Proceedings of the Iowa Academy of Science

Volume 50 | Annual Issue Article 32

1943

Internal Myxosporidian Infections of Some Fishes of the Okoboji Region

George R. Otto
State University of Iowa

Theodore L. Jahn
Iowa State College

INTERNAL MYXOSPORIDIAN INFECTIONS OF SOME FISHES OF THE OKOBOJI REGION

GEORGE R. OTTO AND THEODORE L. JAHN

Protozoa of the order Myxosporidia are primarily parasites of fishes, and no major group of fishes is entirely free from infection. Apparently most species of Myxosporidia do not produce serious pathological changes. However, some of the most destructive diseases of fish, such as the "wormy" halibut of the Pacific coast of North America; the "boil" disease of barbel in European waters; and the "twist" disease of salmonoid fish, are caused by myxosporidian infection. These infections are often fatal and sometimes occur in epidemic form. The life history of the myxosporidia has been discussed by Kudo (1920, 1939).

The present paper is primarily a report of a survey of myxosporidian parasites which occur in the internal organs of fishes of the Okoboji region.

MATERIALS AND METHODS

During this study, one hundred and thirty-one fishes, of seventeen species, were examined. These were taken from Swan Lake, East Okoboji Lake, West Okoboji Lake, Otis Lake, and Spirit Lake. The fish were obtained through the assistance of the Iowa Conservation Commission under the direction of Mr. Otto Koch and staff to whom we are greatly indebted for their splendid cooperation and many services.

All of the fish were examined within a few hours after they were killed. The internal organs were dissected out, and each organ was examined both internally and externally for parasites. All fluids in the cavities of the host were examined for the presence of trophozoites or spores. Organs examined included the kidney, urinary bladder, liver, gall bladder, stomach, intestine, and air bladder. The mesenteries, and peritoneum were also examined. The gills of these fishes were also examined, but (with one exception) the results of the gill examinations are to be reported separately (Rice and Jahn, 1943).

After the trophozoites had been studied in a fresh condition, smears were made and all trophozoites were stained with either Lugol's solution or Delafield's Haematoxylin. Delafield-stained whole mounts were made of some of the trophozoites.

OCCURRENCE OF PARASITES

The seventeen species of fish which were examined were found to harbor nine species of Myxosporidia. Table I contains a list of the fish examined, the number of fish found infected, the site of infection, and the species of Myxosporidia involved in the infection.

TABLE 1—TABLE OF FISHES EXAMINED

FISHES EXAMINED	Number Examined	Number Infected	Organ Infected	Myxosporidian found
Abramis crysoleucas (Mitchill). The Golden Shiner	1	0		
Allotis humilis (Girard). The Orange spotted Sunfish	1	0		
Ambloplites repestris (Rafinesque). The Rock Bass	2	0		
Ameiurus melas (Rafinesque). The Common Black Bullhead	44	27	Gall bladder	*Myxidium melum*, n. sp.
Aplites salmoides (Rafinesque). The Large-mouthed Black Bass	6	0		
Aplodinotis grunniens (Rafinesque). The Sheepshead	10	2	Gall bladder	*Myxidium macrocapsulare*
Apomotis cyanellus (Rafinesque). The Green Sunfish	1	0		
Cyrpinus carpio Linnaeus. The Carp	5	0		
Esox lucius Linnaeus. The Northern Pike	3	0		
Helioperca macrochira (Rafinesque). The Bluegill	7	1	Gall bladder	*Myxobolus osburni*
Hybopsis storerianus (Dirtland). The Silver Chub	1	0		
Ictiobus bubalis (Rafinesque). The Small-mouthed Buffalo	17	2	Intestine	*Myxobolus bubalis*, n. sp.
Lepibema chrysops (Rafinesque). The Silver Bass	7	0		
Lepisosteus platostomus (Rafinesque). The Short-nosed Gar	4	0		
Perca flavescens (Mitchill). The Yellow Perch	3	0		
Pomoxis sparoides (Lacepede). The Black Crappie	17	5	Gall bladder	*Chloromyxum trijugum*
		1	Gall bladder	*Chloromyxum trijugum* *Myxobolus osburni*
		1	Gall bladder Intestine	*Myxidium melum*, n. sp. *Chloromyxum trijugum* *Myxosoma* sp. *Myxobolus sparoidis*, n. sp
		1	Gall bladder Intestine	*Myxobolus sparoidis*, n. sp. *Myxobolus sparoidis*, n. sp. *Myxobolus okobojiensis*, n. sp.
		2	Intestine	*Myxobolus sparoidis*, n. sp.
		1	Intestine	*Myxobolus okobojiensis*, n. sp.
		1	Gills	*Myxobolus iowensis*, n. sp.
Stizostedion vitreum (Mitchill). The Walleyed Pike	2	0		
TOTAL	131	44		

From the table it may be seen that the common black bullhead, *Ameiures melas* (Rafinesque), and the black crappie, *Pomoxis sparoides* Lacepede, were the most heavily infected fish. The percentage of infection in the bullhead was 61.3% and only one species of myxosporidian was involved in the infection. Infection in the bullhead was most common among larger fish (about 11 inches in length), of which 76.4% were parasitized. Twenty per cent of the fish about 9 inches in length, and none of the smaller fish examined (about 6 inches in length) were infected. Of the black crappies examined, 70.5% were infected with a total of seven different species of Myxosporidia.

DESCRIPTION OF SPECIES

CHLOROMYXUM TRIJUGUM Kudo (Figs. 1, 2, 3, and 4)

Habitat: Several specimens of *Pomoxis sparoides* Lacepede collected from Little Miller's Bay on August 2, 1938, contained free spores of this species in the bile. One fish examined on August 3, 1938, one fish examined August 12, 1938, one fish examined August 16, 1939, and two fish examined August 17, 1939, harbored the same parasites and had the same site of infection. None of the remainder of the seventeen fish of this species which were examined showed this infection.

Vegetative form; The bile of the black crappie which was examined on August 16, 1939, contained many disporous trophozoites. No distinct ectoplasm was distinguished. The endoplasm was extremely granular, and seemed to be more dense at its outer edge. Dimensions of the fresh trophozoite were 13 to 19 μ long, by 10 to 11 μ broad.

Spore: in one case, there were several deeply stained folds at the posterior end of the spore. Spore spherical to sub-spherical in shape, with four polar capsules of varying size. Polar capsules open to the exterior through separate foramina. The granular sporoplasm occupies less than half of the spore. The spore membrane is fairly thick. The dimensions of fresh spores were: length and breadth 7.3 to 8.8 μ, thickness 5.6 μ, polar capsules 2.2 by 2.9 μ.

Identification: These spores were similar in size and shape to those of *Chloromyxum trijugum*. The only apparent difference was that the outer sutural ridges of these spores were not as far from the middle ridge as indicated by Kudo (1920). This species was reported from *Lepomis megalotis* Raf. by Kudo (1920) and from *Pomoxis sparoides* Lacepede by Meglitsch (1937).

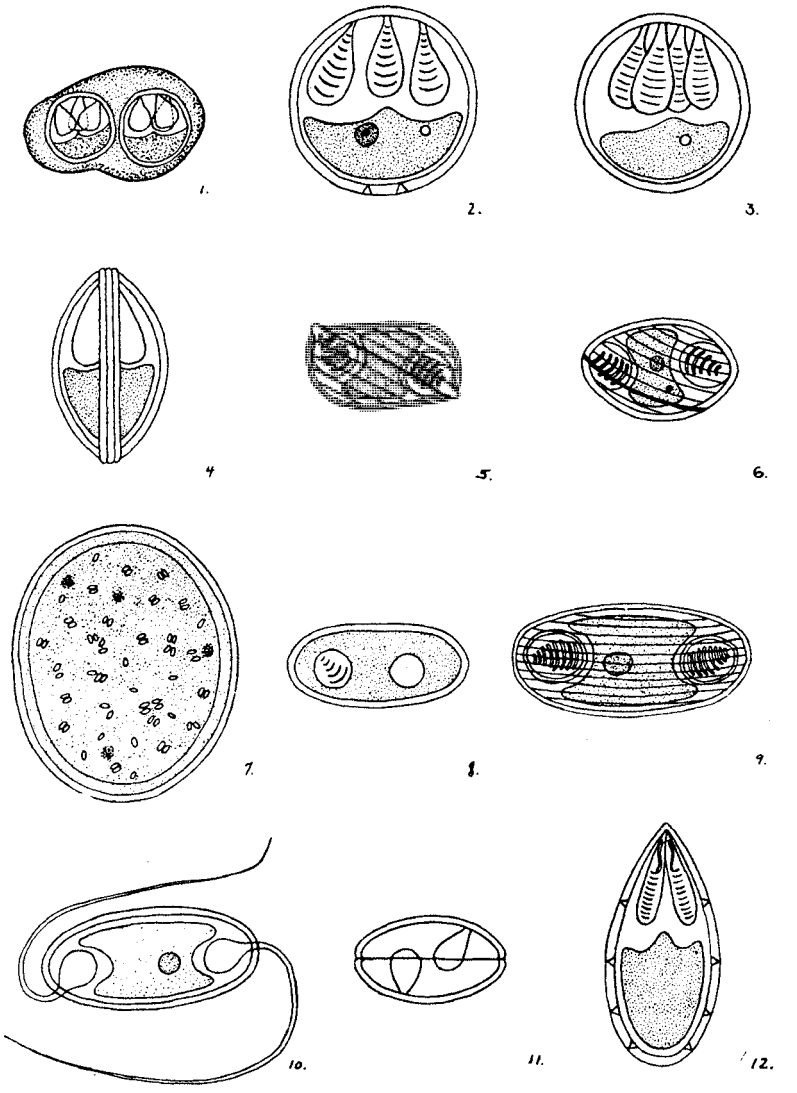
MYXIDIUM MACROCAPSULARE Auerbach

(Figs. 5 and 6)

Habitat: Two specimens of *Aplodinotis grunniens* Rafinesque taken on July 26, 1936, and examined on August 12, 1939, contained numerous free spores of this Myxosporidian in the bile.

Vegetative form: not observed.

Spore: The spores were elongated elliptical in surface view. Polar capsules were almost spherical. The shell membrane was thin, and



KEY TO PLATE I

Fig. 1 Trophozoite of *Chloromyxum trijugum* Kudo.

Fig. 2 Front view of *Chloromyxum trijugum* Kudo spore, showing unusual sutural folds.

Fig. c Front view of *Chloromyxum trijugum* Kudo spore.

Fig. 4 Side view of *Chloromyxum trijugum* Kudo spore.

Fig. 5 Front view of *Myxidium macrocapsulare* Auerbach spore.

Fig. 6 Oblique front view of *Myxidium macrocapsulare* Auerbach spore.

striated six or eight times parallel to the sutural line. In side view the ends of the spore were slightly pointed in opposite directions, and the polar capsules were rounded pyriform. The granular sporoplasm did not occupy all of the space not taken up by the polar capsules. The thick polar filament was coiled five or six times. Fresh spores measured 12.2 μ long, 5.3 to 6.8 μ broad, 5.3 to 6.8 μ broad, 5.3 μ thick. Polar capsules were 3.8 by 4.6 μ. The spore in Lugol's measured 10.6 μ long, 6.1 μ broad, and the polar capsules were 3 by 3.1 μ. The sutural ridge was not pronounced, and the sutural line was rather fine.

Identification: Although this is a different host for *Myxidium macrocapsulare*, the dimensions and form of the spore are practically the same. It is assumed that this spore is *Myxidium macrocapsulare* Auersbach.

MYXIDIUM MELUM, n. sp.
(Figs. 7, 8, 9, 10, and 11)

Habitat: A specimen of *Ameiurus melas* (Rafinesque) which was taken from Swan Lake and examined on July 20, 1938, was found to have several large trophozoites floating free in the bile. Between this date and August 15, 1938, thirty-three other specimens of this fish were examined which included specimens from Little Miller's Bay, East Okoboji, and West Okoboji. At least several fish from each of these places were found to be infected with the same myxosporidian. Ten specimens of the same fish taken from East Okoboji about July 23, 1939, and examined between August 10,1939, and August 17, 1939, contained these parasites in seven cases. In all, twenty-seven of the forty-four fish examined were infected with this *Myxidium*, or 61.3%. In addition, several spores of this parasite were found free in the bile of a specimen of *Pomoxis sparoides* Lacepede which was examined on August 2, 1938.

Vegetative form: The white trophozoites varied from spherical to oblong in shape. They were exceedingly flat, and tended to curl at the ends. No pseudopodia were observed. The ectoplasm had two distinct regions, the inner being more granular than the outer layer. The endoplasm was extremely granular, and contained many nuclei and mature spores. In some instances, immature spores were found. The size of the trophozoite varied considerably. The smallest one found measured 336 μ by 511 μ. They averaged about 550 μ by 1070 μ. The largest trophozoite found measured 1310 μ by 2770 μ. The number of trophozoites found in a single specimen varied from one to fourteen. Disporoplastic.

Fig. 7 Trophozoite of *Myxidium melum*, n. sp.

Fig. 8 Immature spore of *Myxidium melum*, n. sp.

Fig. 9 Front view of mature spore of *Myxidium melum*, n. sp.

Fig. 10 Front view of *Myxidium melum*, n. sp., spore with polar filaments extruded.

Fig. 11 End view of *Myxidium melum*, n. sp., spore showing position of the polar capsules and location of the foramen.

Fig. 12 Front view of *Myxosoma* sp. spore.

Spore: The spore was rounded oblong in shape in surface view. The shell membrane was rather thin, and had about nine to eleven longitudinal striations on each valve. The polar capsules were globular in front view, pyriform in end view. There was no apparent ridge on the sutural line. The sporoplasm, which had one or two nuclei visible in stained specimens, occupied most of the space not taken up by the polar capsules. The filament of the polar capsules was coiled about eight or ten times. Fresh spores had the following dimmensions: length 11 to 12 μ, breadth 5 to 6 μ, and the polar capsules, which open to opposite sides of the spore, were about 3 μ in diameter.

Identification: There were sixty known species of *Myxidium* up to 1933 (Kudo, 1933), several of which resembled this spore to a certain degree. *Myxidium oncorhynchi* Fujita (1923) is approximately the same size, but has fewer striations and is spindle shaped in lateral view. *M. gurgeli* Pinto (1928) has the same number of striations as this spore and somewhat the same appearance, but differs in that it has more pointed ends, the sporoplasm occupies only the center of the spore, and the polar capsules open at the ends of the spore. Also, the dimensions of both trophozoite and spore are considerably larger than those for this *Myxidium*. The spore of *M. matsuii* Fujita (1929) has a shape similar to this spore, except that it is more pointed. It is also a larger spore in all dimensions and has fewer striations than this species.

A number of species of *Myxidium* have been reported since 1933 (Kudo, 1934; Meglitsch, 1937). Of these, only *Myxidium kudoi* Meglitsch is comparable to this spore. However, the ends of the present spore are more rounded than those of *M. kudoi*, and there are more striations on the shell membrane. The polar capsules of *M. kudoi* seem to open at the ends of the spore, while the polar capsules of this spore open to the side and in opposite directions to each other. In addition, these spores are larger in all dimensions than *M. kudoi*. Therefore, the present organism is considered to be a new species, and the name proposed is *Myxidium melum*, n. sp.

MYXOSOMA sp.
(Fig. 12)

Habitat: A specimen of *Pomoxis sparoides* Lacepede which was taken from Little Miller's Bay on August 2, 1938, and examined the same day was found to harbor, among other species, a single spore of the genus *Myxosoma*. This was found floating free in the bile of the host.

KEY TO PLATE II

Fig. 13 Front view of *Myxobolus osburni* Herrick spore.
Fig. 14 Front view of *Myxobolus osburni* Herrick spore showing polar filaments extruded.
Fig. 15 Top view of *Myxobolus osburni* Herrick spore.
Fig. 16 Side view of *Myxobolus osburni* Herrick spore.
Fig. 17 Front view of *Myxobolus bubalis*, n. sp., spore.
Fig. 18 Front view of *Myxobolus sparoidis*, n. sp. spore.

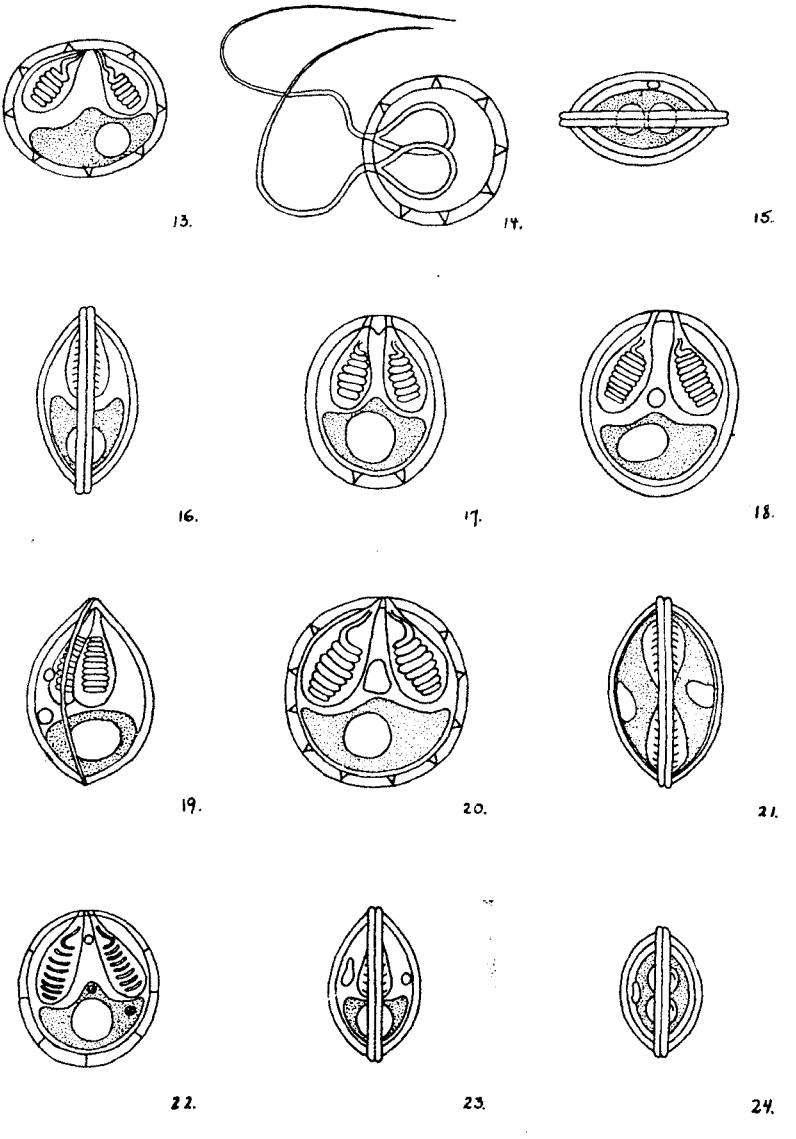


Fig. 19 Skewed side view of *Myxobolus sparoidis*, n. sp., spore.
Fig. 20 Front view of *Myxobolus okobojiensis*, n. sp., spore.
Fig. 21 Top view of spore of *Myxobolus okobojiensis*, n. sp.
Fig. 22 Front view of spore of *Myxobolus iowensis*, n. sp.
Fig. 23 Side view of spore of *Myxobolus iowensis*, n. sp.
Fig. 24 Top view of spore of *Myxobolus iowensis*, n. sp.

Vegetative form: Not observed.

Spore: The elongate pyriform spore had a thick shell membrane. Eight sutural folds were distributed around the spore. The polar capsules occupied less than half of the spore cavity, the sporoplasm approximately half. The polar filament was very fine and coiled many times. Measurements of the spore in Lugol's solution were: length 15.3 μ, breadth 5.8 μ, and polar capsules 5.8 μ.

Identification: A number of species of *Myxosoma* (Bond, 1937; Kudo, 1923; Kudo, 1934; Fujita, 1923) have been described since Kudo's first list of 1920. None of them seems to have this combination of spore size, polar capsular size, and sutural folds. However, since only a single spore was observed, it is not desirable to designate this as a new species.

MYXOBOLUS OSBURNI Herrick

(Figs. 13, 14, 15, and 16)

Habitat: A specimen of *Helioperca macrochira* (Rafinesque) collected from Little Miller's Bay and examined on August 1, 1938, had several spherical trophozoites floating free in the bile. Of the other six fish of this species which were examined at various times between July 20, 1938 and August 10, 1938, none was found to be infected. However, a specimen of *Pomoxis sparoides* Lacepede which was examined on August 2, 1938, had four spores in the bile with the same dimensions, shape, and characteristics. There was no sporoplasm in any of these four spores, and the polar filaments were extruded.

Vegetative form: The creamy white trophozoites were almost spherical in shape, and were filled entirely with mature spores. Dimensions of fresh trophozoites were 177 μ by 184 μ.

Spore: The spores were wider than long, and had a distinct iodinophilous vacuole. The shell membrane was fairly thick, and the sutural ridge had about eight distinct sutural folds. The polar filament, which was very distinct in Lugol's solution, was coiled about six times. Dimensions of the spores in Lugol's solution were: length 7.3 to 8 μ, breadth 8.7 to 10.2 μ, thickness 5.8 μ, polar capsules 3.7 to 4.4 μ, iodinophilous vacuole 2.2 μ, polar filament 17.5 μ. The sporoplasm was rather small, and projected up slightly between the polar capsules.

Identification: Fantham and Porter (1939) reported one species of *Myxobolus* which was wider than long and somewhat similar to this spore, but which had no sutural folds.

Herrick (1936) reported a species of *Myxobolus* from *Micropterus dolomieu* Lacepede and *Euponotis gibbosus* (Linnaeus) which he named *Myxobolus osburni*. The only differences between *M. osburni* and this spore from *Helioperca macrochira* (Rafinesque) are those of size and the number of sutural folds. The fact that Herrick measured the spores in a fresh condition may account for the difference in size. The difference in number of sutural folds (Herrick found about 10) is not considered sufficient to warrant calling this a new species.

MYXOBOLUS BUBALIS, n. sp.
(Fig. 17)

Habitat: A specimen of *Ictiobus bubalis* (Rafinesque) taken from Little Miller's Bay on July 27, 1938, and examined the same day had a number of cysts attached to the intestine. Another specimen of the same fish taken from East Okoboji and examined on August 11, 1938, had a single such cyst in the same location. None of the remainder of the sixteen specimens of this fish examined showed any infection.

Vegetative form: The cysts were white, almost spherical but somewhat flattened. The cysts were not on or in the muscle of the intestine, but were seemingly attached by a stalk to the intestine. Each cyst contained a considerable number of mature spores. Dimensions of the cysts averaged about 438 μ.

Spore: The oval spore possessed a thick shell. Located between the polar capsules was a triangular appendix. At the posterior end of the spore were two, and sometimes more, broad sutural folds. Spores measured in Lugol's solution had the following dimensions: 13.1 to 14.7 μ long, 10.2 to 11.7 μ broad, polar capsules 6.3 to 5.8 μ by 2.2 to 2.9 μ, iodinophilous vacuole 2 to 4.4 μ in diameter. The polar filament, which was very distinct in Lugol's solution had about six or seven turns. The granular sporoplasm, with its rather large iodinophilous vacuole, occupied approximately the lower half of the spore and projected up between the polar capsules.

Identification: This spore resembles, to a certain degree, that of *Myxobolus intestinalis* Kudo (1929). However, Kudo found the cyst of*M. intestinalis* as a swelling in the circular muscle of the intestinal wall. In the present specimens, the cysts were attached to the outer intestinal wall. Kudo also reported that the polar filament of *M. intestinalis* was but faintly differentiated through staining, and was coiled about ten or twelve times. In these spores, the polar capsules were easily seen in both fresh and stained spores, and the filaments were coiled but six or seven times. The dimensions of the spores found by Kudo were: length 12 to 13 μ, breadth 10 to 12.5 μ, thickness 8 μ, polar capsules 7.5 to 8.5 μ by 3.5 to 4 μ, iodinophilous vacuole 2 to 3 μ in diameter. It may be seen that although these spores were measured in Lugol's solution, which should have made them smaller (Kudo, 1930), they were actually larger than the spores of *M. intestinalis*. The host is different, since Kudo found *M. intestinalis* in the black crappie. The valves of these spores are similar in form, while those of *M. intestinalis* are not. In view of these differences, it seems justifiable to consider this a new species, and the name *Myxobolus bubalis*, n. sp., is proposed.

MYXOBOLUS SPAROIDIS, n. sp.
(Figs. 18 and 19)

Habitat: A specimen of *Pomoxis sparoides* Lasepede taken from West Okoboji on July 29, 1938, and examined the same day was found to have a number of cysts of a myxospordian on the intestine. Three fish of the same species which were taken from Little Miller's Bay

and examined on August 2, 4, and 11, 1938, were found to be parasitized with the same myxosporidian, and with the same site of infection. In addition, the specimen examined on August 4, 1938, had numerous spores of this parasite floating free in the bile.

Vegetative form: The yellowish-white cysts, which were full of mature spores, were almost spherical in form. The location of the cysts were on the walls of the intestine. The fresh cysts measured about 200 μ in diameter.

Spore: The spore was rounded ovoidal in shape. The shell membrane of the spore was uniformly thick. There was no intercapsular appendix or sutural folds. One to several fat globules were found between the polar capsules. The sporoplasm, with its distinct iodinophilous vacoule occupied little more than one-third of the spore cavity. The sutural ridge was rather thin. The polar filament was coiled about nine or ten times. Dimensions of spores measured in Lugol's solution were: length 11.7 to 12.4 μ, breadth 8.8 to 9.3 μ, thickness 8.5 μ, polar capsules 4.4 to 5.4 μ, iodinophilous vacuole 2.9 to 3.1 μ.

Identification: Kudo (1920) described a myxosporidian, *Myxobolus oviformis* Thelohan, which is flattened ovoidal with a pointed anterior end. This species differs from *M. oviformis* in that it is rounded ovoidal, has a rounded anterior end, and is somewhat larger despite the fact that it was measured in Lugol's solution. *M. oviformis* was found on the fin, spleen, kidney, and liver of *Gobio gobio* L.; branchiae of *Alburnus lucidus* Heck., *Cyprinus carpio* L., *Blicca bjorkna* L., *Abramis brama* L. and *A. vimba L.* These differences in host, site of infection, size, and shape are considered to be sufficient to justify calling this spore a new species. Therefore, the name *Myxobolus sparoidis*, n. sp., is proposed.

MYXOBOLUS OKOBOJIENSIS, n. sp.

(Figs. 20 and 21)

Habitat: Three cysts were found on the intestine of a specimen of *Pomoxis sparoides* Lacepede which was collected from Little Miller's Bay and examined on August 4, 1938. Only one other specimen of this fish, which was examined on August 5, 1938, showed the same infection.

Vegetative form: The cysts were almost spherical in form. The color was creamy-white. Dimensions of the fresh cysts were: 524 by 524 μ, 385 by 308 μ, and 277 by 246 μ.

Spore: The spores were spherical, or almost spherical in shape. The spore membrane was fairly thick. A triangular fat body was found between the polar capsules of most spores. There was no intercapsular appendix. The sporoplasm with its large iodinophilous vacuole occupied almost half of the spore cavity. There were eight to fourteen sutural folds. Dimensions of spores measured in Lugol's solution were: length 11.7 μ, breadth 10.2 μ to 11.7 μ, polar capsules 5.8 μ, iodinophilous vacuole 2.2 to 2.9 μ. The polar filament was coiled about eight times.

Identification: Only two species of *Myxobolus* resemble these spores

to a marked degree. *M. mesentericus* Kudo (1920) was found in the mesentery, liver, spleen, and wall of stomach, pyloric caecum, intestine, and gall bladder of *Lepomis cyanellus*. The differences between *M. mesentericus* and this spore are its shape, which is broadly oval, and its size. Kudo found the average length of *M. mesentericus* to be 9.5 μ, the breadth to be 8 μ, and the polar capsules to average 4.75 μ long. These spores are considerably larger, although they were measured in Lugol's solution and those of Kudo were measured fresh. In addition, Kudo found "about eight folds on the sutural edge" whereas these spores have eight sutural folds as a minimum number.

Myxobolus conspicuus Kudo (1929) differs from this spore in that it is less rounded, and has fewer sutural folds (5 to 8). It sometimes has an intercapsular appendix, which was not observed in this spore, and its polar filament is coiled about ten times as compared to the eight coils of this spore. *M. conspicuus* is not as broad as this spore, and has a different host and site of infection.

The differences between the spores of the present specimens and those of *M. mesentericus* and *M. conspicuus* seem significantly different to justify the creation of a new species. Therefore, the name *Myxobolus okobojiensis*, n. sp., is proposed.

MYXOBOLUS IOWENSIS, n. sp.
(Figs. 22, 23, and 24)

Habitat: A specimen of *Pomoxis sparoides* Lacepede taken from East Okoboji on August 14, 1939, and examined on the following day had numerous cysts within the tips of the gill filaments.

Vegetative form: Trophozoites were creamy-white, and sub-spherical in shape. All of the trophozoites examined were filled with mature spores. Dimensions of the cysts averaged about 210 μ by 338 μ.

Spore: The spores were sub-circular in front view, and spindle shaped in side view. The spore membrane was thicker at the bottom than at the top of the spore. There were three to seven sutural folds distributed about the spore. The spore had no intercapsular appendix. The iodinophilous vacuole occupied most of the space taken up by the sporoplasm. The polar capsules were long, and occupied more than half of the spore. Between the polar capsules were several triangular or spherical fat globules. Few spores did not have these, and in most cases there was one large one and one small one. The sporoplasm projects up somewhat between the polar capsules. Dimensions of the spores were: 12.2 to 12.9 μ long, 10.6 to 11.4 μ wide, 7.6 μ thick, polar capsules 7.6 μ long and 3 to 3.8 μ wide, iodinophilous vacuole 3.8 μ in diameter. In side view the sutural ridge was very distinct, but the sutural line was difficult to distinguish. The polar filament is coiled about eight or nine times. The sporoplasm occupies about one-third of the spore.

Identification: These spores are somewhat similar to *Myxobolus lintoni* Gurley, and *M. carassii* Klokacewa. The differences between *M. lintoni* Gurley and these spores are that *M. lintoni* has a much thicker shell membrane, lacks the sutural folds, and has a much

smaller iodinophilous vacuole. There is also a difference in host and site of infection, and in the shape of both spore and cyst. The present specimens differ from *M. carassii* Klokacewa in their host, site of infection, color of cysts, shape and size of the spore.

The differences between these spores and those of *M. lintoni* and *M. carassii* are considered to be sufficient to warrant calling this a new species. Accordingly, the name *Myxobolus iowensis*, n. sp., is proposed.

SUMMARY

1. The internal organs of 131 fishes belonging to 17 species were examined for Myxosporidia. Infections were found in forty-four cases.

2. Five new species of Myxosporidia were found and described. Three known species and one undetermined species were also found.

3. Five species of fish contained all of the Myxosporidia found, and the remaining twelve species showed no infection.

4. The fish showing the highest percentage of infection was the black crappie with an infection of 70.5%. This fish harbored one species of *Chloromyxum*, four species of *Myxobolus*, one species of *Myxidium*, and one species of *Myxosoma*. The only other fish with a high percentage of infection was the common black bullhead with an infection of 61.3%, and which harbored only one species of *Myxidium*.

ZOOLOGICAL LABORATORIES
STATE UNIVERSITY OF IOWA
AND
IOWA LAKESIDE LABORATORY

Literature Cited

Bond, F. F. 1937. Myxosoma grandis Kudo in Fish From the Hudson River Drainage System. J. Parasit. 23:231-232.

Fantham, H. B. and Porter, A. 1937. Some Effects of Invasion by Myxosporidia on Certain Canadian Fishes. J. Parasit. 23:565.

Fujita, T. 1923. Studies on Myxosporidia of Japan. Jour. Coll. Agr. Hokkaido Imp. Univ. 10:191-248.

——— 1929. The Skin Disease of the Eel. Ann. Zool. Japan. 12:245-250.

Herrick, J. A. 1936. Two New Species of *Myxobolus* from Fishes of Lake Erie. Trans. Amer. Micr. Soc. 55:194-198.

Kudo, R. R. 1920. Studies on Myxosporidia. III. Biol. Mono. 5:1-265.

——— 1923. Development of a Myxosporidian, *Myxosoma catostomi* nov. spec. Anat. Record. 24:269.

——— 1929. Histozoic Myxosporidia Found in Freshwater Fishes of Illinois, U. S. A. Archiv. f. Prostistk. 65:364-378.

——— 1930. Myxosporidia. Ch. XXXII in Problems and Methods of Research in Protozoology. Edited by R. Hegner and J. Andrews.

——— 1933. A Taxonomic Consideration of Myxosporidia. Trans. Amer. Micr. Soc. 52:195-216.

——— 1934. Studies on Some Protozoan Parasites of Fishes of Illinois. III. Bio. Mono. 13:1-44.

——— 1939. Protozoology. C. C. Thomas, Springfield, Ill.

Meglitsch, P. A. 1937. On Some New and Known Myxosporidia of the Fishes of Illinois. J. Parasit. 23:467-477.

Pinto, C. 1928. *Myxidium gurgeli*, nova especie. Myxsporideo parasito da vasicula biliar de peixe (Acestrorhamphus sp.) de aqua doce do Brasil. Sciencia Med. Rio de Janeiro. 6:86-87.

Rice, Verne J. and T. L. Jahn. 1943. Myxosporidian parasites from the gills of some Okoboji fishes. Proc. Iowa Acad. Sci. 50: