller, (60). Prosopium sp.---Lesser Slave Lake - Miller, (59).

Saskatchewan:

Definitive Host: Esox lucius---Nesslin Lake - Wheaton and Rawson, (110), Rawson & Wheaton (75); Mosher Lake - Wheaton and Rawson, (110); Lake Athabaska - Rawson, (72).

Second Intermediate Hosts: Coregonus clupeaformis--- Nesslin Lake - Wheaton & Rawson, (110), Rawson & Wheaton, (75); Mosher Lake - Wheaton and Rawson, (110); Lake Athabasca - Rawson, (72). Leucichthys sp.---Mosher Lake - Wheaton and Rawson, (110); Lake Athabasca - Rawson, (72). Cristivomer namaycush---Lake Athabasca - Rawson, (72); Lac la Ronge - Rawson, (74).

British Columbia:

Definitive Host: Esox lucius---Teslin Lake Territory -

Clemens et al., (14).

Second Intermediate Hosts: Coregonus clupeaformis---

Teslin Lake Territory - Clemens et al., (14).

Leucichthys sp.---Teslin Lake Territory - Clemens et al., (14).

Author's Findings

Between September 1 and 6, 1959, 38 of 102 (37.2%) lake trout (Salvelinus namaycush) from Forbes Lake, situated in The Manitoba Whiteshell Forest Reserve, were found to be infected with T. crassus plerocercoids. The plerocercoids were encysted in the flesh of the trout, the cysts being of different size and shape. Twelve cysts found in a single trout represented the heaviest infestation. Lake trout measuring 17 - 21 inches in length were most heavily infested.

Measurements of Specimens

The plerocercoids of T. crassus greatly varied in length, and so did the size of the cyst; the longer the plerocercoid, the larger the cyst. The longest specimen was 120 mm. long and about 1 mm. wide. Most specimens were white, 50 - 80 mm. long, with a large, well developed scolex. Miller (60) describes the plerocercoid of T. crassus as a "long, coiled white thread about 1 mm. in diameter and up to 130 mm. long. At one end is a complete scolex formed as in the adult; the strobilia is the same diameter throughout and lacks sex organs. At the posterior end of the strobilia, a filament of variable length, termed the cauda, is often present." A number of the smaller plerocercoids possessed a cauda, which was usually yellow.

The scolex is characteristic of T. crassus, provided with two suckers and four three-pronged hooks (Fig.2). The hooks are large with three short, slightly curved projections (Fig. 4). The width of the basal plate of the hooks was 260 - 275 (μ), its depth (anterior-posterior) 75 - 135 (μ), and the length of the marginal prong 245 (μ). Dimensions of the scolex hooks in my material (5 specimens measured) are compared to measurements given by other authors in Table 10.

Species Identification

T. crassus was identified on the basis of the structure of the scolex hooks. Measurements of the scolex hooks are given in Table 10. T. crassus is larger than T. nodulosus and T. stizostedionis and has the largest scolex hooks. The absence of the fourth projection on the basal plate of T. crassus serves to distinguish this species from T. nodulosus. The protuberance on the middle surface of each hook characteristic of T. stizostedionis is lacking in T. crassus.

Triaenophorus in lake trout

There are but a few reports of T. crassus from lake trout in North America. These fish are not common intermediate hosts for this parasite. Miller (60) states, "The plerocercoids of Triaenophorus crassus encyst normally in the flesh of fishes of the genus Leucichthys; the whitefishes, Coregonus clupeaformis and Prosopium oregonium are common alternative hosts in Lesser Slave Lake. Elsewhere lake trout, Cristivomer namaycush, and possibly the inconnu, Stenodus leucichthys,

TABLE 10

Dimensions of the scolex hooks of T. crassus(μ)

Author	Width of basal plate	Depth of basal plate (anterior-posterior)	Length of marginal prong
Scheuring (77)	285-300	125-135	240-255
Ekbaum (21)	275	138	245
Miller (58)	255-300	132-140	-
Cooper (16)	280-310	-	-
Present Paper	260-275	75-135	245

may occasionally serve as hosts". Reports of Triaenophorus from lake trout in Canadian lakes are as follows:

Triaenophorus sp.- Childs Lake, Man.- Stewart-Hay, (83)

T. nodulosus & T. crassus- Lake Athapapuskow- Stewart-Hay, (87)

T. crassus- Great Slave Lake, N.W.T.- Miller, (60), Rawson, (72), (73)

T. crassus- Great Bear Lake, N.W.T.- Miller, (62)

T. crassus- Lake Athabasca, Sask.- Rawson, (72)

T. crassus- Lac la Ronge, Sask.- Rawson, (74)

Types of Triaenophorus cysts in lake trout.

Cysts of T. crassus in trout from Forbes Lake varied in their size and shape. The morphology of T. crassus cysts has been described by Cooper (16), Hjortland (31), Newton (66), Miller (60) and by numerous European authors on the basis of material from Coregonidae. In a review of Triaenophorus in Canadian lakes, Miller (63) describes the typical plerocercoid cyst, "Each plerocercoid is enclosed in a cyst, the cyst is usually yellowish in colour, typically spindle-shaped and from one-quarter of an inch to one inch in length. It is composed of connective tissue formed by the host. Within the cyst is the plerocercoid and a variable quantity of thick yellowish liquid; this liquid is composed of broken-down host tissue, on which the plerocercoid feeds, and excretory products from the worm.....The cysts are exceedingly variable in shape."

Three distinct types of cysts were observed in the trout from Forbes Lake which I have designated as A, B, and C. These are compared to types of cysts described by Miller (60) in Leucichthys sp.

Type A - large, mostly irregular, pocket-like cysts containing a creamy deposit and one, sometimes two, plerocercoids. These fleshy white cysts were mostly situated in the dorsal musculature next to the skin. Miller (60) describes similar cysts as being large, thin walled, containing, "the longest plerocercoids and pale non-granular contents". He interprets these large cysts containing young plerocercoids as the most recent stage of infection.

Type B - smaller cysts filled with a yellow matter and a small plerocercoid. These cysts were usually smaller than Type A cysts and more uniform in shape. Miller (60) describes similar cysts as follows: "smaller cysts contained smaller plerocercoids with long caudae (more than one-half the length of the worm); the fluid contents were yellow and contained large calcareous particles.....the small cysts are those of older plerocercoids, starting to degenerate".

Type C - very small spindle-shaped cysts approximately one-quarter inch long. Their color varied from deep yellow to almost orange. Miller (60) states, "The smallest cysts sometimes contained no plerocercoid, sometimes just the scolex or scolex hooks, and the content had become almost solid and orange in colour.....the smallest are very old and represent the final stage in the complete degeneration of the plerocercoid".

The number of different types of cysts found in lake trout from Forbes Lake are shown in Table 11.

Unencysted *T. crassus* Plerocercoids in lake trout

Some of the trout examined contained unencysted *T. crassus*

TABLE 11

Numbers of type A, B, and C cysts in lake trout from Forbes Lake

Types of Cysts	No. of Fish Infected	No. of Cysts Per Fish A	B	C	Total
A Type (only)	6	1	-	-	1
	2	2	-	-	2
	2	4	-	-	4
	1	5	-	-	5
B Type (only)	1	-	1	-	1
	1	-	3	-	3
	1	-	6	-	6
C Type (only)	6	-	-	1	1
	1	-	-	3	3
A Type	1	1	1	-	2
	2	2	1	-	3
&	1	3	1	-	4
	1	1	2	-	3
B Type	1	1	4	-	5
A Type	2	1	-	1	2
&	2	2	-	1	3
C Type	1	1	-	4	5
A Type	1	1	1	1	3
&	1	10	1	1	12
B Type	1	4	1	2	7
&	1	1	3	2	6
C Type	1	1	2	3	6
	1	1	1	4	6

plerocercoids. These appeared to extend through several myotomes. In all cases the free plerocercoids were accompanied by encysted ones. Unencysted T. crassus plerocercoids are not common in North America. Miller (63) states, "In European fishes it is common to find plerocercoids naked in the flesh, that is, not enclosed in cysts. In North America this is unusual and has been reported only in yearling coregonines. The author has found such plerocercoids in ciscoes from Lake Winnipeg and from Baptiste Lake, Alberta. Recently, Lawler (1950) has found all the plerocercoids to be naked in the infected ciscoes and whitefish of six inches and less from Heming Lake."

Size of lake trout and T. crassus infestation

All trout caught in Forbes Lake were measured to the nearest one-eighth of an inch, using fork length measurements (distance from the tip of the nose to the fork in the tail). Only 12% (3 of 25) trout less than 17 inches long were infected. The infection rate of trout measuring 17 to 21 inches was 44.1% (30 of 68). The greatest percentage of T. crassus infection occurred in trout over 21 inches long; 5 of 9 (55.5%) were infected. It seems thus that the percent of infected fish increases with the length and probably with its weight and age. However, the number of trout examined is not sufficient to warrant final conclusion. Table 12 shows the increase in the infection rate with increasing size of the host.

TABLE 12

Influence of size (length) of lake trout on *T. crassus* infestation

Fork Length in inches	Number of Fish Examined	Number of Fish Infected
12 - 13	2	0
13 - 14	2	1
14 - 15	6	0
15 - 16	6	0
16 - 17	9	2
17 - 18	17	5
18 - 19	18	6
19 - 20	17	6
20 - 21	16	13
21 - 22	7	4
22 - 23	1	1
23 - 24	0	0
24 - 25	1	0

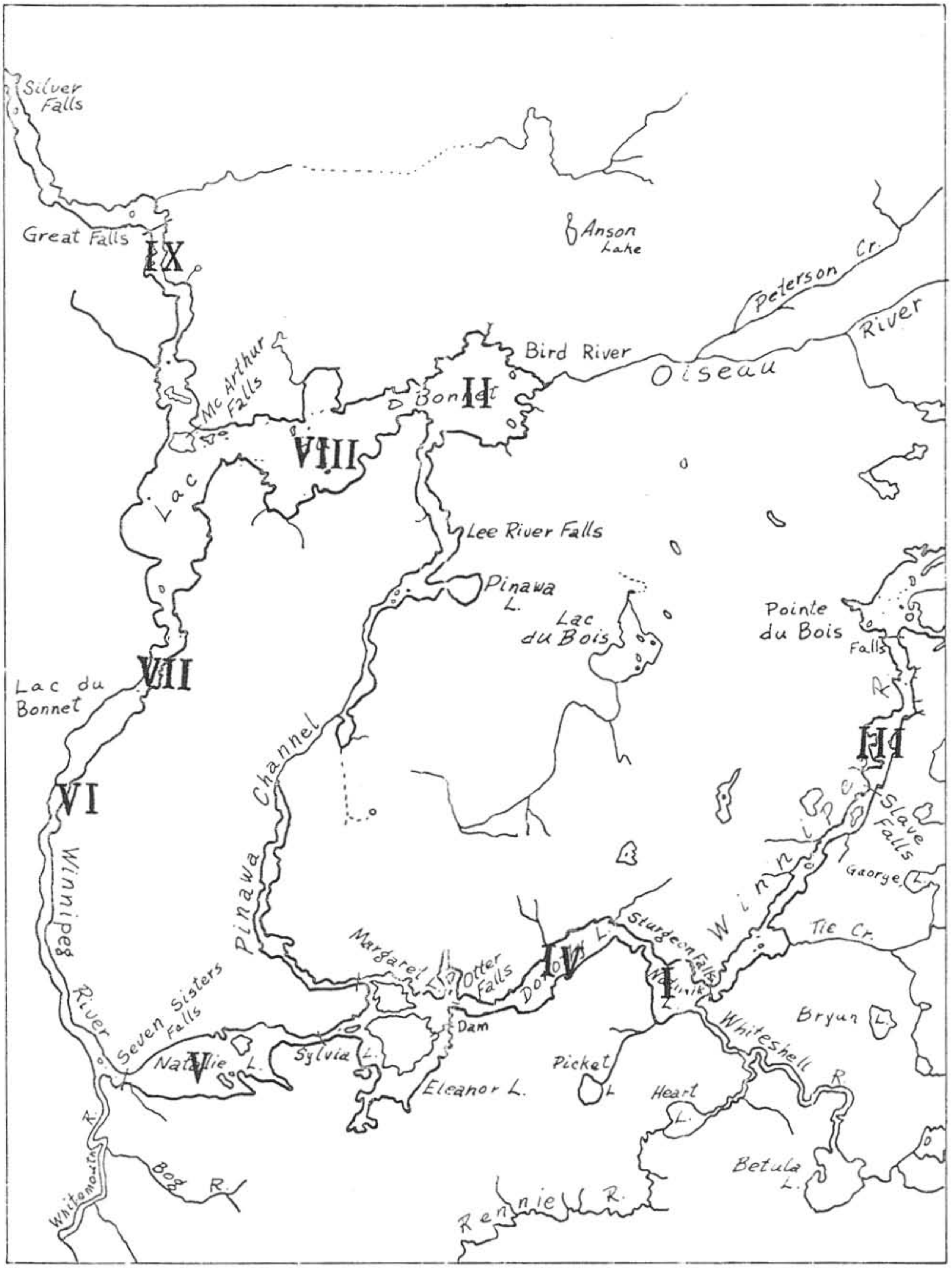
SOME ASPECTS OF ECOLOGY AND HOST-PARASITE RELATIONSHIPS

In studying parasites from a particular host or locality it is necessary to consider host-parasite relationships and pertinent ecological factors. Information of this nature was obtained from the investigation of the intestinal helminths of *Stizostedion vitreum* and *Perca flavescens* from the Winnipeg River. Fifty-two *P. flavescens* and 28 *S. vitreum* were examined. The material was collected from nine stations on the Winnipeg River (Map 12). The unequal number of individuals of the two species examined is chiefly a reflection of their relative abundance in this water body. The yellow perch is more abundant, and consequently more fish of this species was examined. Because of the small number of fish examined, however, this material is only indicative of the possible host-parasite relationships and, of the probable influence of the ecology of these fishes on the fauna of their parasites.

Intensity of parasitism

It is natural that when a large number of hosts are examined, the list of parasites encountered will be greater than when only a few individuals have been studied. Data on the intensity of parasitism of yellow perch and pikeperch in the Winnipeg River are not conclusive because of the limited number of hosts examined. Allowance should therefore be made for this fact when interpreting the tables. The percent of *S. vitreum* and *P. flavescens* infected by intestinal helminths is shown in Table 13. 96.3% of the fish harboured one or more species of parasites. Trematodes were the predominant group in the fish

Map 12 Sampling stations on the Winnipeg River.



WINNIPEG RIVER - Silver Falls to Pointe du Bois.

Stations I - IX

5 0 5 Miles

5 0 5 Kilometers

TABLE 13

Per cent infection of *S. vitreum* and *P. flavescens* with intestinal helminths

Hosts	Number Examined	Number Infected	Per Cent Infected	Per Cent with Cestodes	Per Cent with Nematodes	Per Cent with Tremadotes	Per Cent with Acanthocephala	Per Cent with Multiple Infections	Number of Stations Examined
Stizostedion vitreum	28	28	100	96.4	35.7	71.4	75	100	8
Perca flavescens	52	49	94.2	48	48	75	1.9	69.2	8

examined. Cestodes were found in 96.4% of S. vitreum, whereas only 48% of P. flavescens were infected. Nematode infection was relatively light in both fish species. 75% of the S. vitreum were infected with the single species of acanthocephalan collected. Multiple infections were found in all S. vitreum examined and in 69.2% of P. flavescens.

Infection rate at different stations

Five of nine sampling stations on the Winnipeg River yielded yellow perch heavily infected with parasites. This high incidence and intensity of infection was at first attributed to the examination of older individuals from these stations: the older the fish the greater the parasite load (Dubinin, (19); Dogiel and Petrushevski, (18). The check of the age of these fish has, however, shown that this was not the case. Heavier infection in these stations (2, 3, 4, 5, and 8) is probably due to conditions favorable to potential intermediate hosts of these parasites. These stations are primarily characterized by shallow water, mud, clay, and silt bottoms and are influenced only slightly by the main current of the river. The remaining stations (1, 6, 7) are characterized by rocky bottom, deep water, and swift current. VanCleave and Mueller (93) state "the type of parasitism is more or less closely correlated with the habitat from which the fish is taken". Their study of two distinct groups of perch, those from deep water (30 - 50 feet) and those from shallow water (shoreline localities), showed that there is a definite correlation between incidence of infection and the habitat of the host.

Stations 2, 4, 6, and 8 yielded the most heavily infected pikeperch. Stations 2, 4, and 8 were most suitable for parasite infection of yellow perch and pikeperch. The rates of infection of these fish at each station are shown in Table 14. The symbols +, ++, and +++, refer to light, moderate and heavy infections respectively.

Influence of age on infestation

Fish are well suited for the study of the influence of the age of the host on its parasite fauna. The life span of most fresh-water, non-migratory fishes is sufficiently long, and the age of each individual can be determined with exactness suitable for this purpose.

Gorbunova (28) distinguished three ways in which the age of the host influences the abundance of parasites. Some intestinal helminths of yellow perch and pikeperch from the Winnipeg River could be, with a considerable degree of certainty, placed in the groups discussed by Gorbunova.

Group I: Parasites independent of the age of the host.

Three of 7 (42.8%) species of parasites from the intestine of yellow perch, Bothriocephalus cuspidatus, Proteocephalus sp., and Crepidostomum cooperi were found to persist in all seven year classes of perch examined.

No parasites of the pikeperch can be placed into this group as only old (7 - 9 years) and young (1 - 2 years) fish of this species were caught. Gorbunova (28) found that 6 of 18 (33.3%) common parasites of Esox lucius belonged to Group I.

Group II: Parasites decreasing in abundance with the age of the host.

To this group belonged only one of 7 (14.2%) parasites of the yellow perch, Raphidascaris canadensis whose larvae were found in

TABLE 14

Rates of infection of S. vitreum and P. flavescens per station

Sampling Station	Parasite Infestation per station																
	Perca flavescens								*Stizostedion vitreum*								
	Number examined	Rhabdochona cascadilla	Crepidostomum cooperi	Bothriocephalus sp.	Proteocephalus sp.	Spinitectus sp.	Raphidascaris canadensis	Neoechinorhynchus cylindratus	Number examined	Bothriocephalus cuspidatus	Triaenophorus stizostedionis	Neoechinorhynchus cylindratus	Bucephaloides pusilla	Proteocephalus luciopercae	Spinitectus sp.	Centrovarium lobotes	Rhabdochona cascadilla
1	2	+	+						-								
2	17	+-++	+-+++	+	+	+	+		5	++	+	+	+++	++	+	+	+
3	5	+	+++	+	+				-								
4	12	++	++-+++	+	+	+		+	4	++	+	+-++	++-+++	++	+	+	
5	3	++	+++		+		+		4	++		++	++-+++				
6	3	++	+++						9	+-++	+	+	+++	++	+		
7	1	+	++			+			3			+	++-+++	++			
8	6	+-++	+++	+	+	+			3	+-++	+	+	+	+-++			
9	3	++	+-++			+			-								

+ = Light(1-9 worms per fish; ++ = Moderate(10-49 worms per fish; +++ = Heavy(50-or more worms per fish).

one and two year old perch in decreasing numbers.

Age of the host (years)	1	2	3	4	5-7
Incidence (%)	75	33.3	-	-	-

In the early stages of growth perch feed on small aquatic insect larvae and other benthic organisms. Such food habits are favourable for infection with the larvae of R. canadensis. The ingested larvae undergo further development in the intestine of the young perch before becoming encysted in the liver and mesenteries. This accounts for the presence of R. canadensis larvae in the intestine of young perch and its absence in older individuals. The absence of larvae in the older perch can probably be attributed to (a) a change in food habits; older perch becoming more carnivorous in their diet, or (b) having invaded the intestine during the early years of growth, the larvae are now encysted in the liver and mesenteries which were not examined.

Gorbunova uses the infection of Esox lucius with the tapeworm Proteocephalus cernuae to illustrate Group II as follows:

Age of the fish (years)	0+	1	2	3	4	5-11
Incidence (%)	70.6	26.4	13.2	6.6	14.7	19.0

She attributes this kind of age dependence to the fact that "E. lucius feeds on plankton during the first months of its life and plankton contains copepods, the intermediate hosts of Proteocephalus".

Group III: Parasites increasing in abundance with the age of the host.

Four of 8 (50%) species of parasites from S. vitreum and one of 7 (14.2%) parasites from P. flavescens were found to increase in abundance with the age of the host. Infestation increased with age not only in incidence but also in intensity (Tables 15 & 16). These parasites are *Bothriocephalus cuspidatus*, *Proteocephalus luciopercae*, *Bucephaloides pusilla*, and *Neoechinorhynchus cylindratus* from *S. vitreum*, and *Crepidostomum cooperi* from *P. flavescens*.

Gorbunova placed 10 species (55.5%) of parasites of *Esox lucius* into this group. Infestation of *E. lucius* increased both in incidence and intensity with the age of the host.

TABLE 15

Increase in incidence (%) and intensity (Average number per fish) of infection of S. vitreum with age

Age in Years	Bothriocephalus cuspidatus		Proteocephalus luciopercae		Bucephaloides pusilla		Neoechinorhynchus cylindratus	
	%	Int.	%	Int.	%	Int.	%	Int.
1 - 2	71.4	7.4	35.7	5.2	42.8	8.3	62.5	5
7 - 9	87.5	25.1	50	17	87.5	39.7	78.5	9

TABLE 16

Increase in incidence (%) and intensity (average number per fish) of infection with C.cooperi in P.flavescens with age

Age in Years	1	2	3	4	5 - 7
Incidence (%)	33.3	100	71.4	76.9	78.2
Intensity	3	14.4	28	31	65.5

SUMMARY AND CONCLUSIONS

SUMMARY:

1. 52 Perca flavescens and 28 Stizostedion vitreum from the Winnipeg River were examined for intestinal helminths. Parasites found included five species of cestodes, three of trematodes, three nematodes, and one acanthocephalan. New locality and host records have been reported. The distribution of these parasites in Manitoba and Canada is presented.
2. 102 lake trout from Forbes Lake were examined for Triaenophorus. 37.2% were infected with T. crassus. Its distribution in Manitoba and Canada is reported. Three types of cysts and unencysted plerocercoids are reported from lake trout. The percent of infected fish increases with the length of the fish.
3. A note describing the dependence of some intestinal helminths and the age of their hosts is included.

CONCLUSIONS:

1. The writer wishes to point out that because of the small number of fish examined the data presented are indicative rather than conclusive. This is particularly true for the discussion on host-parasite relationships. Our material does, however, support the evidence for the fact that some parasites are independent of the age of the host, some decrease in number with their age, and some parasites

increase in intensity and incidence with increasing age of the host.

2. A definite correlation exists between host infection and areas of collection. Stations characterized by shallow water, mud bottom, and sluggish current produced more highly infected fish than stations characterized by deep water, swift current, and rock bottom. The higher degree of infection is attributed to conditions favourable to intermediate hosts of these parasites.

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APPENDIX

SCIENTIFIC AND COMMON NAMES OF FISHES

The following list of scientific and common names of fishes referred to in the context of the thesis has been prepared from Bailey et al. (3) and Slastenenko (78).

Acrocheilus alutaceus Agassiz and Pickering - Chiselmouth

Ambloplites rupestris (Rafinesque) - Rock bass

Ameiurus (=Ictalurus) natalis (Le Sueur) - Yellow Bullhead

Ameiurus (=Ictalurus) nebulosus (Le Sueur) - Brown bullhead

Amphiodon (=Hiodon) alosoides (Rafinesque) - Goldeye

Anquilla chrysopa Jordan and Evermann (=A. rostrata Le Sueur) - American eel

Boleosoma (=Etheostoma) nigrum Rafinesque - Johnny darter

Carpiodes cyprinus (Le Sueur) - Quillback

Catostomus catostomus (Forster) - Longnose sucker

Catostomus commersoni (Lacépède) - White sucker

Catostomus macrocheilus Girard - Largescale sucker

Chrosomus eos Cope - Northern redbelly dace

Coregonus clupeaformis (Mitchill) - Lake whitefish

Cottus cognatus Richardson - Slimy sculpin

Couesius (=Hybopsis) plumbea (Agassiz) - Lake chub

Cristivomer (=Salvelinus) namaycush (Walbaum) - Lake trout

Cyprinus carpio Linnaeus - Carp

Esox lucius Linnaeus - Northern Pike

Esox masquinongy Mitchell - Muskellunge

Esox niger Le Sueur - Chain pickerel

Esox americanus vermiculatus Le Sueur - Grass pickerel

Eucalia inconstans (Kirtland) - Brook stickleback

Eupomotis gibbosus Jordan and Evermann (=Lepomis gibbosus (Linnaeus))

- Pumpkinseed

Fundulus heteroclitus (Linnaeus) - Mummichog

Hiodon chrysopsis Richardson (=Amphiodon alosoides Rafinesque) - Goldeye

Hiodon tergisus Le Sueur - Mooneye

Huro (=Micropterus) salmoides (Lacépède) - Largemouth bass

Hyborhynchus (=Pimephales) notatus (Rafinesque) - Bluntnose minnow

Ictalurus punctatus (Rafinesque) - Channel catfish

Lepibema (=Roccus) chrysops (Rafinesque) - White bass

Lepomis gibbosus (Linnaeus) (=Eupomotis gibbosus Jordanaand Evermann)

- Pumpkinseed

Lepomis pallidus Jordan and Evermann (=L. macrochirus Rafinesque)

Leucichthys sp. - Cisco

Leucichthys (=Coregonus) artedii Le Sueur - Cisco or lake herring

Leucichthys (=Coregonus) artedii tullibee (Rawson) - Shallowwater cisco

Leucichthys (=Coregonus) hoyi (Gill) - Bloater

Leucichthys (=Coregonus) nigripinnis (Gill) - Blackfin cisco

Leucichthys (=Coregonus) nipigon (Koelz) - Nipigon cisco

Leucichthys (Coregonus) zenithecus (Jordan and Evermann) - Shortjaw cisco

Leucosomas corporalis Dymond (=Semotilus corporalis (Mitchill)) - Fall fish

Lota lota (Linnaeus) - Burbot

Margariscus margarita nachtriebi (Cox) - Northern pearl dace

Micropterus dolomieui Lacépède - Smallmouth bass

Micropterus salmoides(Lacépède) - Largemouth bass

Mylocheilus caurinus (Richardson) - Peamouth

Notropis sp. - Shiner

Notropis bifrenatus (Cope) - Bridle shiner

Notropis cornutus (Mitchell) - Common shiner

Notropis stramineus (Cope) - Sand shiner

Notropis heterolepis Eigenmann and Eigenmann - Blacknose shiner

Notropis hudsonius (Clinton) - Spottail shiner

Notropis volucellus (Cope) - Mimic shiner

Oncorhynchus nerka (Walbaum) - Sockeye salmon

Perca flavescens (Mitchell) - Yellow perch

Percopsis omiscomaycus (Walbaum) - Troutperch

Poecilichthys (=Etheostoma) exile (Girard) - Iowa darter

Pomoxis nigromaculatus (Le Sueur)

Prosopium sp. - Whitefish

Prosopium cylindraceum (Pallas) - Round Whitefish

Prosopium oregonium (Jordan and Snyder) - Oregon whitefish

Ptychocheilus oregonensis (Richardson) - Northern squawfish

Pungitius pungitius (Linnaeus) - Ninespine stickleback

Rhinichthys cataractae (Valenciennes) - Longnose dace

Richardsonius balteatus (Richardson) - Redside shiner

Salmo clarki Richardson - Cutthroat trout

Salmo gairdneri (=S. irideus Gibbons) Richardson - Rainbow trout

Salvelinus fontinalis (Mitchell) - Brook trout

Salvelinus (=Cristivomer) namaycush (Walbaum) - Lake trout

Semotilus atromaculatus (Mitchell) - Creek chub

Stenodus leucichthys (Güldenstadt) - Inconnu

Stizostedion canadense (Smith) - Sauger

Stizostedion vitreum glaucum Hubbs - Blue pike

Stizostedion vitreum vitreum (Mitchill) - Walleye

Thymallus arcticus (Pallas) (=T. signifer (Richardson) - Arctic grayling

SYNOPTIC TABLES OF FISH PARASITES AND THEIR DISTRIBUTION IN MANITOBA

TABLE A

Distribution of *Dibothriocephalus* in Manitoba

Locality	Species of *Dibothriocephalus* *latus*	*sp.*	Fish Species Infected with *Dibothriocephalus* Plerocercoid	Authority
Lake Winnipeg	x		Stizostedion vitreum	Magath, 1927
Lake Winnipeg	x		Esox lucius	Nicholson, 1928
Lake Winnipeg	x		Esox lucius	Vergeer, 1928-29
Lake Winnipeg	x		Esox lucius	Nicholson, 1932
Lake Winnipeg	x		Stizostedion canadense	Bajkov, 1933
Lake Winnipeg	x		Perca flavescens	Bajkov, 1933
Lake Winnipeg	x		Esox lucius	Bajkov, 1933
Lake Winnipeg	x		Lota lota maculosa	Bajkov, 1933
Lake Winnipeg	x		Stizostedion vitreum	Bajkov, 1933
Lake Winnipeg	x		Esox lucius	Wardle, 1932-33
Lake Winnipeg	x		Perca flavescens	Wardle, 1932-33
Lake Winnipeg	x		Stizostedion vitreum	Wardle, 1932-33

TABLE A (cont'd)

Distribution of Dibothriocephalus in Manitoba

Locality	Species of Dibothriocephalus latus	Species of Dibothriocephalus sp.	Fish Species Infected with Dibothriocephalus Plerocercoid	Authority
Lake Winnipeg	x		Stizostedion canadense	Wardle, 1932-33
Lake Manitoba	x		Stizostedion vitreum	Nicholson, 1928
Lake Manitoba	x		Stizostedion vitreum	Vergeer, 1928-29
Lake Winnipegosis	x		Stizostedion vitreum	Vergeer, 1928-29
Lake Winnipegosis	x		Esox lucius	Wardle, 1932-33
Lake Winnipegosis	x		Perca flavescens	Wardle, 1932-33
Lake Winnipegosis	x		Stizostedion vitreum	Wardle, 1932-33
Lake Winnipegosis	x		Stizostedion canadense	Wardle, 1932-33
Lake Winnipegosis	x	x	Lota lota maculosa	Wardle, 1932-33
Lake Wellman		x	Stizostedion vitreum	Stewart-Hay, 1951
Lake Wellman	x		Stizostedion vitreum	Harvey, 1955
Lake Wellman	x		Perca flavescens	Harvey, 1955

TABLE A (cont'd)

Distribution of Dibothriocephalus in Manitoba

Locality	Species of Dibothriocephalus latus	Species of Dibothriocephalus sp.	Fish Species Infected with Dibothriocephalus Plerocercoid	Authority
Lake Wellman	x		Esox lucius	Harvey, 1955
Lake Childs		x	Salvelinus namaycush	Stewart-Hay, 1951
Lake Armit		x	Esox lucius	Stewart-Hay, 1952
Lake Pickerel		x	Esox lucius	Stewart-Hay, 1952
Lake Pickerel		x	Stizostedion vitreum	Stewart-Hay, 1952
Lake Bell	x		Esox lucius	Stewart-Hay, 1952
Lake South Steeprock	x		Esox lucius	Stewart-Hay, 1952
Lake North Steeprock	x		Esox lucius	Stewart-Hay, 1952
Lake Burton	x		Esox lucius	Stewart-Hay, 1952
Lake Burton	x		Perca flavescens	Stewart-Hay, 1952
Lake Athapapuskow		x	Stizostedion vitreum	Stewart-Hay, 1953
Lake Athapapuskow	x		Salvelinus namaycush	Stewart-Hay, 1953

TABLE A (cont'd)

Distribution of *Dibothriocephalus* in Manitoba

Locality	Species of Dibothriocephalus		Fish Species Infected with Dibothriocephalus Plerocercoid	Authority
	latus	sp.		
Lake Athapapuskow	x		Esox lucius	Stewart-Hay, 1953
Lake Second Cranberry		x	Salvelinus namaycush	Stewart-Hay, 1953
Lake Hemming	x		Esox lucius	Lawler & Watson, 1958
Lake Hemming	x		Stizostedion vitreum	Lawler & Watson, 1958

TABLE B

Distribution of *Triaenophorus* in Manitoba

Locality	Species of *Triaenophorus*: sp.	stizostedionis	crassus	nodulosus	Fish Species Infected(*)	Authority
Lake Winnipeg			x		Coregonus clupeaformis-P	Newton, 1932
Lake Winnipeg			x		Leucichthys sp.-P	Nicholson, 1932
Lake Winnipeg			x		Esox lucius-A	Ekbaum, 1937
Lake Manitoba			x		Leucichthys sp.-P	Keleher, J.J., 1952
Lake Winnipegosis			x		Coregonus clupeaformis-P	Newton, 1932
Lake Dauphin			x		Coregonus clupeaformis-P	Newton, 1932
Lake Dauphin		x			Stizostedion vitreum-P	Stewart-Hay, 1951
Lake St. Martin			x		Coregonus clupeaformis-P	Newton, 1932
Lakes in The Pas District			x		Leucichthys sp.-P	Newton, 1932
Lake Kississing			x		Coregonus clupeaformis-P	Nicholson, 1932
Lake Athapapuskow			x		Coregonus clupeaformis-P	Nicholson, 1932
Lake Athapapuskow			x	x	Coregonus clupeaformis-P	Stewart-Hay, 1953

(*) - Adult-A; Plerocercoid-P.

TABLE B (cont'd)

Distribution of Triaenophorus in Manitoba

Locality	Species of Triaenophorus sp.	stizostedionis	crassus	nodulosus	Fish Species Infected(*)	Authority
Lake Athapapuskow			x	x	Salvelinus namaycush-P	Stewart-Hay, 1953
Lake Athapapuskow			x	x	Esox lucius-A	Stewart-Hay, 1953
Lake Athapapuskow	x				Leucichthys sp.-P	Stewart-Hay, 1953
Lake Heming			x		Coregonus clupeaformis-P	Lawler, 1950
Lake Heming			x		Leucichthys sp.-P	Lawler, 1950
Lake Heming			x	x	Lota lota maculosa-P	Lawler, 1950
Lake Heming				x	Perca flavescens-P	Lawler, 1950
Lake Heming			x	x	Esox lucius-A	Lawler, 1950
Lake Heming		x			Percopsis omiscomaycus-P	Lawler, 1950
Lake Heming		x			Stizostedion vitreum-A	Lawler, 1950
Lake Heming				x	Cottus cognatus gracilis-P	Lawler, 1951
Lake Heming		x			Cottus cognatus gracilis-P	Lawler, 1953 (unpub.)

(*) - Adult-A; Plerocercoid-P.

TABLE B (cont'd)

Distribution of *Triaenophorus* in Manitoba

Locality	Species of *Triaenophorus*: sp.	stizostedionis	crassus	nodulosus	Fish Species Infected(*)	Authority
Lake Heming			x		Coregonus clupeaformis-P	Lawler & Watson, 1958
Lake Heming			x		Leucichthys sp.-P	Lawler & Watson, 1958
Lake Heming			x	x	Esox lucius-A	Lawler & Watson, 1958
Lake Heming				x	Perca flavescens-P	Lawler & Watson, 1958
Lake Heming				x	Cottus cognatus gracilis-P	Lawler & Watson, 1958
Lake Heming				x	Lota lota lucustris-P	Lawler & Watson, 1958
Lake Wellman	x				Stizostedion vitreum-P	Stewart-Hay, 1951
Lake Wellman				x	Perca flavescens-P	Stewart-Hay, 1951
Lake Childs	x				Salvelinus namaycush-P	Stewart-Hay, 1951
Lake Armit			x		Coregonus clupeaformis-P	Stewart-Hay, 1952
Lake Armit			x	x	Esox lucius-A	Stewart-Hay, 1952
Lake South Steeprock				x	Esox lucius-A	Stewart-Hay, 1952

(*) - Adults-A; Plerocercoid-P.

TABLE B (cont'd)

Distribution of Triaenophorus in Manitoba

Locality	Species of Triaenophorus sp.	stizostedionis	crassus	nodulosus	Fish Species Infected(*)	Authority
Lake Burton	x				Esox lucius-A	Stewart-Hay, 1952
Lake Pickerel	x				Esox lucius-A	Stewart-Hay, 1952
Lake Second Cranberry		x			Stizostedion vitreum-A	Stewart-Hay, 1953
Lake Second Cranberry	x				Coregonus clupeaformis-P	Stewart-Hay, 1953
Lake Nueltin			x		Coregonus clupeaformis-P	Federal Department of Fisheries (Lawler & Scott, 1954)
Hudson Bay drainage system	x				Esox lucius-A	Wardle, 1932
Hudson Bay drainage system	x				Coregonus sp.-P	Wardle, 1932
Hudson Bay drainage system	x				Leucichthys sp.-P	Wardle, 1932
Hudson Bay drainage system	x				Perca flavescens-P	Wardle, 1932
Lake Forbes			x		Salvelinus namaycush-P	Present Paper
Winnipeg River		x			Stizostedion vitreum-A	Present Paper

(*) - Adult-A; Plerocercoid-P.

TABLE C

Distribution of Eubothrium in Manitoba

Locality	Species of Eubothrium			Fish Species Infected(*)	Authority
	rugosum	salvelini	sp.		
Lake Winnipeg	x			Lota lota maculosa-A	Ekbaum, 1933
Lake Winnipeg	x			Lota lota maculosa-A	Wardle, 1932
Lake Clear		x		Salvelinus namaycush-A	Ekbaum, 1933
Lake Clear		x		Salvelinus namaycush-A	Wardle, 1932
Lake Wellman			x	Stizostedion vitreum-P	Stewart-Hay, 1951
Lake North Steeprock	x			Lota lota maculosa-A	Stewart-Hay, 1952
Lake Athapapuskow		x		Salvelinus namaycush-A	Stewart-Hay, 1953
Lake Athapapuskow	x			Lota lota maculosa-A	Stewart-Hay, 1953
Lake Second Cranberry		x		Salvelinus namaycush-A	Stewart-Hay, 1953
Lake Groschak			x	Esox lucius-A	McTavish, 1953 (56)

* - Adult-A; Immature-I; Plerocercoid-P.

TABLE D

Distribution of *Bothriocephalus* and *Ligula* in Manitoba

Locality	Species of *Bothriocephalus* *cuspidatus*	*sp.*	Species of *Ligula* *intestinalis*	*sp.*	Fish Species Infected (*)	Authority
Lake Winnipeg			x		Catostomus commersonni-P	Wardle, 1932
Lake Winnipeg			x		Catostomus catostomus-P	Wardle, 1932
Lake Winnipeg			x		Notropis hudsonius selene-P	Wardle, 1932
Hudson Bay drainage system	x				Stizostedion canadense-A	Wardle, 1932
Hudson Bay drainage system	x				Stizostedion vitreum-A	Wardle, 1932
Hudson Bay drainage system	x				Hiodon chrysopsis-A	Wardle, 1932
Hudson Bay drainage system	x				Hiodon tergisus-A	Wardle, 1932
Hudson Bay drainage system	x				Esox lucius-A	Wardle, 1932
Hudson Bay drainage system	x				Perca flavescens-A	Wardle, 1932

* - Adult-A; Immature-I; Plerocercoid-P; Not Reported-N.

TABLE D (cont'd)

Distribution of Bothriocephalus and Ligula in Manitoba

Locality	Species of Bothriocephalus cuspidatus	Species of Bothriocephalus sp.	Species of Ligula intestinalis	Species of Ligula sp.	Fish Species Infected (*)	Authority
Hudson Bay drainage system	x				Leucichthys sp.--A	Wardle, 1932
Lake Caddy	x				Stizostedion vitreum-A	McLeod, 1943
Lake Wellman	x				Stizostedion vitreum-A	Stewart-Hay, 1951
Lake Wellman	x				Stizostedion vitreum-N	Little, 1954
Lake Wellman	x				Esox lucius-N	Little, 1954
Lake Wellman	x				Salvelinus namaycush-N	Little, 1954
Lake Dauphin	x				Stizostedion vitreum-I&A	Stewart-Hay, 1951
Lake Dauphin	x				Stizostedion vitreum-N	Little, 1954
Lake Dauphin	x				Esox lucius-N	Little, 1954
Lake Dauphin	x				Salvelinus namaycush-N	Little, 1954
Lake Childs	x				Stizostedion vitreum-N	Little, 1954
Lake Childs	x				Esox lucius-N	Little, 1954

* - Adult-A; Immature-I; Plerocercoid-P; Not Reported-N.

TABLE D (cont'd)

Distribution of Bothriocephalus and Ligula in Manitoba

Locality	Species of Bothriocephalus cuspidatus	Species of Bothriocephalus sp.	Species of Ligula intestinalis	Species of Ligula sp.	Fish Species Infected (*)	Authority
Lake Childs	x				Salvelinus namaycush-N	Little, 1954
Lake Childs	x				Salvelinus namaycush-I&A	Stewart-Hay, 1951
Lake Pickerel	x				Stizostedion vitreum-A	Stewart-Hay, 1952
Lake Pickerel				x	Notropis hudsonius-P	Stewart-Hay, 1952
Lake Pickerel	x				Stizostedion vitreum-N	Little, 1954
Lake Pickerel	x				Esox lucius-N	Little, 1954
Lake Pickerel	x				Salvelinus namaycush-N	Little, 1954
Lake Burton		x			Esox lucius-A	Stewart-Hay, 1952
Lake Burton		x			Perca flavescens-P	Stewart-Hay, 1952
Lake South Steeprock				x	Esox lucius-P	Stewart-Hay, 1952
Lake South Steeprock				x	Notropis hudsonius-P	Stewart-Hay, 1952

* - Adult-A; Immature-I; Plerocercoid-P; Not Reported-N.

TABLE D (cont'd)

Distribution of *Bothriocephalus* and *Ligula* in Manitoba

Locality	Species of *Bothriocephalus* *cuspidatus*	*sp.*	Species of *Ligula* *intestinalis*	*sp.*	Fish Species Infected (*)	Authority
Lake North Steeprock				x	Notropis hudsonius-P	Stewart-Hay, 1952
Lake Armit				x	Notropis hudsonius-P	Stewart-Hay, 1952
Lake Athapapuskow				x	Coregonus clupeaformis-P	Stewart-Hay, 1952
Lake Athapapuskow	x				Stizostedion vitreum-N	Little, 1954
Lake Athapapuskow	x				Esox lucius-N	Little, 1954
Lake Athapapuskow	x				Salvelinus namaycush-N	Little, 1954
Lake Snow	x				Stizostedion vitreum-N	Little, 1954
Lake Snow	x				Esox lucius-N	Little, 1954
Lake Snow	x				Salvelinus namaycush-N	Little, 1954
Lake Glad	x				Stizostedion vitreum-N	Little, 1954
Lake Glad	x				Esox lucius-N	Little, 1954
Lake Glad	x				Salvelinus namaycush-N	Little, 1954

* - Adult-A; Immature-I; Plerocercoid-P; Not Reported-N.

TABLE D (cont'd)

Distribution of Bothriocephalus and Ligula in Manitoba

Locality	Species of Bothriocephalus		Species of Ligula		Fish Species Infected (*)	Authority
	cuspidatus	sp.	intestinalis	sp.		
Lake Whitefish	x				Stizostedion vitreum-N	Little, 1954
Lake Whitefish	x				Esox lucius-N	Little, 1954
Lake Whitefish	x				Salvelinus namaycush-N	Little, 1954
Mossey River	x				Stizostedion vitreum-N	Little, 1954
Mossey River	x				Esox lucius-N	Little, 1954
Mossey River	x				Salvelinus namaycush-N	Little, 1954
Lake Heming			x		Catostomus commersonni-N	Lawler & Watson, 1958
Lake Heming			x		Notropis hudsonius-N	Lawler & Watson, 1958
Winnipeg River	x				Stizostedion vitreum-A	Present Paper
Winnipeg River		x			Perca flavescens-I	Present Paper
Lake Hunt			x		Catostomus commersonni-I	Dickson, 1959 (unpub.)

* - Adult-A; Immature-I; Plerocercoid-P; Not Reported-N.

TABLE E

Distribution of *Proteocephalus* in Manitoba

Locality	*luciopercae*	*pinguis*	*laruei*	*singularis*	*coregoni*	*pusillus*	*sp.*	Fish Species Infected (*)	Authority
Lake Winnipeg	x							Stizostedion vitreum-A	Wardle, 1932
Lake Winnipeg	x							Stizostedion canadense-A	Wardle, 1932
Lake Winnipeg		x						Esox lucius-A	Wardle, 1932
Lake Winnipeg			x					Coregonus clupeaformis-A	Wardle, 1932
Lake Winnipeg			x					Leucichthys zenithicus-A	Wardle, 1932
Lake Winnipeg			x					Leucichthys hoyi-A	Wardle, 1932
Lake Winnipeg	x							Stizostedion vitreum-A	Little, 1954
Lake Winnipeg	x							Stizostedion canadense-A	Little, 1954
Lake Winnipegosis		x						Esox lucius-A	Wardle, 1932
Lake Caddy							x	Esox lucius-A	McLeod, 1943
Lake Dauphin	x							Stizostedion vitreum-I&A	Stewart-Hay, 1951
Lake Dauphin		x						Esox lucius-A	Stewart-Hay, 1951
Lake Dauphin	x							Stizostedion vitreum-A	Little, 1954
Lake Dauphin	x							Stizostedion canadense-A	Little, 1954
Lake Dauphin		x						Esox lucius-A	Little, 1954

* - Adult-A; Immature-I; Plerocercoid-P.

TABLE E (cont'd)

Distribution of *Proteocephalus* in Manitoba

Locality	luciopercae	pinguis	laruei	singularis	coregoni	pusillus	sp.	Fish Species Infected (*)	Authority
Lake Pickerel	x							Stizostedion vitreum-A	Stewart-Hay, 1951
Lake Pickerel							x	Esox lucius-A	Stewart-Hay, 1952
Lake Wellman	x							Stizostedion vitreum-I	Stewart-Hay, 1951
Lake Wellman		x						Esox lucius-A	Little, 1954
Lake Wellman				x				Coregonus clupeaformis-A	Little, 1954
Lake Armit					x			Coregonus clupeaformis-I&A	Stewart-Hay, 1952
Lake Armit		x						Esox lucius-A	Stewart-Hay, 1952
Lake Bell		x						Esox lucius-A	Stewart-Hay, 1952
Lake Bell		x						Esox lucius-A	Little, 1954
Lake South Steeprock		x						Esox lucius-A	Stewart-Hay, 1952
Lake North Steeprock		x						Esox lucius-I	Stewart-Hay, 1952
Lake North Steeprock		x						Esox lucius-A	Little, 1954
Lake Burton							x	Esox lucius-I	Stewart-Hay, 1952
Lake Burton							x	Perca flavescens-P	Stewart-Hay, 1952
Lake Burton		x						Esox lucius-A	Little, 1954

* - Adult-A; Immature-I; Plerocercoid-P.

TABLE E (cont'd)

Distribution of Proteocephalus in Manitoba

Locality	luciopercae	pinguis	laruei	singularis	coregoni	pusillus	sp.	Fish Species Infected (*)	Authority
Lake Second Cranberry	x							Stizostedion vitreum-A	Stewart-Hay, 1953
Lake Second Cranberry			x		x			Leucichthys sp.-A	Stewart-Hay, 1953
Lake Athapapuskow	x							Stizostedion vitreum-A	Stewart-Hay, 1953
Lake Athapapuskow			x		x			Leucichthys sp.-A	Stewart-Hay, 1953
Lake Athapapuskow					x			Salvelinus namaycush-A	Stewart-Hay, 1953
Lake Athapapuskow					x			Coregonus clupeaformis-A	Stewart-Hay, 1953
Lake Athapapuskow		x						Esox lucius-A	Stewart-Hay, 1953
Lake Athapapuskow		x						Esox lucius-A	Little, 1954
Lake Athapapuskow						x		Leucichthys tullibee-A	Little, 1954
Lake Heming	x							Stizostedion vitreum-A	Little, 1954
Lake Heming		x						Esox lucius-A	Little, 1954
Lake Heming	x							Stizostedion vitreum-N	Lawler & Watson, 1958
Lake Heming		x						Esox lucius-N	Lawler & Watson, 1958
Lake Heming				x				Coregonus clupeaformis-N	Lawler & Watson, 1958
Lake Snow		x						Esox lucius-A	Little, 1954

* - Adult-A; Immature-I; Plerocercoid-P.

TABLE E (cont'd)

Distribution of Proteocephalus in Manitoba

Locality	luciopercae	pinguis	laruei	singularis	coregoni	pusillus	sp.	Fish Species Infected (*)	Authority
Lake South Indian				x				Coregonus clupeaformis-A	Little, 1954
Lake Manitoba				x				Coregonus clupeaformis-A	Little, 1954
Lake Groschak							x	Esox lucius-A	McTavish, 1953
Winnipeg River							x	Perca flavescens--I	Present Paper
Winnipeg River	x							Stizostedion vitreum-A	Present Paper

* - Adult-A; Immature-I; Plerocercoid-P.

TABLE F

Distribution of other Cestoda in Manitoba

Locality	Species of Glaridacris catostomi	Species of Glaridacris sp.	Species of Schistocephalus solidus	Species of Schistocephalus sp.	Cyathocephalus truncatus	Corallobothrium fimbriatum	Spartoides Wardi	Fish Species Infected (*)	Authority
Lake Winnipeg					x			Coregonus clupeaformis-A	Wardle, 1932
Lake Winnipeg					x			Leucichthys zenithicus-A	Wardle, 1932
Lake Winnipeg						x		Ameiurus nebulosus-A	Wardle, 1932
Lake Dauphin							x	Carpiodes cyprinus-A	Stewart-Hay, 1951
Lake Dauphin			x					Notropis hudsonius-P	Stewart-Hay, 1951
Lake Armit		x						Catostomus commersoni-A	Stewart-Hay, 1952
Lake Armit				x				Pungitius pungitius-P	Stewart-Hay, 1952
Lake Whitefish				x				Pungitius pungitius-P	Stewart-Hay, 1952
Lake Athapapuskow	x							Catostomus catostomus-A	Stewart-Hay, 1953
Lake Heming			x					Cottus cognatus gracilis-N	Lawler & Watson, 1958
Lake Heming			x					Eucalia inconstans-N	Lawler & Watson, 1958

(*) - Adult-A; Immature-I; Plerocercoid-P; Not Reported-N.

TABLE G

Distribution of Trematoda in Manitoba

Locality	Metorchis conjunctus	Crepidostomum cooperi	Amphimerus pseudofelinus	Centrovarium lobotes	Clinostomum marginatum	Bucephalopsis pusilla	Fish Species Infected(*)	Authority
Lake Cormorant	x						Catostomus commersoni-L	Allen & Wardle, 1934
Lake Dauphin				x			Stizostedion vitreum-A	Stewart-Hay, 1951
Lake Wellman		x					Perca flavescens-A	Stewart-Hay, 1951
Lake Burton					x		Perca flavescens-L	Stewart-Hay, 1952
Lake Winnipeg	x						Catostomus commersoni-L	Evans,M.Sc.Thesis,1963
Lake Winnipeg	x						Perca flavescens-L	Evans,M.Sc.Thesis,1963
Lake Winnipeg						x	Stizostedion vitreum-A	Woodhead, 1930
Lake Manitoba			x				Catostomus commersoni-L	Evans, 1962
Lake Caribou					x		Perca flavescens-L	Evans, 1963(pers.comm.)
Lake Wallace					x		Perca flavescens-L	Evans, 1963(pers.comm.)
Lake Wallace					x		Stizostedion vitreum-L	Evans, 1963(pers.comm.)
Lake Shoal					x		Perca flavescens-L	Evans, 1963(pers.comm.)
Winnipeg River		x					Perca flavescens-A	Present Paper
Winnipeg River				x		x	Stizostedion vitreum-A	Present Paper

Note: The author has found Clinostomum sp. in Perca flavescens, Salmo irideus, Micropterus dolomieu, Stizostedion vitreum and Ambloplites rupestris from lakes in the Manitoba Whiteshell Forest Reserve. This parasite is believed to be widely distributed throughout the lakes in Manitoba.

(*) - Adult-A; Larva-L.

TABLE H

Distribution of Nematoda in Manitoba

Locality	Species of Raphidascaris		Cystidicola	Rhabdochona			
	canadensis	sp.	stigmatura	cascadilla	Spinitectus sp.	Fish Species Infected(*)	Authority
Lake Winnipeg	x					Esox lucius-A	Smedley,1933
Lake Winnipeg			x			Coregonus clupeaformis-A	Smedley,1933
Lake Winnipegosis	x					Esox lucius-A	Smedley,1933
Lakes in The Pas District	x					Esox lucius-A	Smedley,1933
Lakes in The Pas District			x			Coregonus clupeaformis-A	Smedley,1933
Lake Caddy	x	x				Esox lucius-A	McLeod,1943
Lake Dauphin	x					Esox lucius-A	Stewart-Hay,1951
Lake Dauphin		x				Stizostedion vitreum-N	Stewart-Hay,1951
Lake Burton	x					Esox lucius-A	Stewart-Hay,1952
Lake Burton		x				Perca flavescens-L	Stewart-Hay,1952
Lake Armit	x					Esox lucius-A	Stewart-Hay,1952
Lake Bell	x					Esox lucius-A	Stewart-Hay,1952
Lake North Steeprock	x					Esox lucius-A	Stewart-Hay,1952
Lake South Steeprock	x					Esox lucius-A	Stewart-Hay,1952
Lake Pickerel		x				Esox lucius-A	Stewart-Hay,1952
Lake Pickerel	x					Stizostedion vitreum-N	Stewart-Hay,1952
Lake Athapapuskow	x					Esox lucius-A	Stewart-Hay,1953
Lake Athapapuskow			x			Salvelinus namaycush-A	Stewart-Hay,1953

(*) - Adult-A; Larva-L; Not Reported-N.

TABLE H (cont'd)

Distribution of Nematoda in Manitoba

Locality	Species of Raphidascaris canadensis	Species of Raphidascaris sp.	Cystidicola stigmatura	Rhabdochona cascadilla	Spinitectus sp.	Fish Species Infected(*)	Authority
Lake Second Cranberry			x			Coregonus clupeaformis-A	Stewart-Hay,1953
Lake Second Cranberry			x			Salvelinus namaycush-A	Stewart-Hay,1953
Lake Forbes			x			Salvelinus namaycush-A	Present Paper
Winnipeg River	x			x	x	Perca flavescens-I & A	Present Paper
Winnipeg River				x	x	Stizostedion vitreum-I & A	Present Paper

(*) - Adult-A; Larva-L; Not Reported-N.

TABLE I

Distribution of *Acanthocephala* in Manitoba

Locality	Species of *Neoechinorhynchus*			*Echinorhynchus*	Species of *Pomphorhynchus*		*Tanaorhamphus* sp.	Fish Species Infected	Authority
	crassus	*cylindratus*	*sp.*	*coregoni*	*bulbocolli*	*sp.*			
Lake Dauphin	x					x		Stizostedion vitreum	Stewart-Hay,1951
Lake Dauphin	x				x			Catostomus commersoni	Stewart-Hay,1951
Lake Dauphin	x				x			Catostomus catostomus	Stewart-Hay,1951
Lake Wellman					x			Catostomus commersoni	Stewart-Hay,1951
Lake Burton			x					Catostomus commersoni	Stewart-Hay,1952
Lake Pickerel			x					Stizostedion vitreum	Stewart-Hay,1952
Lake South Steeprock					x			Catostomus commersoni	Stewart-Hay,1952
Lake North Steeprock					x		x	Catostomus commersoni	Stewart-Hay,1952
Lake Armit						x		Catostomus commersoni	Stewart-Hay,1952
Lake Athapapuskow				x				Coregonus clupeaformis	Stewart-Hay,1953
Lake Athapapuskow				x				Salvelinus namaycush	Stewart-Hay,1953
Lake Athapapuskow				x				Catostomus catostomus	Stewart-Hay,1953
Lake Second Cranberry				x				Coregonus clupeaformis	Stewart-Hay,1953
Winnipeg River		x						Stizostedion vitreum	Present Paper
Winnipeg River		x						Perca flavescens	Present Paper

TABLE J

Distribution of parasitic *Copepoda* in Manitoba

Locality	*Argulus stizostethi*	*Salmincola* sp.	*Ergasilus* sp.	Fish Species Infected	Authority
Lake Dauphin	x			Stizostedion vitreum	Stewart-Hay,1951
Lake Dauphin	x			Catostomus commersoni	Stewart-Hay,1951
Lake Armit			x	Notropis sp.	Stewart-Hay,1952
Lake Armit			x	Perca flavescens	Stewart-Hay,1952
Lake Pickerel			x	Perca flavescens	Stewart-Hay,1952
Lake Whitefish			x	Notropis hudsonius	Stewart-Hay,1952
Lake Whitefish			x	Pungitius pungitius	Stewart-Hay,1952
Lake Second Cranberry		x		Salvelinus namaycush	Stewart-Hay,1953
Lake Caddy			x	Perca flavescens	McLeod, 1943
Lake Caddy			x	Stizostedion vitreum	McLeod, 1943