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INCIDENCE OF INFECTION OF FISH WITH *CLINOSTOMUM MARGINATUM* IN NORTHERN MINNESOTA[1]

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Although the life cycle of *Clinostomum marginatum* has been well worked out,[2] to the knowledge of the author there has been little study made as to its incidence in the fish of northern Minnesota lakes. It was for the purpose of gathering data on this problem that a survey of the *Clinostomum* infection in the fish of five northern Minnesota lakes was conducted from June, 1938 to April, 1939. The work was largely made possible through a W. P. A. project which provided much of the labor for the study. The nets used in making the catches were obtained from the Minnesota Department of Conservation.

The adult form of the parasite, *Clinostomum marginatum,* was described in detail by Osborn.[3] These flukes, according to Hunter and Hunter,[4] live in the pharynx of the great blue heron, the most common primary host, a fish-eating bird which summers in the Great Lakes area. Mature eggs may reach the water as the bird is feeding, hatching in ½ to 4 hours to miracidia which remain viable for 6 to 8 hours. The miracidia usually penetrate the snail, *Helisoma campanulatum,* and there transform into mother sporocysts. Subsequent development produces rediae, which in turn produce daughter rediae. These yield fork-tail cercariae which may infect a number of common fresh water fish. The cercariae encyst on the fins and penetrate beneath the scales over other parts of the body, developing in about twenty weeks into the metacercariae or the familiar "yellow grub." In such an encysted condition the parasite may live for months. If eaten by the bird host, it excysts in the stomach, migrates up the esophagus, and matures in three to five days.

The waters from which the fish were taken, with two exceptions were within the Mississippi watershed. Lake Bemidji and Lake Irving on the Mississippi River and Lake Plantagnet on the Schoolcraft River were selected for seining activities because of the abundance and accessibility of their game fish. Bass Lake, a small spring-fed lake draining into Lake Bemidji, was also studied. Grace Lake, lying southeast of Bemidji, was chosen as a survey site because it had no inlet or outlet and it seemed probable that its fauna would

[1] Research conducted at the Biological Laboratories of the State Teachers College, Bemidji, Minnesota, under the direction of Dr. A. M. Elliott.

[2] Hunter, G. W. III and Wanda S., 1934, *Further studies on fish and bird parasites.* Supplement to 24th Annual Report of N. Y. Conservation Dept., No. LX, p. 267–283.

[3] Osborn, H. L., 1911, *On the distribution and mode of occurrence in the U. S. and Canada of Clinostomum marginatum,* Biol. Bull. 20: 350–366.

[4] Hunter, G. W. III and Wanda S., op. cit.

vary from lakes lying in river courses. Fish were also caught in the Mississippi River downstream from Lake Bemidji, in the Schoolcraft River, and in Mud Creek in the Red Lake watershed.

All catches from these locations in the fall and summer were made by W. P. A. men using a seine. Identification of the metacercariae was usually made upon the site of the seining activities although a few specimens were brought back to the laboratory and autopsied. Since most of the fish were returned to the water after a brief examination, and because the seining activities centered about the same regions of the lake, some method of marking the fish that had been examined became necessary. Fish that were found to be infected had the right pectoral fin cut off, while those that were free from infection had their left pectoral fin removed. Many fish were taken more than once but this procedure of marking made it possible to prevent recounting the fish. During the winter months seining became impossible and fish had to be taken through the ice. The number of fish that were obtained was therefore greatly reduced and for much of the data that has been compiled the results from these catches were omitted. It must be remembered that much of the work of identifying the parasites was done by W. P. A. labor. Although these men were instructed how to identify the metacercariae, the possibility that some mistakes may have been made must be admitted. The general results and conclusions of this survey, however, would probably be little changed by any errors that might have been made. We must also bear in mind the fact that examination for the parasite was hurried and if all specimens had been autopsied we may safely assume the percentage of infection would be higher. For example, one perch showing five external metacercariae, when autopsied, showed over one hundred encysted parasites. Other fish showing no evidence of external infection were actually heavily infected.

The greatest number of fish that were taken were yellow perch (*Perca flavescens*). Of the 1,132 perch examined 379 (33.5%) were found to be infected with *Clinostomum*. Rock bass, however, showed the highest percentage of infection with 30 out of 78 fish (38.4%) harboring the parasite. 31 out of 90 tullibee (34.4%) were infected. A low percentage of infection was found in the common sunfish (8.0%), white sucker (6.4%), and the pickerel or northern pike (3.0%). The wall-eyed pike, red horse, and bullhead that were examined showed no "yellow grubs."

Because yellow perch were netted in the largest numbers, the data obtained from an examination of these fish was used as a basis for determining the variation in the incidence of infection as related to the time of the year and the type of lake surveyed. The percentage of infection rose from 41.3% in July to 67.3% in October. In November the percentage of infection dropped to 13.5%, only 59 of the 432 fish examined harbored the parasite. (The sudden decrease may partially be due to the fact that a great number of

fish taken in November were from Mud Creek, which had a comparatively low percentage of infection. Fish from other sources, however, showed a marked decrease in the percentage of the infestation after October.) In July 138 out of 334 fish were found to be infected, in August 70 out of 161, in September 69 out of 142, and in October 35 out of 52. Since the fish obtained during the winter months were so few, the data and compilations have been omitted. However, in spite of the small number of specimens taken, the incidence of infection in the perch remained high enough so that we can safely assume that this fish can act as a host to the metacercariae of *Clinostomum* throughout the winter. When four perch, caught February 23 were autopsied it was found that all were infected. Thirty-five perch caught April 17 in a small inland lake near Bemidji from which catches had not previously been taken, showed a 100% infection.

A complementary survey of the Rabideau Lake heronry[5] disclosed the evidence that herons returning to this location in the spring do not seem to carry the parasite but become infected soon after their return. On April 1, 1938 four birds were taken at the Rabideau heronry and none showed any signs of infestation. Nine days later four birds were taken and upon examination it was found that one was acting as a host to adult *Clinostomum*. Herons taken later in the spring always showed a hundred per cent infection. This evidence further points out that the yellow perch because of its great numbers and high incidence of infection, act as the principle reservoir of the infection. It is also interesting to note that tullibees, heavily infected in the late fall showed no infection whatsoever after the middle of December. Although the number of tullibee taken was comparatively few, this evidence might lead one to believe that they do not carry the parasite until spring.

Sixty-three per cent of the yellow perch caught in Grace Lake had *Clinostomum* infection, but the fish of Lakes Plantagnet and Irving were also heavily infected, showing a 49% and 47% infection respectively. Because of this high incidence we can say that these lakes may be classed as epidemic centers of the infection. The Schoolcraft River perch were found to be 36% infected, Lake Bemidji perch 34% infected, and the perch from Mud Creek showed a 13% infection. No species of fish from Bass Lake were found to be a host to the parasite.

Although the numbers of fish examined were not large the survey indicates that there exists a very high incidence of infection of *Clinostomum marginatum* in the fish of some northern Minnesota lakes and rivers. Since many of these lakes are important sport-

[5] This is the largest heronry in the Bemidji vicinity, covering some 80 acres. It was found that there were about 30 nests on each 100 square rods of ground making an estimated total of nearly 4,000 nests in the heronry. If one would figure two adults and three young per nest this heronry would have a population of about 20,000 birds. Other known heronries in this region are at Grace Lake and Itasca State Park.

fishing centers there is no doubt that the situation is of some direct commercial importance. The data that we have obtained also indicates that the percentage of infection increases throughout the summer and reaches its height in the early fall. An attempt has been made to show that the yellow perch is the principle reservoir of the infection. Perhaps the infection could be most easily checked by reducing the numbers of the great blue heron, but the consequences of such an undertaking can only be conjectured. Before any definite moves be made in attempting to reduce the high percentage of infection of fish with *Clinostomum marginatum* in northern Minnesota, much intensive work along the lines of this survey is needed.

FOOD AND DEVELOPMENT OF THE WORKER AND THE QUEEN HONEYBEE

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THE LIGHT RESPONSE OF THE MARINE TUBIFICID WORM, *CLITELLIO ARENARIUS*

(O. F. Müller) Published in Jour. Exp. Zool. 82:397–417. 1939.

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LIGHT AND PITUITARY ACTIVITY IN THE BIRD

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The seasonal character of reproductive activity in many of our wild birds is substantial evidence for the belief that some environmental factor is concerned in effecting the sexual cycle. Ever since the initial observations of Rowan [1, 2] on the junco and of Bisson-

[1] Rowan, W. Relation of light to bird migration and developmental changes. Nature. 115:494–495. 1925.

[2] ———. The riddle of migration. The Williams and Wilkins Co., Baltimore. 1931.