

THE OHIO JOURNAL OF SCIENCE

VOL. XXVI

MAY, 1926

No. 3

PARASITES OTHER THAN CESTODES IN BLACK BASS OF OHIO.

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While studying the cestode parasites of large- and small-mouth bass many other parasites were found and identified. Often certain of these were more injurious to the host than the cestodes present. This was especially true of the acanthocephala which were found most often in the adult fish and in the largest numbers. No attempt will be made to give complete records for each species of parasite, but sufficient data will be included to give distribution records and degree of infestation.

TREMATODE PARASITES.

Ancyrocephalus sp.

This gill parasite is either *A. paradoxus* (Crepl.) or *A. cruciatus* (Weld.)

Cooper (1915, p. 190) reported these species from gills of *M. dolomieu*.

J. Stafford, 1905, reported the occurrence of *Tetraonchus unguiculatus* Wag.—(*A. paradoxus* Crepl.) from *Ambloplitis rupestris* and *Eupomotis gibbosus*.

H. J. Van Cleve (1921, p. 37) reports light infestation on gills of *Lepomis pallidus*, *Ictalurus punctatus*, *Lepomis humilis*, and *M. salmoides* at the Fisheries Biological Station, Fairport, Iowa.

These were found on the gills of young large-mouth bass taken in the vicinity of Put-in-Bay and West Harbor, Lake Erie. The bass varied in length from 21–42 mm. There were from 5–20 of these trematodes on the gills of the fish found infested. Only a small proportion of the fish were infested.

Cryptogonimus chyli Osborn.

This form was described by H. L. Osborn in 1903 (p. 517-536), from fishes of Michigan and New York. The species was reported for *M. dolomieu*, from Lake Chautauqua, N. Y., and from St. Mary's River, Mich. It was also reported for *Ambloplitis rupestris* in Canadian waters by Stafford, '05.

The adults of this species were found in the pyloric caeca and upper intestine of nearly all the small-mouth bass, large-mouth bass, and rock bass examined. This trematode occurred as an adult first when the bass reached a size of 45-50 mm. They were not found sexually mature in younger bass, but were often found as skin and muscle cysts.

In northeastern Ohio many young bass were heavily infested with larval cysts of this form. These cysts were beneath the skin and between the fin rays. Mr. E. L. Wickliff and Mr. R. N. McCormick report thirty-six species of fish infested with these skin cysts. Their collections were made in northern Ohio during August and September, 1922. Their list follows:

BLACK PARASITIC SKIN CYSTS (IMMATURE TREMATODES) *C. chyli* IN OHIO FISH,
ZOOLOGY DEPARTMENT COLLECTION, OHIO STATE UNIVERSITY.

FISH.

1. Common Sucker (*Catostomus commersonii*).
2. White-nosed Sucker (*Moxostoma anisurum*).
3. Quillback (*Carpionotus velifer*).
4. Small-mouth Bass (*Micropterus dolomieu*).
5. Large-mouth Bass (*Micropterus salmoides*).
6. Rock Bass (*Ambloplites rupestris*).
7. Green Sunfish (*Lepomis cyanellus*).
8. White Crappie (*Pomoxis annularis*).
9. River Chub (*Hybopsis kentuckiensis*).
10. Creek Chub (*Semotilus atromaculatus*).
11. Common Sunfish (*Eupomotis gibbosus*).
12. Golden Shiner (*Notemigonus crysoleucas*).
13. Log Perch (*Percina caprodes*).
14. Yellow Perch (*Perca flavescens*).
15. Stone Roller (*Campostoma anomalum*).
16. Johnny Darter (*Boleosoma nigrum*).
17. Sand Darter (*Ammocrypta pellucida*).
18. Black-sided Darter (*Hadropterus aspro*).
19. Rainbow Darter (*Etheostoma coeruleum*).
20. Fan-tail Darter (*Etheostoma flabellare*).
21. Green-sided Darter (*Diplesion blennioides*).
22. Storer's Chub (*Hybopsis storerianus*).
23. Black-nosed Dace (*Rhinichthys atronasus*).
24. Common Shiner (*Notropis cronutus*).
25. Steel-colored minnow (*Notropis whipplii*).
26. Blunt-nose minnow (*Pimephales notatus*).
27. Fat-head minnow (*Pimephales promelas*).
28. Sucker-mouth minnow (*Phenacobius mirabilis*).
29. Bullhead minnow (*Cliola vigilax*).
30. Emerald minnow (*Notropis atherinoides*).
31. Straw-colored minnow (*Notropis blennius*).
32. Shumard's minnow (*Notropis shumardi*).

The bass at Put-in-Bay were never heavily infested. Fifty skin cysts on a 65 mm. small-mouth bass was the maximum. The heaviest infestation was in Geauga County. McCormick reported a black-nosed dace (*Rhinichtys atronasus*) 75 mm. long with 420 cysts. A 70 mm. large-mouth bass from this county had 100 cysts. These two fish were collected August 10, 1922. An 85 mm. small-mouth bass collected August 16, 1922, Conneaut Creek, Ashtabula County, had a few skin cysts, and hundreds of these immature trematodes in the intestine and body cavity. The liver of this fish was riddled with large watery cysts of another trematode, *Clinostomum marginatum*.

An 87 mm. small-mouth bass from a brook near Tiffin had over 100 skin cysts. Other bass taken from various northern Ohio streams showed this infestation. The infestation was heavier in the minnows.

Crepidostomum cornutum (Osborn) 1903.

This trematode was described by Osborn (1903, p. 63-73) as *Bunodera cornuta*, but was later placed in the genus *Crepidostomum* Braun, 1900. This trematode was found frequently in the stomach of young and adult individuals of large- and small-mouth bass and rock bass in every locality where these species were examined.

Osborn 1903, described larval cysts of this form in the crayfish and established it as an intermediate host prior to the adult stage of this species in the fish. My work confirmed this in most cases. Cysts with emerging flukes were found in partially digested crayfish taken from the stomach of adult bass. In southern Ohio streams crayfish formed the chief article of diet and this form was abundant.

Young fish obtain this trematode very early. The cysts in this case must be carried by smaller crustaceans. The forms found in the young bass were in the stage of early sexual maturity.

This fluke was easy to stain and gave the best preparations of any of the trematodes studied. This distome was found in the stomach and pyloric caeca of nearly all small-mouth bass examined from the streams of southern Ohio. The numbers of parasites per fish ranged from 4-25. These parasites were often obtained early by the young fish. In a 15 mm. small-mouth bass taken June 26, 1922, six immature *C. cornutum*

were found in the stomach. They averaged .3-1.0 mm. in length. Many others were found in June and July from young bass 17-28 mm. in length. In one case an immature fluke of this species was found encysted in the liver of an adult small-mouth bass taken at Put-in-Bay.

Clinostomum marginatum Leidy, 1856.

This fluke was first reported in America by Leidy (1856) in the intestine of pike (*Esox lucius*) in the Delaware River and in cysts attached to the gills of the sunfish (*Eupomotis vulgaris*).

Braun (1900) in a revision of the genus recognizes eight species of the genus *Clinostomum*, among them *C. marginatum*. Osborn (1911), (p. 350-364), gives many records for the distribution of this form and among the hosts infected reports specimens of this fluke encysted in the muscle tissues of *M. dolomieu*, collected at Nebish, Michigan. He also records its occurrence in *M. dolomieu* taken at Troy, Ohio, from the Miami River. Some of these larval flukes were encysted in muscle and others in the skin on the internal aspect of the branchiostigal membranes. According to Osborn, 1911, these cysts were most abundant the latter part of August and early in September. Osborn (1911, p. 354) gives a table showing distribution records. The following additions can be made from my data.

Clinostomum marginatum.

Host	Adult	Locality	Number Parasites	Location in Host	Date
<i>M. dolomieu</i>	Adult	Little Miami Lebanon	8	cysts about tail	9-4-22
<i>M. dolomieu</i>	4.2 cm.	Sugar Isle Lake Erie	4	stomach cysts from food	7-11-22
<i>M. dolomieu</i>	8.5 cm.	Conneaut Creek Ashtabula	many	liver cysts	9-16-22
<i>M. salmoides</i>	30 cm.	Newtown Fish Hatchery	4	liver cysts	9-2-22
<i>Eupomotis gibbosus</i>	Adult	Put-in-Bay	many	liver riddled muscle cysts	7-25-22

These forms were all small and usually few in number. They were all sexually immature.

Leuceruthrus micropteri Goldberger, 1911.

The genus was described by Marshall and Gilbert (1905) and this form described from the black bass of Wisconsin and Indiana by Goldberger ('11). These flukes enter the bass quite early. All these flukes were found in the stomach. They were usually in larval condition. The most unusual occurrence was the finding of two of these adult flukes, one measuring 6.4 mm. in length and the other 7.4 mm. long, in a 17 mm. large-mouth bass examined June 28, 1922. They were sexually mature and had the uterus filled with eggs. All others found were larval or in early maturity. These forms were more often found in the large-mouth bass than in the small-mouth bass.

These flukes were found in small numbers. The heaviest infestation occurred in an 11.2 cm. large-mouth bass from West Harbor, Lake Erie. There were ten in the stomach. They measured 2.0–3.5 mm. in length. These were not usually obtained until the bass attained a length of 35–40 mm.

All of these distomes were found in bass obtained from various locations in Lake Erie. They were not found in fish taken at the State Hatcheries or from Ohio streams.

Azygia Looss, 1899.

Many records have been given for species belonging to this genus in *M. salmoides* and *M. dolomieu* as well as for other fish. All the flukes found belonging to this genus were in early sexual maturity.

Two of these parasites were found in the stomach of a 52 mm. small-mouth bass from Put-in-Bay. Six large-mouth bass from East Harbor had from 2–6 of these flukes in the stomach.

Microphallus opacus Ward, 1901.

This form has been reported for *M. dolomieu*, *Amia calva*, *Anguilla chrysypa*, *Ictalurus punctatus*, and *Perca flavescens*. As reported by Ward ('94) and Osborn ('02), this form has its earlier stage in crayfish, according to Ward: "in the space in the cephalothorax above the heart and sexual organs"—and Osborn says: "it is found invariably in the liver (of crayfish) whose effective area is frequently greatly reduced by the cysts."

My only findings for this species were in two large-mouth bass obtained at Paint Creek, Fayette County, Ohio. One specimen 28 cm. in length had ten of these parasites in the upper intestine. They measured .50-.85 mm. in length. The other bass measured 17 cm. and had six of these parasites in the upper intestine.

NEMATODE PARASITES.

No attempt will be made at this time to describe or identify all the nematode species found in the large- and small-mouth bass. These parasites were never found in large numbers in the bass.

The adult small-mouth bass of southeastern Ohio were most frequently infested with intestinal nematodes. These were the largest forms found in the bass. They probably belonged to the family Ascaridæ. They have a mouth with three rather prominent lips, a smooth body and no spines. The females measure from 30-45 mm: and have an abruptly pointed posterior end. The males measure 20-35 mm. and have two prominent spirules of equal size.

In the young small-mouth bass at Put-in-Bay nematodes appeared late in the first season and never in large numbers. The form most often found was *Spinitictus gracilis* (Ward and Magath). Five were found July 17, 1921, in the intestine of a 50 mm. small-mouth bass. Other nematodes of this species were found in larger small-mouth bass, but never in large numbers.

No nematodes were found in 1922 until July 15 and then only in about one-third of the young fish examined during the season. In some of the bass many encysted forms were found belonging to the family *Filariidæ*.

The large-mouth bass had likewise few nematode parasites. More encysted *Filaria* were found, these after the bass had reached 30 mm. in size.

In the intestine of a 10 cm. large-mouth bass from West Harbor, obtained July 12, 1922, two nematodes belonging to the genus *Camallanus* were found. Similar individuals were found in a few other large-mouth bass. In a slide labeled "Young small-mouth nematodes," July 20, 1921, Put-in-Bay, two individuals of this genus were present.

ACANTHOCEPHALA.

This group of parasites has been studied for the bass as well as other hosts by Van Cleave ('13 and '19, a and b). Acanthocephala were often found in large numbers attached to the inner wall of the intestinal tract of adult bass. They were more prevalent in small-mouth bass. In younger bass one form, *Echinorhynchus thecatus* Linton, 1891, was often found encysted in the mesentery and pyloric caeca. This species was the one found in largest numbers in adult bass.

E. thecatus and *N. cylindratus*.
Measurements in cm.

Host	Size	Date	Locality	N. cyl. in host	E. the. encysted	E. the. in int.
M. salmoides	3.6	7-15-21	W. H.			1
" "	13.5	7-15-21	W. H.			Many
" "	4.9	7-26-21	E. H.	1		1
" "	15.0	7-26-21	E. H.	7		2
" " 17 spec.	4.5-6.0	8- -21	Akron Hatchery	few	1-10 in viscera	2-25
M. salmoides	3.1	7-12-22	W. H.	1		
" "	2.9	7-12-22	W. H.	1	3 pyl. caec.	
" "	3.5	7-12-22	W. H.			2
" "	3.6	7-14-22	W. H.	1		1
" "	3.1	7-19-22	P-i-B	3	2 mes.	
" "	17.0	7-26-22	Akron Hatchery	20		3
" "	17.0	8-8-22	London Hatchery	1		
" "	5.6	8-27-22	P-i-B		5 mes.	
" "	9.5	9-13-22	W. H.	few int.	5 mes. 2 pyl. caec.	
" "	18.5	9-8-22	Fayette Co.	many int.		

E. H.—East Harbor.
W. H.—West Harbor
P-i-B—Put-in-Bay.

Van Cleave '20, studies the life history of *E. thecatus* and says regarding this: "Larvæ of *E. thecatus* have been found in *Hyalella knickerbockeri*. The young bass fed on these amphipods acquire a general infestation of *E. thecatus*." He also says ('20, p. 170), after discussing the amphipod as the intermediate host: "Data from other sources furnish incontestable evidence that one or more intermediate hosts may be intercalated between the primary and the definitive hosts of *E. thecatus*. Larvæ which unmistakably belong to this species have been encountered frequently encysted in the viscera of various fishes."

In my studies none of the encysted forms were found until the bass began to eat amphipods. No encysted *E. thecatus*

E. thecatus and *N. cylindratu*s.
Measurements in cm.

Host	Size host	Date	Locality	N. cyl.	E. the.	Degree of infestation in E. the.
M. dolomieu	4.0	7-6-21	P. B.		int.	medium
" "	6.0	7-18-21	P. B.	2		
" "	12.5	7-18-21	P. B.		int.	6
" "	6.4	7-20-21	P. B.	1	int.	1
" "	5.8	7-22-21	P. B.	3		
25 " "	18-35	9- -21	Clinton and Green Counties	few	int.	medium to heavy
" "	10.0	7-4-22	P. B.	20	int.	light
" "	18.5	7-9-22	P. B.		int.	50
" "	23.0	7-15-22	P. B.		int. pyl. caeca	heavy 300
" "	3.5	7-19-22	P. B.	2	int.	1
" "	11.0	7-19-22	P. B.	3		
" "	20-34	7-27-22	P. B.	few	int. pyl. caeca	heavy
" "	6.5	8-26-22	P. B.	4	int.	2
" "	15-32	10- -22	Clinton and Green Co.	few	int. pyl. caeca	medium

P. B.—Put-in-Bay.

were found in the small-mouth bass of Put-in-Bay where there are few amphipods in the diet of the bass.

Nearly all adult large- and small-mouth bass examined contained *E. thecatus* in numbers ranging from 1 to more than 200. They were found in about equal numbers in the adult bass from Lake Erie and southern Ohio. They were more abundant in bass examined in the fall.

The other species found in the large- and small-mouth bass was *Neoechinorhynchus cylindratus* Van Cleave, 1913. This species was found from many localities in large- and small-mouth bass, but never in large numbers. They were not found in the encysted stage, but always free in the intestine. The following tables give some idea of the time of infestation in young bass.

PARASITIC COPEPODS.

Two species belonging to the family Ergasilidæ were found attached to the gills of large- and small-mouth bass in a few cases. There were never more than three or four of these parasites per fish. In all, not more than thirty of these parasites were found in all of the fish examined. The Ergasilidæ in North America were studied and new species recorded by Wilson ('11).

One species of Lernaeidæ was occasionally found attached to the host. Usually but one specimen was found on a host and but few bass were infested with this form.

DISCUSSION.

The parasites which were most injurious to the bass in addition to the cestode parasites, *P. ambloplitis* and *P. fluviatilis*, were, the trematodes which infest the liver, skin and muscles, and those acanthocephala which are found encysted in the mesenteries in immature stages and as adults attached to the intestinal mucosa.

In young bass the most evident damage was done by forms which infest the liver and mesenteries such as was evident in a few cases where *Clinostomum marginatum* were found in large numbers, and by the encysted forms of *E. thecatus*. The size of a badly infested fish as compared with others of the same age, and the amount of fat in the mesenteries were criteria for estimating the damage. The more the retardation in development of the fish, the greater opportunity there is for

this fish to be eaten by bass or other carnivorous forms. In older fish the vitality is often much lowered by parasitism.

A small-mouth bass three years old which died at the Akron Hatchery was examined and found to be very heavily infested with *E. thecatus* in mesenteries and adults of the same species in the intestine. The fish was 12 cm. in length and weighed but 14 ounces. Several other fish were found in almost the same condition. Some had their gonads destroyed by a larval cestode *P. ambloplitis*.

Considerable damage was reported in adult bass taken in northwestern Ohio, due to skin and muscle cysts of *C. marginatum* and *C. chyli*. In many cases these fish were unfit for food. Too few of these badly infested fish were examined to give data as to the extent of this infestation.

Parasitism seems to be of considerable importance at certain of the inland fish hatcheries. At the Newtown and London hatcheries very few infested fish were found and those that were found were usually the adult fish brought in from some other location. Perhaps the intermediate hosts had not become established. At the Akron hatchery there was marked infestation of both large- and small-mouth bass. In general the infestation of young bass was much heavier than those studied from Lake Erie in the vicinity of Put-in-Bay. More work should be undertaken regarding the importance of parasitism as a limiting factor at the fish hatcheries.

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