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## MYXOSPORIDIAN PARASITES FROM THE GILLS OF SOME FISHES OF THE OKOBOJI REGION

VERNE J. RICE AND THEODORE L. JAHN

The Myxosporidia are protozoan parasites which infect various lower groups of vertebrates, and which cause several serious epidemic diseases of fishes (Kudo, 1920, 1939). The purpose of the present papers is to describe some of the species of Myxosporidia which have been found parasitizing fishes of the Okoboji region.

The present study includes only the Myxosporidia found on the gills. The internal organs were also examined, but the results of these examinations are reported in a separate paper (Otto and Jahn, 1943).

### MATERIAL

The fishes examined in this survey consisted of one hundred and sixteen specimens of nineteen species. These fishes were taken from the following lakes in the Okoboji region: Spirit Lake, Swan Lake, East Okoboji, West Okoboji, and Otis Lake. All material was fresh at the time of examination. These fish were obtained through the aid and cooperation of The Iowa Conservation Commission, under the direction of Mr. Otto Koch and his staff, whom we wish to thank heartily for their splendid assistance.

### OCCURRENCE OF PARASITES

The nineteen species of fishes examined were found to harbor nine species of Myxosporidia. The parasites found in each species of fish are shown in Table I. The Buffalo (*Ictiobus bubalis*) was the most heavily infected fish. One hundred percent of the specimens of this species was parasitized by a total of six species of Myxosporidia. For only one other species of fish was the incidence of infection one hundred percent, and that was for the Fulton catfish (*Ictalurus furcatus*) of which only one specimen was available. The species of Myxosporidia found are described below.

### DESCRIPTION OF SPECIES

#### MYXOSOMA MULTIPLICATUM (Reuss)

Fig. 1

Habitat. This Myxosporidian was found in the gills of nineteen of the twenty three specimens *Ictiobus bubalis* (Rafinesque) the Small Mouth Buffalo taken from the Narrows of East Okoboji and from West Okoboji. These fish ranged in weight from one to fifteen pounds, and were collected and examined between July 12 and August 15, 1938.

Vegetative Form. The cysts were more or less oval, and ranged in size from  $200 \mu \times 261 \mu$  to  $292 \mu \times 492 \mu$ . They were attached to the gill filaments and gill arches, were whitish to creamy in color, and were usually present in considerable numbers.

TABLE 1—TABLE OF FISHES EXAMINED

FISHES EXAMINED	Number Examined	Number Infected	Organ Infected	Myxosporidian found
Buffalo, <i>Ictiobus bubalis</i> (Rafinesque).....	23	23	Gills	<i>Myzosoma multiplicatum</i> <i>Myzosoma ovalis</i> <i>Myzosoma okobojeensis</i> , n. sp. <i>Myzobolus transovalis</i> , Gurley <i>Myzobolus symmetricus</i> , n. sp. <i>Myxiditum</i> , sp.
Sheepshead, <i>Aplidonotus grunniens</i> (Rafinesque) .	9	0	Gills	
Fulton Cat, <i>Ictalurus furcatus</i> (LeSueur).....	1	1	Gills	<i>Henneguya ezilis</i>
Bullhead, <i>Ameiurus melas</i> (Rafinesque).....	17	3	Gills	<i>Henneguya ezilis</i>
Black Crappie, <i>Pomoxis sparoides</i> (Lacepede)....	15	1	Gills	<i>Myzobolus discrepans</i>
Bluegill, <i>Helioperca macrochira</i> (Rafinesque).....	7	0	Gills	
Northern Pike, <i>Esox lucius</i> Linn .....	4	0	Gills	
Orange spotted Sunfish, <i>Allotis humilis</i> (Girard) .	1	0	Gills	
Green Sunfish, <i>Apomotis cyanellus</i> (Rafinesque) .	1	0	Gills	
White Bass, <i>Lepibema chrysops</i> (Rafinesque)....	15	2	Gills	<i>Henneguya magna</i> , n. sp.
Short nosed Gar, <i>Lepisosteus platostomus</i> (Rafinesque).....	2	0	Gills	
Carp, <i>Cyprinus carpio</i> Linn .....	5	0	Gills	
Silver Chub, <i>Hybopsis storerianus</i> (Kirtland)....	1	0	Gills	
Large Mouth Bass, <i>Micropterus salmoides</i> (Lacepede).....	4	0	Gills	
Golden Shiner, <i>Abramis crysoleucas</i> (Mitchill) . . .	1	0	Gills	
Wall Eye Pike, <i>Stizostedion vitreum</i> (Mitchill) . . .	4	0	Gills	
Yellow Perch <i>Perca flavescens</i> (Mitchill).....	3	0	Gills	
Common Sucker <i>Catostomus commersonii</i> (Lacepede).....	1	0	Gills	
Rock Bass, <i>Ambloplites rupestris</i> (Rafinesque) . . .	2	0	Gills	
TOTAL.....	116	30		

**Spore.** The average measurement of the fresh spores was  $10.9 \mu$  antero-posteriorly and  $9.3 \mu$  laterally. The polar capsules were quite uniform in size and were egg shaped with the more pointed end anterior. The average size of the capsules was  $4.7 \mu$  long and  $3.1 \mu$  in diameter, and there were seven to nine turns in the polar filaments. There were 12 to 14 folds in the sutural ridge, and these folds were more distinct in the posterior than in the anterior region.

**Identification.** At the present time there are 35 known species of *Myxosoma* (Kudo, 1933; Meglitsch, 1937; Fantham 1939). The spore under consideration fits the key and description of *M. multiplicatum* given by Kudo (1920). There is, however, a distinct geographical and host difference. The dimensions given by Kudo were  $12.0 \mu$  by  $9.5 \mu$  for the spore and  $4 \mu \times 2.3 \mu$  for the polar capsule. The average dimensions of these spores taken from *I. bubalis* were: spore,  $10.9 \mu$  in length by  $9.3 \mu$  in width; polar capsule,  $4.7 \mu$  in length by  $3.1 \mu$  in width.

#### MYXOSOMA OVALIS (Davis)

Fig. 2.

**Habitat.** This protozoan was found in the gills of *Ictiobus bubalis* taken from the Narrows of East Lake on July 12, 1938. The parasite was found in nineteen of the twenty three specimens examined, and the infection was usually heavy.

**Spore.** The spore was ovoidal, and the shell was rather uniform in thickness but slightly thickened posteriorly. The polar capsules filled the anterior two thirds of the spore. The polar filaments had only eight to ten turns. The sporoplasm, rather small, projected almost halfway between the polar capsules. It contained a single nucleus of about the same granular appearance as the sporoplasm. Dimensions of spore:  $12.4 \mu$  long  $\times$   $15.5 \mu$  wide. Polar capsule:  $7.0 \mu$  long  $\times$   $4.4 \mu$  wide.

**Identification.** This myxosporidian is very similar to the description given by Davis (1923) for *M. ovalis* from *I. bubalis* and *I. cypripinella* except for the facts that the spore here described was usually found to be broader than long, rather than spherical or longer than broad, and that the polar filaments have about eight turns instead of five. The cysts were smaller than those mentioned by Davis, but he states, however, that there is considerable variation in both cysts and spores. These differences might be of sufficient importance to consider the present organism a new species, but because of the general similarity and because of the wide variations described by Davis it is considered to be *M. ovalis*.

#### MYXOSOMA OKOBOJIENSIS, n. sp.

Fig. 3.

**Habitat.** The gills of specimens of *Ictiobus bubalis* taken from West Okobo Lake on July 28, 1938 were infected with both *Myxosoma multiplicatum* and a new species of *Myxosoma* which is described below and for which the name *M. okobojiensis*, n. sp., is proposed. Only

three specimens of *I. bubalis* were found to contain both species of *Myxosoma*. Five specimens of *I. bubalis* examined contained *M. okobojiensis*, n. sp.

**Vegetative Form.** Cysts were quite numerous and formed cream colored pustules on the gill filaments. Size varied between 175 and 200  $\mu$  in length. Ovoidal in shape.

**Spore.** The spore was similar in shape to *M. ovalis* but was slightly broader. The sporoplasm filled about the bottom third of the spore and projected as a narrow process which separated the two polar capsules as far anteriorly as the spore membrane. The polar capsules were considerably larger than those of *M. ovalis* and had from 14 to 16 turns in the polar filament. The spore membrane was slightly thinner and formed a small intercapsular appendix which appeared to meet the sporoplasm. A single granular nucleus was also observed. Dimensions of spore: 16.3  $\mu$  wide x 13.2  $\mu$  long. Polar capsule: 7.8  $\mu$  x 6.2  $\mu$ .

**Identification.** In an examination of all available literature no described species of *Myxosoma* was found which was similar to the above organism. While most species of *Myxosoma* seem to have a spore longer or as long or only slightly wider than long, this species was decidedly wider than long. The shape together with the large polar capsules with the finely coiled filaments, the shape of the sporoplasm, and the small intercapsular appendix serve to distinguish this species from all known descriptions.

Because of these rather distinctive characteristics it seems proper to consider this a new species, and the name *M. okobojiensis*, n. sp. is proposed.

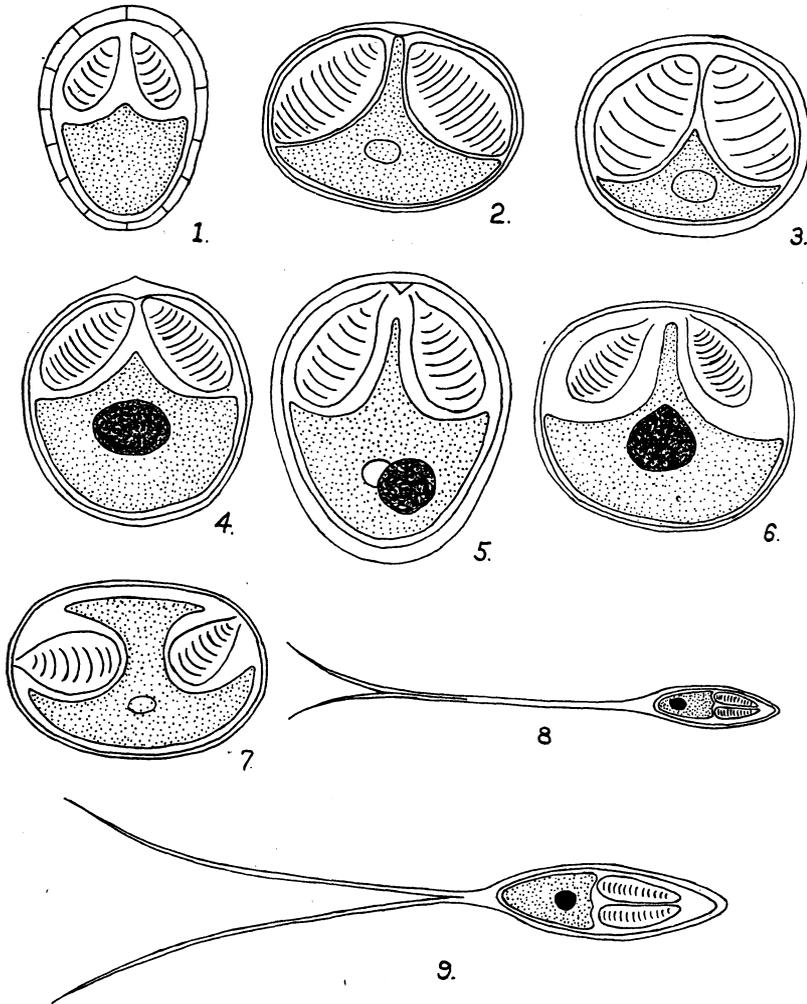
#### MYXOBOLUS SYMMETRICUS, n. sp.

##### Fig. 4

**Habitat.** A smear from the gill filament of the black crappie *Pomoxis sparoides* (Lacepede), which was taken from Little Miller's Bay of West Okoboji August 14, 1938 yielded a few specimens of this protozoan. It was the only fish of the fifteen of this species examined which was found to be infected in the gill with any species of Myxosporidia.

**Vegetative Form.** No details of the vegetative form were observed as the only evidence of this parasite was found by making a smear with the gill filament which harbored a sort of fungoid appearing mass which might have been the vegetative form.

**Spore.** The spore was almost round in flat view and was 10  $\mu$  anterior-posteriorly and 9.3  $\mu$  in width. There was a slight protruding point on the anterior end, and the inner surface formed a similar projection between the two polar capsules which converged near this inner point. The capsules were 3.1  $\mu$  long by 2.32  $\mu$  wide. The polar filaments had from 12 to 14 turns. The finely granular sporoplasm occupied roughly three fifths of the spore, and contained a rather large iodophilous vacuole which was 3.9  $\mu$  in width and 3.1  $\mu$  in



LEGEND FOR FIGURES

- Fig. 1 *Myxosoma multiplicatum* (Reuss)
- Fig. 2. *Myxosoma ovalis* (Davis)
- Fig. 3. *Myxosoma okobojiensis*, n. sp.
- Fig. 4. *Myxobolus symmetricus*, n. sp.
- Fig. 5. *Myxobolus discrepans* Kudo
- Fig. 6. *Myxobolus transovalis* Gurley
- Fig. 7. *Myxidium* sp.
- Fig. 8. *Henneguya exilis* Kudo
- Fig. 9. *Henneguya magna*, n. sp.

?

**Identification.** The size of this Myxosporidian was quite similar to that of *M. pfeifferi*. However, in the following characters it was quite different. There were no sutural folds or markings observed, the polar capsules were considerably smaller, the polar filaments finely coiled from 11 to 12 times. There was a small but distinct intercapsular appendix and a small anterior projection on the outer surface of the spore membrane. It is proposed that it be considered a new species, and the name *Myxobolus symmetricus*, n. sp. is suggested.

#### MYXOBOLUS DISCREPANS Kudo

Fig. 5.

**Habitat.** This species was found on only one specimen of the Buffalo fish, *Ictiobus bubalis* (Rafinesque), which was taken from Otis Lake, August 15, 1938.

**Vegetative Form.** Not Observed.

**Spore.** This spore was oval in shape and tapered somewhat toward the posterior end. The shell was quite thin anteriorly but considerably thicker in the posterior region. The sporoplasm occupied the lower half of the spore and projected about three fourths of the distance anteriorly between the polar capsules. In appearance it was quite finely granular and contained a readily recognizable iodophilous vacuole and a single nucleus. The two polar capsules were pyriform in shape and tapered to a narrow neck. The smaller ends of the capsules lay on each side of a small triangular intercapsular projection. The polar filaments were coiled from eight to ten times. The spore was  $15.5 \mu$  long by  $13.9 \mu$  wide. The polar capsules were  $5.4 \mu$  long by  $3.9 \mu$  wide.

**Identification.** This myxosporidian closely resembles one which Davis (1923) said "is probably *M. discrepans* and is quite abundant on the gills of the buffalo fishes." It fits the description of Kudo (1920) with the exceptions that these spores were slightly larger and that there were no shell markings on the posterior margin. Kudo's material was preserved in alcohol while the above examination was made of fresh material.

#### MYXOBOLUS TRANSVALIS Gurley

Fig. 6

**Habitat.** The host for this parasite was a fifteen pound specimen of *Ictiobus bubalis* which was taken from Spirit Lake, August 15, 1938.

**Vegetative form.** Not observed.

**Spore.** These spores, which were observed in great numbers, were  $9.3 \mu$  in width by  $7.7 \mu$  in length. The shell was of uniform thickness. The sporoplasm occupied the posterior half of the spore and projected as a narrow process between the two polar capsules. The iodophilous vacuole was comparatively large and usually slightly irregular (about  $2.3 \mu$  in diameter). The polar capsules were pyriform and tapered to narrow necks at the anterior end. Size of capsule:  $3.1 \mu$  by  $1.6 \mu$ . The polar filaments had from ten to twelve turns.

**Identification.** This species was originally reported by Gurley in

1893 (description, Kudo 1920) from under the scales on the external surface of *Phoxinus (Clinostomus) funduloides* Girard, Four-Mile Run, Carlisle, Virginia tributary of Potomac River (June). The spore was reported as elliptical, with the largest diameter passing through the two polar capsules. Shell thin, sutural edge narrow. The vacuole in the sporoplasm was difficult to detect. The sporoplasm usually contained two nuclei, rarely one,  $1\ \mu$  to  $1.5\ \mu$  in diameter. Dimensions of spore: length  $6\ \mu$  to  $7\ \mu$ , breadth  $8\ \mu$ .

The present spores were slightly larger, and the iodophilous vacuole was seen readily when stained with Lugol's solution. The nuclei were not observed, and the host and geographical locations were quite different from those described by Gurley. However, the general structure and size were approximately the same, and the present organism is considered to be *M. transovalis*. Apparently this species has not been reported in the literature since it was originally described by Gurley.

#### MYXIDIUM sp.

Fig. 7

Habitat. This myxosporidian was found on the gills of *I. bubalis*, and only one cyst was found. This was the only parasite of the genus *Myxidium* found on the gills of the 116 fishes examined. Kudo (1919) lists only one *Myxidium* found in the branchiae and that was an unidentified species found in *Cottus scorpius* in Russia.

Vegetative Form. Small oval cream colored cyst.

Spore. The spore of this *Myxidium* was almost perfectly oval. The shell valves were uniformly thin and unstriated. The sporoplasm divided the polar capsules and formed a large arc posteriorly with a smaller arc anteriorly. The two arcs almost enveloped the polar capsules which were pointed away from each other at an oblique angle. The spore measured  $9.3\ \mu$  in length and  $7.8\ \mu$  in width. The polar capsules were pyriform in shape and were  $3.8\ \mu$  long and  $2.3\ \mu$  wide. The polar filaments had from 8 to 10 turns.

This organism is not described as a new species because of lack of sufficient material to allow a more complete description.

#### HENNEGUYA EXILIS Kudo

Fig. 8

Habitat. The cysts of this parasite were found in the gills of the Fulton catfish *Ictalurus furcatus* (Le Sueur) and of the Bullhead *Ameiurus melas* Rafinesque. Only one specimen of *I. furcatus* was available. It was collected from the Narrows between East and West Okoboji Lakes, July 12, 1938.

Vegetative Form. These cysts were quite numerous and varied in size from  $200\ \mu$  to  $231\ \mu$  in width and from  $339\ \mu$  to  $385\ \mu$  in length. They were ovoidal or egg-shaped and they were colored a light cream.

Spore. The spore body was rather short as compared to the total length. It was moderately tapered both anteriorly and posteriorly. The tail process was slender and bifurcated and about three times as long as the body.

The two polar capsules did not completely fill the anterior half of the spore body, and the polar filaments had numerous fine coils. The sporoplasm occupied the posterior half of the spore body, and was highly granular in appearance. The iodophilous vacuole stained readily with Lugol's solution.

The dimensions of the spore: overall length, 62.0  $\mu$ ; spore body, 15.5  $\mu$  x 5.5  $\mu$ ; tail or posterior process; 46.5  $\mu$  in length, 1.5  $\mu$  wide.

Identification. The spore under observation is very similar to the description given by Kudo (1929). There was some difference in that both the present spore and the polar capsules were considerably shorter than those described by Kudo. These differences, however, do not seem sufficient to distinguish it as a new species.

HENNEGUYA MAGNA, n. sp.

Fig. 9

Habitat. The gills of two specimens of White (Silver) Bass *Lepibema chrysops* (Rafinesque) were heavily infected with this protozoan. They were taken from Spirit Lake, July 17, 1938.

Vegetative Form. Not observed.

Spore. The overall length of the spore was about 87  $\mu$ . The body of the spore 24.8  $\mu$  in length and 6.2  $\mu$  in width. The tail or posterior process was 62  $\mu$  long and was divided throughout its entire length. The polar capsules were elongat, pyriform, rather pointed anteriorly, and 4.0  $\mu$  in length. They contained finely coiled polar filaments. The sporoplasm occupied somewhat more than the posterior one third of the spore and contained a small and rather indistinct iodophilous vacuole.

Identification. This Myxosporidian was much larger than any of the species of *Henneguya* listed by Kudo (1919) with the exception of *H. gigantea* Nemeček which was discovered in a different host, *Lucioperca sandra* Cuv. and in a much different geographical location. Nemeček mentioned that the infection occurred in only young fish. He also described the tail process as being bifurcated for only half of its length. The dimensions given were: total length, 87.5  $\mu$  to 11.5  $\mu$ ; body 10.5  $\mu$  long by 5  $\mu$  wide; length of tail; 77  $\mu$  to 100  $\mu$ ; length of polar capsules; 5  $\mu$ .

The present species has the tail process divided the entire length of the body. The total length (86.8  $\mu$ ) is near the range for *H. gigantea*, but the body size is much larger (24.8  $\mu$  long by 6.2  $\mu$  wide), and the tail process is relatively shorter. The polar capsules are also shorter than those of *H. gigantea*.

In view of these differences, and the failure of this protozoan to fit any of the other available descriptions it is proposed to call this a new species *Henneguya magna*, n. sp.

SUMMARY

1. A report of the results of the examination of the gills of 116 fishes

2. Three new species of Myxosporidia are described, and six known species were observed.
3. The fish found to be most highly infected was the Buffalo *Ictiobus bubalis* (Rafinesque) which was 100 per cent infected, harboring three species of *Myxosoma*, two species of *Myxobolus*, and one of *Myxidium*.
4. Five species of fish contained all the myxosporidian parasites found, and fourteen species apparently were not infected in the gills.
5. The gills of 30 of the 116 fishes examined were infected with at least one species of Myxosporidia.

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