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# Parasites of Fish from the Inland Waters of Michigan: A Synopsis and Review of the Literature, 1882–2022

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## Abstract

Ninety-one studies during 1882–2022 have reported on some aspect of a parasite species infecting one or more fish species in Michigan waters. A total of 113 parasite species in 10 taxonomic groups (2 Ciliophora, 1 Microspora, 3 Myxozoa, 24 adult and 15 larval/immature Digenea, 9 Monogenea, 15 adult and 5 larval/immature Cestoda, 10 adult and 5 larval/immature Nematoda, 11 adult Acanthocephala, 6 Hirudinea, 7 Copepoda) have been reported in the scientific literature from fish in the inland waters of the Lower Peninsula of Michigan. The ciliophoran *Trichodina* sp. infected seven fish species in the Lower Peninsula. The adult digenetic trematodes *Crepidostomum cooperi* and *Crepidostomum cornutum* infected five and six fish species, respectively. Of the larval digeneans, 10 species are in the Diplostomidae, with *Tylodelphys scheuringi* infecting nine fish species. Three species of monogeneans found are in the Ancyrocephalidae family and four species are in the Dactylogyridae family. Adult cestodes in the genus *Proteocephalus* and adult nematodes in the genera *Spinitectus* and *Rhabdochona* are common parasites of fish in Michigan. The acanthocephalans *Pomphorhynchus bulbocolli* and *Leptorhynchoides thecatus* infected 10 and seven fish species, respectively. The leech *Myzobdella lugubris* infested Largemouth Bass *Micropterus salmoides* in several lakes. Seven species of copepods in three families were found on fish, with three species in the genus *Ergasilus*. Fifty-three fish species (39%) from 15 families out of 135 fish species in the Lower Peninsula of Michigan have had parasites reported from them. Fish species with the largest number of parasite species reported (in parentheses) are Bluegill *Lepomis macrochirus* (25), Smallmouth Bass *Micropterus dolomieu* (18), White Sucker *Catostomus commersonii* (17), Largemouth Bass (17), and Brook Trout *Salvelinus fontinalis* (16). Eighty fish species in the inland waters of Michigan have not had information published on their parasites.

Forty-three parasite species in nine taxonomic groups (3 Ciliophora, 2 Myxozoa, 7 adult and 8 larval/immature Digenea, 1 Monogenea, 5 adult and 3 larval/immature Cestoda, 6 adult and 2 larval/immature Nematoda, 3 adult Acanthocephala, 2 Hirudinea, 1 Mollusca) have been reported in 11 studies and three grey literature sources during 1912–1995 from 8 of 15 counties in the Upper Peninsula of Michigan. Eighteen fish species have had parasites reported from them.

## INTRODUCTION

In North America, Margolis and Arthur (1979) reviewed the parasites of fishes from Canada. Dechtiar and Lawrie (1988), Dechtiar et al. (1988), Dechtiar and Nepszy (1988), and Dechtiar and Christie (1988) surveyed the parasites of fish from the Canadian waters of lakes Superior, Huron, Erie, and Ontario, respectively. Muzzall and Whelan (2011) reviewed the parasites of fish reported from the Great Lakes and their connecting water bodies. The parasites of fishes have been partially summarized in some states of the United States, i.e., Alaska (Moles 2007), North Dakota (Hugghins 1959), Massachusetts (Sindermann 1953), Maine (Meyer 1954), and in the north central United States and Canada (Wyatt 1997). Allison et al. (1977) provided brief information, and some illustrations and photographs of pathogens and parasites of fishes in the inland waters of Michigan and the surrounding Great Lakes.

The literature on the parasites of fish in the inland waters of Michigan is diverse but fragmented throughout many documents. Many of the parasite studies are limited by: the study of one parasite species or parasite group; having only one fish species examined for parasites; small sample size; or the studies are very old. Furthermore, only a few of these studies involve parasites that are considered to be disease agents and mortality factors. Scattered among these publications are a few dealing with the presence of parasites in edible fish products and fish-transmitted parasites of human health importance. These studies were not prompted by some pressing or continuous issue involving fish biology, parasites, or pathology, but are believed to represent the interests of specific investigators at certain institutions or agencies. The objectives of this synopsis are to:

1) summarize the published information on the parasites reported from fish in inland waters of Michigan from the earliest known record in 1882 through 2022;
2) provide baseline data for the long-term changes in the occurrence and distribution of fish parasites in Michigan to allow future comparative analyses;
3) assist fish health workers, state competent fish health authorities, and policymakers in developing strategies to minimize the risks associated with the movement of fish and their parasites, and to make informed assessments on the possible threats presented by proposed movements of individual species of live fish between states;
4) provide information to help determine when new exotic parasite species are first identified in fish in Michigan;
5) provide baseline data for biologists who are concerned with host-parasite research and management of fish in the inland waters of Michigan; and
6) assist in developing a comprehensive online database on the pathogens and parasites of Michigan fish.

## LITERATURE ANALYSIS

### Literature Analyses and Parasite-Host Fish Species

Information for this synopsis was gleaned from all forms of scientific literature on fish parasites from the inland waters of Michigan ranging from peer-reviewed journal articles and reports to fisheries agency reports to other grey literature. It is important to emphasize that some data and information were difficult to interpret in some original sources and may be interpreted differently depending on the investigator. Furthermore, we did our best to understand the data and the author(s) interpretation of the results. This information is presented as a parasite-host list and as a host-parasite list. The parasite-host list is organized on a taxonomic basis and includes for each parasite species: the major taxonomic group; family; synonym(s), if any; the site of infection in or on the fish; the host-fish species; author(s) and date(s) of article(s); date(s) when fish were collected; parasite prevalence (percentage of fish infected in a sample), and or mean intensity (mean number of individual parasites per infected fish), and or mean abundance (mean number of individual parasites per examined fish); and study location, including latitude and longitude, if available. Authors responsible for this information are listed in alphabetical order. When the site of infection for a parasite species in or on its fish host was not provided in the original record, the site typical for that parasite infecting that fish host from non-Michigan records is provided in brackets. The compiled information covers the period 1882 through 2022 and the results are separated between the Lower and Upper Peninsulas of Michigan. This synopsis does not report on the parasites of fish from hatcheries, other aquaculture facilities, ornamental ponds or laboratory-controlled experimental infections. Furthermore, studies on viruses, bacteria, fungi, and lamprey parasitism of Michigan fish are not included.

### Classification, Taxonomy, and Helminth Developmental Stages

The basis of the higher morphological classification used for the Ciliophora, Microspora, and Myxozoa is that proposed by Lom and Dykova (1992). Taxonomic systems for the helminth phyla and families and leeches are based on the following sources: Monogenea (Yamaguti 1963a; Schell 1985), Digenea (Yamaguti 1953, 1971; Schell 1985; Gibson 1996); Cestoda (Wardle and Mcleod 1952; Yamaguti 1959); Nematoda (Yamaguti 1961; Anderson 1992); Acanthocephala (Yamaguti 1963b; Amin 2002); Hirudinea (Klemm 1972, 1991). and Copepoda (Yamaguti 1963c; Kabata 1969; 1988).

Hoffman (1999) was consulted for information on the taxonomic status of several parasite species if there was ambiguity or differences in the above sources. Current accepted scientific names are used for each parasite species. Synonyms of parasite species used in the past are included to assist the reader in interpreting earlier studies. Over the years, the scientific names of many parasite species have changed. It is emphasized that investigators check the status of these current names when work is being done on each parasite species. Remarks for each parasite's species (biology, taxonomy, misidentification, etc.) are included where appropriate.

Developmental stages of helminths were divided into larvae, immatures or juveniles, and adults. Larval stages are generally considered to be encysted and not occurring in the digestive tract. Also, larval stages of some species of the digenetic trematode, *Diplostomum* and a few

species of other digenetic trematode genera and other helminth species do not encyst, but these were still considered larvae if they were not in the digestive tract. Immature and juvenile stages were not gravid and usually occurred in the digestive tract. Adult helminths mature and become gravid in their fish hosts, no matter where they infect the fish.

**Host Fish Species-Parasite Analyses**

The host-parasite list is organized according to the taxonomy of the fish host by family. Within each fish family, genera and species are listed alphabetically. Fish scientific and common names by family are used as presented by Bailey et al. (2004). Parasites reported in each fish species are followed by the specific literature source(s) listed alphabetically by author(s). When a parasite species such as *Sterliadochona ephemeridarum* occurs in a fish species such as Brook Trout *Salvelinus fontinalus*, and the genus *Sterliadochona* sp. is also found, these are counted as only one species when quantitative information is presented. Furthermore, when a parasite species is reported as an adult in a fish species and as a larval or immature or juvenile stage in the same fish species or different fish species in the same fish family, this parasite is only counted in the adult parasite category.

**Interpretation of the Occurrence of Fish Species in Michigan**

The information in Bailey et al. (2004) was interpreted and used to determine the fish species that occur in inland waters of Michigan used in this synopsis. This approach provided 135 fish species from 26 families considered to be resident in the inland waters of Michigan and were considered in this synopsis (Table 1). Twenty fish species in eight families based on the information in Bailey et al. (2004) and Latta (2000) that we do not believe occur in the inland waters of Michigan or are so infrequent in them that they are not included in this synopsis are listed in Table 2.

# RESULTS

## Lower Peninsula

*Parasite studies and number of parasite species*

Ninety-one studies on the parasites of fish have been performed in the Lower Peninsula of Michigan from 1882 through 2022 (Table 3, Figure 1). Ten-year periods that had at least 10 parasitological studies performed on fish were 1920–1929, 1930–1939, 1940–1949, and 2000–2009. The concentration of studies during these periods was likely attributable to: 1) after World War I, there was a general increase in interest in the field of descriptive parasitology along with an increase in the range of organisms examined for parasites; 2) the peak after World War II is likely from the return of many veterans back to their former jobs, an increase in the number of veterans seeking new professions that had them returning to school, and a recognition of the importance of pathogens during the conflict; and 3) the final peak was the result of an increase in the number of fish health researchers at the prime of their careers working in Michigan during the 2000–2009 period, in particular Dr. Mohamed Faisal and his associates and Dr. Patrick Muzzall and his colleagues. The mean number of studies by 10-year periods performed on the parasites of fish from the inland waters of the Lower Peninsula was seven (range 1–17). There have not been any studies on the parasites of fish from the inland waters of Michigan since 2014, and this date refers to an abstract.

A total of 117 studies have been performed on the parasites of fish in 32 counties in the Lower Peninsula (Table 4). The number of studies listed by county and the total number of studies (91) performed on the parasites of fish are different because some studies reported on the parasites of fish involve more than one county. Twenty-nine studies were performed in Cheboygan County (most from 1919–1947), followed by 18 studies in Washtenaw County (most from 1929–1942) and 15 studies in Kalamazoo County (all in 1971–2014). Carney and Brooks (1991), Hnath (1970), and Meyer (1946) reported on the parasites of Michigan fish but did not include the county involved. Muzzall (1990) reported on the parasites of Arctic Grayling *Thymallus arcticus* from counties in both the Lower and Upper Peninsulas.

A total of 113 parasite species in 10 taxonomic groups (2 Ciliophora, 1 Microspora, 3 Myxozoa, 24 adult and 15 larval/immature Digenea, 9 Monogenea, 15 adult and 5 larval/immature Cestoda, 10 adult and 5 larval/immature Nematoda, 11 adult Acanthocephala, 6 Hirudinea, 7 Copepoda) have been reported in the literature from fish in the Lower Peninsula of Michigan (Table 5).

*Ciliophorans, microsporans, and myxozoans*

Two genera of ciliates (*Epistylis* sp., *Trichodina* sp.) representing two families have been reported in the literature from fish in the inland waters of the Lower Peninsula (Table 5). *Epistylis* sp. infected Mottled Sculpin *Cottus bairdii* and three salmonid species. *Trichodina* sp. infected four salmonid species, Bluegill *Lepomis macrochirus*, and Mottled Sculpin. One species of *Glugea* (microsporan) has been reported from the Mottled Sculpin.

Three species of myxozoans in one family have been found. *Myxobolus cerebralis* infected three species of salmonids and is considered an invasive non-native myxosporidan. *Myxobolus* sp. infecting the Bluegill and the unidentified species from Mottled Sculpin are considered to be two distinct species from *Myxobolus cerebralis*.

*Digenetic trematodes*

At least 24 species of adult digenetic trematodes in 11 families were reported from fish in the literature. Five species are in the Allocreadiidae family and three of these are in the genus *Crepidostomum*. *Crepidostomum cooperi* and *Crepidostomum cornutum* infected five, and six fish species and one *Lepomis* sp. hybrid, respectively. *Plagioporus sinitsini* was reported from 9 fish species, including 7 cyprinid species. All digenean species represented as adults occurred in the digestive tract except for *Acetodextra amiuri* (body cavity), *Phyllodistomum etheostomae* and *Phyllodistomum undulans* (urinary bladder), *Phyllodistomum lysteri* (ureters, urinary bladder), *Plagioporus sinitsini* (some individuals found in gall bladder), *Sanguinicola occidentalis* (bulbous arteriosus, gill filaments, eye, body cavity washings) and *Sanguinicola huronis* (ureter).

Many adult trematode species are host specific to one fish species or host group. *Bunodera sacculata* and *S. occidentalis* only infected Yellow Perch *Perca flavescens*; *Crepidostomum isostomum* only Johnny Darter *Etheostoma nigrum*; *Bucephalus elegans* only Rock Bass *Ambloplitis rupestris*; *Acetodextra amiuri* and *Alloglosidium corti* only Tadpole Madtom *Noturus gyrinus*; *Caecincola parvulus* only Bass *Micropterus* spp.; *Phyllodistomum etheostomae* only Greenside Darter *Etheostoma blennoides* and *Percina* spp.; *Phyllodistomum lysteri* only White Sucker *Catostomus commersonii*; *Phyllodistomum undulans* only Mottled Sculpin; *Megalogonia ictaluri* only Yellow Bullhead *Ameiurus natalis*; *Lissorchis hypenteli* only Northern Hog Sucker *Hypentelium nigricans*; *Lissorchis mutabile* only Lake Chubsucker *Erimyzon sucetta*; *Macroderoides typicus* only Bowfin *Amia calva*; *Podocotyle* sp. only Johnny Darter and Blackside Darter *Percina maculata*; and *Sanguinicola huronis* only Largemouth Bass.

At least 15 species of larval trematodes representing six families have been reported. Eight species in at least six genera are in the Diplostomidae. *Diplostomum flexicaudum* infected the White Sucker; *Diplostomum huronense* infected the Trout-Perch *Percopsis omiscomaycus* and Yellow Perch; and *Diplostomum spathaceum* infected White Sucker and Yellow Perch. Individuals of *Diplostomum* spp. were reported from 12 fish species in eight families. It is believed that individuals of *Diplostomum* spp. in these fish species are represented by two or more species. The taxonomic situation of species of *Diplostomum* and some other larval trematodes is at best confusing. Until further research is done, *D. flexicaudum*, *D. huronense*, and *D. spathaceum* are considered to be separate species in this synopsis. *Neascus* sp. and *Posthodiplostomum minimum* each infected four fish species, and *Tylodelphys scheuringi* occurred in nine fish species.

Stages of many of the species represented as larvae occurred as metacercariae. The larval digenetic trematodes named *Cercaria* followed by a species name or sp. were not included in the number counted because they might represent species or genera of larval trematodes already listed. The term "*Cercaria*" used by parasitologists in the early years referred to an unknown

genus or species of digenetic trematode which was based on the cercarial stage. *Uvulifer ambloplitis* infected Rock Bass and Smallmouth Bass *Micropterus dolomieu*. Individuals of *Ichthyocotylurus pileatus*, *Ichthyocotylurus platycephalus*, and *Ichthyocotylurus* sp. were reported as metacercariase from eight fish species. Three species of immature trematode species (*Azygia* sp., *Maritreminoides* sp., and *Podocotyle* sp.) were found in the digestive tract of fish.

*Monogeneans*

Nine species of monogeneans representing three families were reported. Three species in the Ancyrocephalidae and four species in the Dactylogyridae were found on fish. All species occurred on the gills except for *Acolpenteron catostomi* and *Acolpenteron ureteroectes* that infected the ureters and urinary bladder. All monogeneans identified to species (*A. catostomi*, *A. ureteroectes*, *Dactylogyrus semotilus*, *Gyrodactylus bairdi*) were host-specific infesting only one fish species or genus. All other monogeneans identified only to genus are believed to represent distinct species. Nine species of fish were infected with monogeneans.

*Cestodes*

At least 15 species of adult cestodes in five families have been reported. Three species of caryophyllid cestodes (*Glaridacris catostomi*, *Glaridacris laruei*, *Isoglaridacris folius*) occurred in catostomids. Eight species are in the Proteocephalidae family, and five of these are in the genus *Proteocephalus*. Many adult cestode species such as the caryophyllideans, *Eubothrium salvelini*, *Bothriocephalus claviceps*, *Bothriocephalus formosus*, *Haplobothrium globuliforme*, *Corallobothrium fimbriatum*, *Megathylocoides giganteum*, *Corallobothrium parvum*, *Proteocephalus ambloplitis*, *Proteocephalus buplanensis*, *Proteocephalus fluviatilis*, and *Proteocephalus pinguis* have been found in only one host species or host fish group.

It is believed that both Pacific Salmon *Oncorhynchus* spp. in the Great Lakes and salmonids such as Brook Trout in Michigan inland waters can become infected with *E. salvelini*. Therefore *E. salvelini* can be placed in both categories of Great Lake origin and of river origin (Table 5). Since non-feeding Pacific Salmon entering streams and rivers to spawn have gravid adults of *E. salvelini,* this is clear evidence of infection occurring in the Great Lakes. Resident Brook Trout in streams and rivers are also infected with gravid adults of this cestode from river sources.

*Eubothrium crassum* and *Cyathocephalus truncatus* were not included in the number of species of adult cestodes reported above for the following two reasons. The identification and occurrence of *E. crassum* in Brook Trout by Cooper (1919) is questioned and the specimens maybe *E. salvelini*. Secondly, the intermediate hosts for *C. truncatus* are the amphipod *Monoporeia* (= *Pontoporeia*) *affinis* and the opossum shrimp *Mysis relicta* that occur in Lake Michigan and not in the Pere Marquette River. Therefore, Chinook Salmon *Oncorhynchus tshawytscha* became infected with *C. truncatus* in Lake Michigan. This is also true for Pink Salmon *Oncorhynchus gorbuscha* infected with *C. truncatus* in the Upper Peninsula.

At least five species of larval cestodes (*Ligula* sp., *Haplobothrium globuliforme*, *Proteocephalus ambloplitis*, individuals of some *Proteocephalus* spp., *Triaenophorus* sp.) in four fish families were found. *Ligula* sp. was found in five fish species and *P. ambloplitis* in three

centrarchid species. Individuals of *Proteocephalus* spp. has been found in at least 20 fish species. *Triaenophorus* sp. has been reported only once and that was from the Lake Herring *Coregonus artedi*. All species of larval cestodes occurred in nonintestinal sites. Immature individuals of *Eubothrium* sp., *Bothriocephalus cuspidatus*, and of *Proteocephalus* spp. occurred in the digestive tract of fishes.

*Nematodes*

Ten species of adult nematodes from five families were reported in the literature. *Camallanus oxycephalus* infected two centrarchid species. Four species are in the Cystidicolidae family with three species in the genus *Spinitectus*. *Spinitectus micracanthus* was found in five centrarchid species. Three species in the genus *Rhabdochona* are in the family Rhabdochonidae. *Rhabdochona cascadilla* infected cyprinids and *Rhabdochona cotti* only occurred in Mottled Sculpin. *Sterliadochonas ephemeridarum* was only found in Brook Trout, Brown Trout *Salmo trutta*, Pink Salmon, and Coho Salmon. All nematode species have been found in the digestive tract except for *Philometroides nodulosa* (upper lip) in White Sucker. *Capillaria salvelini* and *Cystidicola farionis* were not included in this number of 10 nematodes because fish became infected in the Great Lakes.

Two species of larval nematodes (*Spinitectus* sp., *Spiroxys* sp.) from two families were reported. *Spiroxys* sp. was encysted in and on the stomach wall and mesentery of four fish species. *Contracaecum* sp., *Camallanus oxycephalus*, *Camallanus* sp., *Capillaria* sp., *Truttaedacnitis clitellarius*, *Truttaedacnitis* sp., *S. ephemeridarum*, and *Rhabdochona* sp. were reported as immature individuals found in the digestive tract. Immature individuals of *Rhabdochona* sp. were found in seven fish species.

*Acanthocephalans*

Eleven species of adult acanthocephalans in five families were reported occurring in the intestine. *Acanthocephalus dirus* was found in four salmonid species. Five species of *Neoechinorhynchus* have been reported. *Pomphorhynchus bulbocolli* was found in 10 fish species representing five fish families. *Leptorhynchoides thecatus* was found in seven fish species, six of which are in the Centrarchidae family. Several species are host specific with *Neoechinorhynchus crassus*, *Neoechinorhynchus cristatus*, and *Octospinifer macilentus* to White Sucker; *Neoechinorhynchus cylindratus* to *Micropterus* spp.; *Neoechinorhynchus limi* to Central Mudminnow *Umbra limi*; and *Paulisentis missouriensis* to Creek Chub *Semotilus atromaculatus*. *Echinorhynchus salmonis* was not counted because the salmonid hosts became infected in Lake Michigan. The intermediate host for *Echinorhynchus salmonis* is *P. affinis* that occurs in Lake Michigan and not in the Pere Marquette River. Therefore, Coho Salmon *Oncorhynchus kisutch*, Rainbow Trout *Oncorhynchus mykiss*, and Chinook Salmon became infected with *E. salmonis* in Lake Michigan. This is also true for Pink Salmon infected with *E. salmonis* in the Upper Peninsula. All species of acanthocephalans represented as immature adults were also reported as adults in the examined fish. Immature *P. bulbocolli* occurred in the pyloric ceca, anterior intestine, and in intestinal cysts of 16 fish species, representing six families. Immature *L. thecatus* infected the intestine of six fish species.

*Leeches*

Six species of leeches in two families (Glossiphonidae, Piscicolidae) were reported infesting fish in the reviewed literature. *Actinobdella inequiannulata* infested the White Sucker. *Myzobdella lugubris* infected the body surface, buccal cavity, and fins of Largemouth Bass in lakes in the Lower Peninsula. *Piscicola geometra* infested Pumpkinseed *Lepomis gibbosus*; *Piscicola milneri* infested White Sucker; and *Piscicola punctata* infested Yellow Perch and Brook Trout. Meyer (1946) reported *Piscicola punctata* infesting Brook Trout in Michigan, but the specific location is unknown.

*Crustaceans*

Seven species of copepods representing three families were found on fish in the literature. Three species are in the Ergasilidae family, and two species each are in the Lernaeidae and Lernaeopodidae families. *Ergasilus caeruleus*, *Ergasilus centrarchidarum*, and *Ergasilus megaceros* primarily infected the gills of four centrarchid species. *Ergasilus megaceros* also infected the olfactory sac of Sea Lamprey *Petromyzon marinus*. *Lernaea cruciata* infected three centrarchid species. *Lernaea cyprinacea* infected the Green Sunfish *Lepomis cyanellus* and the Common Shiner *Luxilus cornutus*. *Achtheres pimelodi* was reported on the gill arches, gill rakers, gill filaments, and buccal cavity of three species of centrarchids. *Salmincola edwardsii* is host specific to Brook Trout, infesting several sites.

*Fish species-parasite analyses*

A total of 53 (39%) fish species and one *Lepomis* sp. hybrid from 14 families out of 135 fish species in the inland waters of the Lower Peninsula of Michigan have had parasites reported from them (Table 6). Fish species with the largest number of parasite species reported and the number of studies on their parasites (number of parasite species, number of known studies) are: Bluegill (27,11), Rock Bass (21, 14), Smallmouth Bass (20, 21), Largemouth Bass (19, 15), Brook Trout (18, 13), White Sucker (17, 15), Yellow Perch (16, 19), Mottled Sculpin (15, 8), Brown Trout (13, 5), and Tadpole Madtom (10, 1). Eighty-two (61%) fish species out of 135 fish species known to occur in the inland waters of Michigan have not had information published or reported on their parasites (Table 1).

The parasites of Coho Salmon, Rainbow Trout, Chinook Salmon, and Pink Salmon are difficult to list as one entry because individuals of different ages of these species may be infected in the river with one parasite species and in a Great Lake with another parasite species. Therefore, the parasites of these four salmonid species are listed by river origin, Great Lake origin, or origin could not be determined based on what the authors know about the specific system studied (Tables 5 and 6). Pink Salmon only in the Upper Peninsula, and Coho Salmon, Rainbow Trout, and Chinook Salmon are included in the number of fish whose parasites have been studied in the inland waters of Michigan because they have parasites considered to be of river origin. Furthermore, difficulty in listing parasites is also possible because pre-smolt and smolt Steelhead *Oncorhynchus mykiss* may have been raised in a Michigan hatchery and released into inland waters. We acknowledge that other scientists may disagree with our separation of parasites with this approach or in what category some parasites were placed. Also, since the early

life stages of Coho Salmon, Chinook Salmon, and Pink Salmon occur in the inland waters of Michigan, they are considered to be species whose parasites could have been studied.

**Upper Peninsula**

*Parasite species and number of parasite species*

Forty-three species of parasites (3 Ciliophora, 2 Myxozoa, 7 adult and 8 larval/immature Digenea, 1 Monogenea, 5 adult and 3 larval/immature Cestoda, 6 adult and 2 larval/immature Nematoda, 3 adult Acanthocephala, 2 Hirudinea, 1 Mollusca) were reported in fish from the Upper Peninsula of Michigan in 14 studies conducted in 8 of 15 Upper Peninsula counties from 1912 through 1995 (Tables 3, 4, 5 and 6). The number of studies listed by county (18) and the total number of studies (14) performed on the parasites of fish are different because some studies reported on the parasites of fish from more than one county.

*Ciliophorans and myxozoans*

Three genera of ciliates representing three families infested the gills of fish from the Upper Peninsula. *Epistylis* sp. and *Trichodina* sp. were found on Longnose Dace *Rhinichthys cataractae* and Burbot *Lota lota. Capriniana* sp. occurred on Arctic Grayling. It is believed that the myxozoans, *Myxobolus* spp. infecting the gills and mesentery of Longnose Dace and Burbot are represented by at least two separate species.

*Digenetic Trematodes*

At least seven species of adult digenetic trematodes representing three families have been reported from fish. *Allocreadium lobatum* was found in Creek Chub; *Bunodera luciopercae*, *Bunodera sacculata*, and *Azygia angusticauda* in Yellow Perch*; Crepidostomum farionis* in Pink Salmon and Burbot; *Crepidostomum* sp. in Brook Trout and Arctic Grayling; *Proterometra autraini* in Rock Bass, Mottled Sculpin, Smallmouth Bass, Burbot, and Yellow Perch; and *Phyllodistomum brevicecum* in Central Mudminnow. All species infected the digestive tract except for *Crepidostomum farionis* (some individuals found in gall bladder) and *P. brevicecum* (urinary bladder).

At least eight species of larval/immature trematodes have been reported in Michigan fish. *Neascus* sp. and *Posthodiplostomum minimum* were found in Longnose Dace; *Apophallus imperator* in Brook Trout; *Ornithodiplostomum* sp. and *Diplostomum* sp. in Arctic Grayling; *Clinostomum* sp. and *Crassiphiala bulboglossa* in Yellow Perch; *Clinostomum complanatum* in Black Bullhead *Ameiurus melas*; *Clinostomum* sp. infected Yellow Perch; *Posthodiplostomum* sp. in Burbot; and unidentified strigeids have been reported from Bluegill and Yellow Perch. One immature species (*Azygia* sp.) was found in Burbot.

*Monogeneans and cestodes*

One species of monogenean, *Gyrodactylus* sp., infested the gills of Longnose Dace. Adults of the cestode, *Eubothrium salvelini* occurred in the intestine of Pink Salmon, Coho Salmon, and

Chinook Salmon. Adults of *Bothriocephalus* sp. (also Bluegill) and *Proteocephalus* sp. (also Largemouth Bass) infected Yellow Perch and Walleye *Sander vitreus*. Larval cestodes of *Diphyllobothrium latum* infected Northern Pike *Esox lucius*, Burbot, and *Sander* spp.; and *Diphyllobothrium* sp. infected Chinook Salmon, Coho Salmon, Rainbow Trout and Pink Salmon. *Ligula* sp. infected Rock Bass, White Sucker, Yellow Perch, Bridle Shiner *Notropis bifrenatus*, and Spottail Shiner *Notropis hudsonius*. *Shistocephalus solidus* infected Brook Trout. Larval cestodes (plerocercoids) were found in the flesh, viscera, gonads, wall of digestive tract, mesentery, and body cavity of fish. Unidentified plerocercoids were found in Walleye.

*Nematodes*

Adults of six different nematode species found in the digestive tract were reported in the literature. *Raphidascaris acus* and *Haplonema hamulatum* infected Burbot; *Rhabdochona canadensis* infected Longnose Dace, Pink Salmon, and Coho Salmon; and *Rhabdochona cotti* infected Mottled Sculpin. *Sterliadochona ephemeridarum* occurred in Brook Trout, Pink Salmon, and Coho Salmon; and *Spinitectus gracilis* occurred in Pink Salmon, Coho Salmon, and Chinook Salmon. Larvae of *R. acus* infected the liver of Longnose Dace. Larvae of *Spiroxys* sp. occurred in cyst-like structures in and on the stomach wall, liver, and mesentery of Arctic Grayling. An unidentified larva occurred in Black Bullhead *Ameiurus melas*. Immature individuals of *S. ephemeridarum* occurred in the stomach of Burbot and Longnose Dace.

*Acanthocephalans, leeches, molluscs*

Adults of three species of acanthocephalans *Neoechinorhynchus pungitius*, *Neoechinorhynchus saginatus*, and *Leptorhynchoides thecatus* infected the intestine of Burbot, Longnose Dace, and Yellow Perch, respectively. Immature individuals of *N. saginatus* were found in Burbot. The leech *Myzobdella lugubris* occurred on Burbot and Yellow Perch. *Piscicola* sp. infested Yellow Perch. Glochidia of the mollusc *Elliptio* sp. infested the gills of Burbot.

*Fish species-parasite analyses*

Eleven published studies and three grey literature sources report on some aspect of a parasite infecting at least 18 fish species (Longnose Dace, Creek Chub, Black Bullhead, Northern Pike, Central Mudminnow, Coho Salmon, Chinook Salmon, Pink Salmon, Brook Trout, Arctic Grayling, Burbot, Mottled Sculpin, Rock Bass, Bluegill, Smallmouth Bass, Largemouth Bass, Yellow Perch, Walleye) from eight counties in the Upper Peninsula (Tables 4, 5, 6).

Sixteen species of parasites have been reported from Burbot in three studies and 13 parasite species from Longnose Dace in one study. Fewer parasite species were found in other fish species from the Upper Peninsula including: five parasite species in Pink Salmon in one study; four in Coho Salmon in one study; four species in Brook Trout in one study; six parasite species in Arctic Grayling in one study; 11 parasite species in Yellow Perch in five studies; three parasite species in Black Bullhead in two studies; three parasite species in Bluegill in two studies; three species in Smallmouth Bass in two studies; three species in Walleye in two studies; two species in Northern Pike in two studies; two species in Chinook Salmon in one study; two species in

Mottled Sculpin in two studies; and one parasite species in each of Rock Bass, Creek Chub, Central Mudminnow, Largemouth Bass, and *Sander* spp.

Parasites identified to species found in fish in both the Upper and Lower Peninsulas by taxonomic group: adult digenetic trematodes including *A. lobatum*, *B. sacculata*; larval digenetic trematodes including *P. minimum*, *U. ambloplitis*; adult cestodes including *E. salvelini*, *Corallobothrium fimbriata*, *P. ambloplitis*; adult nematodes including *S. ephemeridarum*, *S. gracilis*, *R. canadensis*, *R. cotti*; adult acanthocephalans including *L. thecatus*, *N. saginatus*; leech *M. lugubris*.

## DISCUSSION

Most parasite studies in inland waters were found to be clustered around a few locations associated with academic institutions and little data have been collected in most of the 83 counties (68 in the Lower Peninsula and 15 in the Upper Peninsula) in Michigan (Figure 1). Michigan has over 35,000 inland lakes and ponds with a surface area of one-tenth of an acre or more (Wolfson 1991) and has more than 72,000 miles of rivers, streams, creeks, and ditches (Michigan Department of Natural Resources, unpublished data). Most of these waters have never been surveyed for fish parasites. A large number of studies on the parasites of fish have been performed in and around both Douglas Lake and Gull Lake and also in Washtenaw County in the Lower Peninsula.(Figure 1). Twenty-two studies (22% of the total statewide) involve Douglas Lake and include studies by Cooper (1918, 1920), LaRue (1919, 1932), LaRue et al. (1926), Van Cleave (1919), Butler (1920), Hughes (1927, 1928a,1928c, 1929), Hughes and Piszczek (1928), Hughes and Berkhout (1929), Hughes and Hall (1929), Thomas (1929, 1930), Winfield (1929), Van Haitsma (1925, 1930a, 1930b, 1931), and Larsh (1941). Obviously, these studies were performed a number of years ago. Many, if not all these authors of these studies were associated with the University of Michigan Field Station, Pellston, Michigan, Cheboygan County. Eleven studies (11% of the total statewide) involve Gull Lake and include studies by Esch (1971), Esch and Huffines (1973), Esch et al. (1975, 1976), Muzzall et al. (1995), Gillilland and Muzzall (2004), Steinauer (2004), Steinauer et al. (2006, 2007), Pracheil and Muzzall (2009, 2010). Most of these researchers were associated with the Kellogg Biological Station, Kalamazoo, Michigan and/or Michigan State University. More information on ecological parasitology involving Gull Lake can be found in Esch (2016). Most of the 18 parasitological studies performed in Washtenaw County in the Lower Peninsula involved parasitologists associated with the University of Michigan and scientists visiting this university. There is only one published study (Woodhead 1930) on the parasites of a fish species from Houghton Lake, the largest lake in the Lower Peninsula, that examined Walleye and found the digenetic trematode *Prosorhynchoides pusilla*.

Some parasitological studies do not include the county the study was conducted in and we could not obtain the abstract by Homola et al. (2012b), which might include the county. Furthermore, two or more studies might involve the same parasite species infecting the same fish species in the same county such as Muzzall and Buckner (1982) and Muzzall (1984a); Steinauer (2004) and Steinauer et al. (2006, 2007); and Homola et al. (2011, 2012a, 2012b, 2014).

Most inland water studies on fish parasites in the Upper Peninsula involved investigators associated with Michigan State University (Muzzall and Peebles 1986; Muzzall et al. 1987;

Muzzall 1990; Muzzall et al. 1992; Muzzall and Whelan 1995) and Northern Michigan University in Marquette (Spence and Peters 1971; LaBeau and Peters 1995; and grey literature-Tompkins 1947; Pynnonen 1960; Taylor 1964) (Figure 1). The finding of the cestode, *Proteocephalus macrocephalus* in Walleye, Yellow Perch, and Largemouth Bass by Tompkins (1947) is questioned since *P. macrocephalus* is a parasite of eels *Anguilla* spp. Based on this information and his drawings, this cestode will be referred to as Proteocephalus sp. in this document. Also based on his drawings, we believe Tompkins (1947) identified Bothriocephalus sp.in Walleye, Yellow Perch, and Bluegill, not Haplobothrium sp., and will therefore use Bothriocephalus sp. in our synopsis. *Crepidostomum* sp. and *S. ephemeridarum* infected Brook Trout from the Ford River (Patrick Muzzall, personal observation, 1984). We are not aware of any published fish parasite studies conducted on Lake Gogebic, the largest lake in the Upper Peninsula. Furthermore, there are no published studies on the parasites of fish from the inland waters of Isle Royale or Beaver Island, Michigan.

The clustering of parasitological studies in a few locations leaves fisheries managers generally uninformed on the potential fish parasites in most of Michigan. The lack of information ensures that the ability of fisheries managers to effectively manage natural mortality from parasites will continue to be impaired until more is known about this group of pathogens statewide.

**Biology of Michigan's inland fish parasites and their likely effects on fish**

*Ciliophorans and microsporans*

At least three species of ciliophorans have been reported from fish in the inland waters of the Lower and Upper Peninsulas of Michigan. The life cycles of *Epistylis* sp., *Trichodina* sp., and *Capriniana* sp. are direct, meaning an intermediate host is not involved. In heavy infestations of the gills, *Epistylis* sp. and *Trichodina* sp. can cause destruction and hemorrhaging of the gills, as well as other pathology in wild fish (Richardson 1938; Davis 1947; Hoffman and Lom 1967).

*Glugea* sp. infected Mottled Sculpin in the Lower Peninsula. Homola et al. (2014) found that Mottled Sculpin infected with *Glugea* sp. were significantly heavier than uninfected fish, but the parasite had little influence on fish growth and condition. *Glugea* sp. and the other microsporans are now considered to be housed taxonomically in the kingdom Fungi based on molecular evidence. The life cycle of *Glugea* sp. is probably direct but not known for certain. Some species of *Glugea*, in particular, *Glugea cepedianae* and *Glugea hertwigi*, are known to cause pathology including xenomas in the viscera and have directly caused mortality in Gizzard Shad *Dorosoma cepedianum* and Rainbow Smelt *Osmerus mordax* (see Dechtiar 1972; Nepszy et al. 1978; Putz et al. 1965).

*Myxozoans*

It is believed that 4 species of Myxozoans have been found in Michigan fish and include *Myxobolus cerebralis* and one each *Myxobolus* sp. reported from Bluegill, Longnose Dace, and Burbot. This is suggested because species of *Myxobolus* are host specific. *Myxobolus cerebralis*

and other myxozoans have been considered myxozoan protozoans in the past, but they have been moved to the phylum Cnidaria by parasitologists based on molecular analyses and the presence of cnidocytes. The life cycle of *M. cerebralis* is indirect, using aquatic annelids (tubificid oligochaetes) and salmonids as hosts. Aquatic oligochaetes, i.e., *Tubifex tubifex*, become infected by ingesting a stage called the myxospore that is released from the infected salmonid and infection susceptibility between *T. tubifex* clades differ. Once in contact with the epithelial cell of the intestinal lining, the myxospore inserts its polar filaments into the cell. An amoeba-like stage called the sporoplast then penetrates the host cell and begins to multiply rapidly. The host cell of the tubificid eventually bursts, releasing triactinomyxon (TAM) spores in the water. Once in the water, the TAM spore attaches to and penetrates the epidermal or gill epithelial cell of the salmonid and begins to replicate itself, establishing the infection in the fish. *Myxobolus cerebralis* causes a disease in salmon and trout called "whirling disease", characterized by infection and erosion of the cartilage, misshapen head and trunk, black tail, and tail chasing and whirling (Allison et al. 1977). These disease symptoms remain if these small, infected fish survive.

*Digenetic trematodes*

Digenetic trematodes are common parasites of fishes in the inland waters of Michigan. Much of the early information on their general life cycle was generated by University of Michigan Biological Station parasitologists working in Douglas Lake and the surrounding area prior to 1940. The correct identification of larval digenetic trematodes, including studies on the metacercariae in the Douglas Lake area is interesting, and in some cases, confusing. Caution is urged in reading some of these papers and in understanding what trematode species have been identified because the study authors may refer to two or more trematode species but are really referring to the same trematode species; or the authors of these articles refer to the same trematode species but are really dealing with two or more species. Although this confusion does exist on the identification of some trematode species in the Douglas Lake area, the authors of these early studies should be applauded for their work since in some cases it is difficult to work with larval trematodes, and there was the lack of information on these species as well as the lack of transmission of data and information available to authors before 1940.

The life cycles of digenetic trematodes are always indirect and complex, generally involving two or three hosts, that harbor successive developmental stages of digenetic trematodes. A common feature is that almost all digenetic trematodes have a first intermediate host that is a mollusc, usually a snail, and in a few instances a small bivalve. Generally, the parasite life stages occurring in fish are separated into two biological groups. Those in the first group reach sexual maturity and become gravid in the fish, usually occurring in the digestive tract. Examples of some of these trematodes found in Michigan fish are *Allocreadium lobatum*, *Crepidostomum* spp., *Phyllodistomum* spp., and *Sanguinicola* spp. Some of these species can occur in large numbers in the digestive tract of fish. An example would be 419 individuals of *Crepidostomum cooperi* found in one Brook Trout from Hunt Creek (Muzzall 2007). Generally, it is suggested that adult digenetic trematodes in the fish digestive tract cause minimal pathology, unless they are present in large numbers. Those in the second group remain larval stages called metacercariae in the fish and become adults and mature when they are eaten by a piscivorous

fish, bird, or mammal. Examples of some of these trematode species found in Michigan fish are *Clinostomum* sp., *Diplostomum* spp., *Posthodiplostomum* spp., and *Ichthyocotylurus* spp.

A general life cycle of a digenetic trematode of fish is as follows. Eggs are passed with feces of the final host, and hatch in the water, releasing a free-living minute larval stage called a miracidium. The miracidium is covered with cilia which move this stage in the water. The miracidium must find and penetrate a suitable mollusc host within 1 or 2 days, or it will die. In some species, the mollusc becomes infected by eating the trematode eggs. The miracidium is now within the mollusc and in the first intermediate host transforms into a sac-like larval stage called a sporocyst. The sporocyst may form other sporocysts, or other larval stages called rediae. The sporocysts or rediae asexually form a number of tailed larval stages called cercariae which leave the snail and are free swimming. The cercariae will die within two days unless they find and infect the next suitable host in the life cycle. When one miracidium infects a snail, it produces a large number of cercariae by asexual reproduction that leave the snail.

Depending on the trematode species, the cercaria penetrates a fish and encysts, after which it is called a metacercaria. Metacercariae can be found on the external surface, in the muscle, gills, eyes, liver, and other areas of the fish and can reach numbers of several hundreds. A true metacercaria has a cyst, that is composed of an inner wall formed by the parasite and an outer wall formed by the infected animal. For many species, subsequent recruitment of metacercariae from one year to another year can lead to a cumulative infection in fish, leading to large numbers of them. The metacercaria can develop no further until the infected fish is eaten by the proper final host, another fish, bird, or mammal. Excystation of the metacercariae, and development and maturation of the trematodes in their definitive hosts involves many factors and stimuli, including low oxidation-reduction potential, carbon dioxide, host digestive enzymes, bile salts, host temperature (ectothermic or endothermic), and hormones.

Metacercariae often are visible and/or active in some of these areas, especially when the infected fish is being cleaned, and are the stages most likely to be noticed by anglers. So, fish serve as a second intermediate host harboring the metacercariae, or as the final host harboring the gravid adult worms, usually in the intestine. Therefore, adult gravid worms are usually not seen by the angler.

*Larval digenetic trematodes*

Although *Clinostomum complanatum* and *Clinostomum* sp., commonly called “yellow grub”, have only been reported in six studies (Table 5), they are more common than this because they have been widely found in Bluegill, Smallmouth Bass, Largemouth Bass, other species of centrarchids, and Yellow Perch in Michigan (Patrick M. Muzzall, personal observation, 1999, 2001, 2002). *Clinostomum* sp. had maximum intensities of 481 and 106 in Largemouth Bass and Smallmouth Bass, respectively in Michigan (Patrick M. Muzzall, personal observation, 2002). This larval worm may be yellow or gray in color and up to ¼ inch (approximately 6 mm) in length occurring under the skin, in the muscle tissue and other body locations. Grubs may live for one or more years in the fish, thus large numbers of them may be seen in one fish as their burden increases with time.

Metacercariae of *C. complanatum* moving from the body wall to various fish tissues can cause hemorrhage and tissue damage (Lo et al. 1985). However, only massive infections had serious consequences. Paperna (1991) reported that intense infections of metacercariae of clinostomids in wild and cultured fish were rare, but a few recorded cases demonstrated pathogenicity in fish. Hoffman (1999) commented that if metacercariae of *Clinostomum* are numerous, it causes considerable damage to fishes in hatcheries and in nature, with no specifics provided. Fish heavily infected with clinostomids might show retarded growth, changes in host behavior which may make them more vulnerable to predation, and death (Kalantan et al. 1987; Lo et al. 1985; Shareef and Abidi 2012).

The yellow grub must be eaten by fish-eating birds, such as herons *Ardea* spp. and bitterns *Botaurus* spp., to develop. It attaches to and matures in the mouth and throat of the bird, and eggs pass into the water when the bird feeds or in its feces. The yellow grub has the typical digenetic trematode life cycle. Eggs hatch and release the miracidia that penetrate the suitable snail intermediate host. In the snail, they develop into the sporocysts, then develop into rediae, multiply, and leave the snail as cercariae. When they find a fish, the cercariae burrow through the skin and encyst where they develop into a metacercariae, the yellow grubs. The life cycle is completed when the bird eats the infected fish. These conspicuous cysts containing the yellow grubs are often observed by the angler. Pressure, such as that caused by cleaning the fish, releases these large active grubs from the cysts.

*Posthodiplostomum* spp., commonly called “white grub”, form tiny colorless or white cysts (white metacercariae surrounded by a transparent wall) in the liver, heart, and in other tissues of several fish species. These cysts contain larval trematodes that grow into adults in the intestines of fish-eating birds and possibly mammals. In many cases, they represent the genus *Posthodiplostomum*. The life cycle follows the general pattern as outlined for yellow grub. Very large numbers of them can occur in fish, causing marked mechanical damage with subsequent organ failure, and may lead to increased predation by the piscivorous bird definitive hosts (Ondrackova et al. 2004). Smitherman (1968) demonstrated that Bluegill fingerlings had a significant reduction in growth when large numbers (>353 metacercariae) of *Posthodiplostomum minimum* were present. Muzzall and Peebles (1998) reported that *Posthodiplostomum* sp. had a maximum intensity of 1,341 in one Bluegill from a Michigan lake. John Hnath (Michigan Department of Natural Resources, personal communication, 1997) indicated that there were many visceral adhesions in Bluegill from Lake Mitchell, Michigan resulting from multiple metacercarial cysts in the liver, viscera, and gonads. Another “white grub” trematode, *Tylodelphys scheuringi* had a maximum intensity of 22 metacercariae in the brain of one Central Mudminnow from Michigan (Muzzall and Kilroy 2007).

The metacercariae of *Diplostomum* spp. (commonly called eye worms, eye grubs, cataract worms, and in the past called *Diplostomulum*) infect the vitreous humor or the lens of the eye of several fish species. These larval trematodes are not encysted in the lens, so they are not true metacercariae. They can only be seen with a dissecting or compound microscope. Heavy infection can occur, resulting in blindness due to the presence of one or more metacercariae that cause opaque areas (discoloration) in the lens (Shariff et al. 1980). When many metacercariae are present, the entire lens can appear white in a living fish. LaRue et al. (1926) found maximum intensities of metacercariae of *Diplostomum* sp. of 450 and 135 in the eyes of a single Yellow

Perch and a single White Sucker, respectively from Douglas Lake. *Diplostomum spathaceum* was reported to be the causative agent of a mass mortality of European Perch *Perca fluviatilis* by Nümann (1972). Crowden and Broom (1980) found that Dace *Leuciscus leuciscus* infected with large numbers of *D. spathaceum* spent more time feeding in the surface water, which increased their vulnerability to predators. The cercariae enter the fish by penetration of the integument, move through the circulation, eventually localizing in the eye, where they remain free and active. The life cycle is similar to the one for yellow grub, and gulls as well as other birds serve as definitive hosts. These larval stages may live several months and remain infective to birds. Also, Becker and Brunson (1966) indicated that Herring Gulls *Larus argentatus* became infected with *Diplostomum flexicaudum* by eating infected snails.

The metacercariae of *Uvulifer ambloplitis*, *Neascus* sp., *Crassiphiala bulboglossa*, and *Neascus* of *Ornithodiplostomum ptychocheilus* are obvious as slightly raised black pigmented cysts (size of a small pinhead) occurring in the skin, fins, muscle, and other areas of the fish. Their presence in the fish is called "black spot" or *Neascus* sp. Their occurrence causes the fish's immune system to surround them with a cyst wall in which there is an accumulation of pigment cells that produce the characteristic black spots. It is not known how many metacercariae are in an individual black spot, how many are alive, as well as infective. The term "*Neascus*" is a general one used to describe black spot when the larval trematode has not been identified to genus or species. There are several factors that are involved in causing problems in identifying blackspot. It is difficult to tease the metacercariae out of their cysts intact without damage, making identification very difficult. Furthermore, organs and structures of the metacercariae are not developed enough to be useful for identification. However, feeding live fish infected with blackspot to young uninfected chicks, ducks, and other birds with appropriate permits obtained to do this, is useful in obtaining adult worms from the birds for identification. Molecular analyses will be useful in the identification of these metacercariae for species with available primers.

The trematode metacercariae occurring in these black spots are believed to be species generalists, commonly infecting salmonids, centrarchids, pike, perch, minnows, and a variety of other fish species with a worldwide distribution. The life cycle follows the general account (snail to fish to bird) and one of the main bird hosts is the Belted Kingfisher *Megaceryle alcyon* in Michigan. Fish may be heavily infected and there is evidence that a massive infection of a young fish may cause excessive blood loss, physiological stress, sterility, and even death (McCoy 1928; Krull 1934; Hunter and Hunter 1938; Hoffman 1956). Furthermore, Harrison and Hadley (1982) suggested that black spot infection was related to retarded growth and increased mortality of Northern Pike, but the cause and effect were unclear. Muzzall (1986) and Pracheil and Muzzall (2009) found that the maximum intensity of *Neascus* sp. was 20 in one Brook Trout and 114 in an age 1 Bluegill from Michigan, respectively. The maximum intensity of metacercariae of another trematode, *Cryptogonimus* sp. was 2,387 in an age 2 Bluegill in a Michigan lake (Pracheil and Muzzall 2009).

Metacercariae of *Ichthyocotylurus* spp. (= *Tetracotyle*) have been reported from several fish species in Michigan. Dezfuli et al. (2005) found metacercariae of *Ichthyocotylurus erraticus* embedded in a granulomatous proliferation of heart tissue, forming a reactive fibroconnective capsule around them in the freshwater spiny eel *Mastacembelus armatus*. Vankara and Chikkam

(2013) found pathological changes associated with *Ichthyocotylurus* metacercariae infecting the heart, including atrophy due to pressure, inflammatory cells in the vicinity of the cyst, and loss of striation of cardiac muscle which might have reduced the cardiac efficiency of the Powan *Coregonus lavaretus*. Several authors (Kozicka 1958; Meyer 1958; Bychovaskaya-Pavlovskaya and Petrushevski 1963; Sinclair 1972; Dukes 1975) have reported on the mortalities of fish caused by species of larval trematodes.

It is believed the above-mentioned trematodes except for *Clinostomum* sp. (yellow grub) are incapable of infecting humans, and even heavily infected fish are safe to eat. It may be more aesthetically pleasing to skin a very heavily infected fish or remove the larval trematodes before eating. In any case, thorough cooking kills the larval trematodes, and the flavor of the fish is not affected. The only method of attempting to control these larval trematodes is through the elimination of the other hosts, snails, or birds but these controls are not appropriate from an ecosystem perspective. Adult clinostomids have been reported from humans in several countries including Japan, Korea, Thailand, India (Cameron 1945; Yoshimura et al. 1991; Chung et a. 1995; Tiewchaloern et al. 1999; Kitagowa et al. 2003; Park et al. 2009; Hara et al. 2014). Humans become infected with clinostomids by eating raw or poorly cooked fish and amphibians infected with metacercariae. Clinostomids usually infect the mucus membrane of the human throat, causing pharyngitis or laryngitis. This infection of the human throat with *Clinostomum* and other helminth species is commonly called halzoun which is treatable.

Comments should be made on two other larval digenetic trematodes, *Ribeiroia ondatrae* (Cathaemasiidae) and *Metorchis conjunctus* (Opisthorchiidae). Metacercariae of *R. ondatrae* were reported from the lateral line canal of at least three species of fish from Douglas Lake (Beaver 1939). *Ribeiroia ondatrae* is one of the species of digenetic trematodes that causes limb abnormalities in amphibians. Since Beaver (1939), *R. ondatrae* has not been reported from fish or amphibians in Michigan. Metacercariae of *M. conjunctus* have been reported from the muscle of catostomids and infrequently in Yellow Perch and Northern Pike in North America. We are not aware of any studies published on the metacercariae of this species infecting fish in Michigan. However, Hoffman (1999) stated that this species was reported in Michigan using a personal communication from John Hnath (Michigan Department of Natural Resources, 1973), so there is some evidence that it occurs in Michigan. Dogs, mink, and a variety of other piscivorous mammals serve as definitive hosts when they eat fish infected with metacercariae (Wobeser et al. 1983). There are reports of it causing mortality in sled dogs (Rawson 1960), and epidemics in humans (MacLean et al. 1996).

*Monogeneans*

The monogeneans (examples infesting Michigan fish are *Actinocleidus* sp., *Anchoradiscus* sp., *Dactylogyrus semotilus*, *Gyrodactylus bairdi*) are usually ectoparasites on the body surface, fins, and gills of aquatic vertebrates and have direct life cycles; thus, an intermediate host is not involved. The posterior end of many monogeneans is disc shaped with hooks, which are used to attach the worm to the host. Usually, monogeneans do not cause major problems to wild fish. However, in large numbers, they may cause pathological conditions, especially on fishes kept in captivity, hatcheries, or pond culture, where there is no or minimal water movement and warm water temperatures. Furthermore, fish are crowded in these conditions and the worms can easily

spread from one fish to another. Hooks penetrate the skin or gills, degrading tissue in these areas, along with causing hemorrhaging, epithelial hyperplasia, fusion of lamellae and filaments, and filament clubbing. Additionally, monogenean wounds form open sores that may serve as portals of entry for other pathogens (Mizelle 1938; Dogiel et al. 1958; Prost 1963; Lester and Adams 1974; Hoffman 1976; Williams and Jones 1994).

*Cestodes*

The life cycles of cestodes or tapeworms infecting fish, with very few exceptions, involves two or three hosts. Adult, gravid cestodes usually occur in the intestine of the final definitive host, which is usually a vertebrate. Eggs are passed with the feces of the final host, and from here there are two potential life cycles. One life cycle requires the egg hatching in the water, releasing a spherical, ciliated, free-swimming coracidium which contains a six hooked embryo, called a hexacanth or onchosphere. The coracidium is eaten by a crustacean, often a copepod, which serves as the first intermediate host. The oncosphere moves through the intestinal wall of the copepod into the body cavity developing into a larval stage called a procercoid. The fish eats the infected copepod and the procercoid develops into an adult in the fish's intestine. Examples of cestodes found in Michigan with this life cycle are *Eubothrium salvelini*, *Bothriocephalus formosus*, and *Proteocephalus buplanensis*. It is highly likely the Asian Fish Tapeworm *Schyzocotyle* ( = *Bothriocephalus*) *acheilognathi*, which has this type of life cycle, will be found in the inland waters of Michigan in the near future as it has been documented in Michigan's baitfish supply chain (Muzzall et al. 2016; Boonthai et al. 2017). *Eubothrium salvelini* had a maximum intensity of 16 in one Brook Trout from a Michigan creek (Muzzall 1993b). Catostomids become infected with cestodes in the family Caryophyllaeidae when they eat infected aquatic annelids.

Adults of *Proteocephalus parallacticus* were found in adult Pink Salmon, Coho Salmon, and Chinook Salmon in tributaries of Lake Superior. It is believed these salmonids initially became infected in Lake Superior. Hanzelova and Scholz (1999) suggested that *Proteocephalus parallacticus* is a synonym of *Proteocephalus longicollis*.

The other life cycle involves the infected copepod (and procercoid) that is eaten by a suitable fish which serves as the second intermediate host, and the procercoid moves through the intestinal wall of the fish and develops into an elongate larval stage, called the plerocercoid. Depending on the cestode species, the plerocercoids are found in the body cavity, fish muscle, viscera, and other areas. When the final host, another fish, bird, or mammal eats the infected fish, the plerocercoid develops to maturity in the intestine and begins to lay eggs. Examples of cestodes with this type of life cycle found in fish from Michigan's inland waters are *Proteocephalus ambloplitis*, *Diphyllobothrium* spp., *Ligula* sp., *Schistocephalus solidus*, and *Triaenophorus* sp. In summary, if a fish is the final host for a cestode, gravid adult worms occur in the intestine. Some cestodes are quite large (> 30 centimeters) and will be seen if the digestive tract is cut when the fish is being cleaned. Furthermore, the cestode may be entwined about itself forming a "ball of string". If the fish is an intermediate host, the plerocercoids will be encysted in the muscle, liver, mesentery, or may occur free in the body cavity. These plerocercoids may be seen by the angler when the fish is being cleaned.

Of the adult cestodes reported from Michigan fish, species in the genus *Proteocephalus* are most common. The adult, gravid tapeworms of *Proteocephalus ambloplitis* (bass tapeworm) only occur in the intestines of Smallmouth Bass and Largemouth Bass in many lakes and streams in Michigan. Adults can reach lengths of 20 cm or larger in Bass. The plerocercoid larvae, which are often seen in the body cavity, gonads, and other internal organs infect a variety of centrarchids and other fish species. The plerocercoids do not encyst, but move around, destroying tissues and causing hemorrhages and adhesions that disrupt normal organ functions of the host. This produces infections, visually apparent as a brownish color in the infected areas and adhesions in the fish's visceral mass. Hundreds of plerocercoids may be present in Smallmouth Bass and Largemouth Bass. In larger bass, the sex organs are often heavily infected, sometimes to the point where reproduction is partially or wholly inhibited. Plerocercoids can live for months in fish. Esch and Huffines (1973) suggested that the movement of plerocercoids of *P. ambloplitis* produced severe pathological changes in the spleen, liver, and gonads in Smallmouth Bass from Gull Lake, Michigan. Gillilland and Muzzall (2004) found all Smallmouth Bass and Largemouth Bass examined from Gull Lake infected with plerocercoids of *P. ambloplitis* and suggested that this cestode parasite may reduce the reproductive potential of Smallmouth Bass in this lake due to gonadal infections. They found that the highest mean intensities of plerocercoids of *P. ambloplitis* in the ovaries and testes of Smallmouth Bass from Gull Lake were 34 and 16, respectively. John Hnath (Michigan Department of Natural Resources, personal communication, 1997) indicated that heavy infections of larval *Proteocephalus* sp. caused hepatic necrosis in Bluegill, Redear Sunfish *Lepomis microlophus*, and *Micropterus* sp. from Clear Lake, Michigan. The bass tapeworm does not infect humans.

*Diphyllobothrium latum* (broadfish tapeworm) has been reported from humans, who became infected from eating raw or undercooked infected fish from Portage Lake in the Upper Peninsula by Warthin (1912) and Vergeer (1928). Since these reports, this species has not been reported in Michigan fish. Its life cycle involves copepods as first intermediate hosts, fish as second intermediate hosts and humans as definitive hosts. Although *D. latum* has not been found and reported in the Great Lakes region for almost 100 years, plerocercoids of *Diphyllobothrium* sp. have been found in Pink Salmon, Coho Salmon, and Chinook Salmon in Michigan tributaries of lakes Michigan, Superior and Huron (Muzzall and Peebles 1986; Muzzall 1993a; Patrick Muzzall, personal observation, 1986, 1989, 1993).

*Ligula intestinalis* is the only species of *Ligula* in the northern hemisphere. It is usually identified from adult cestodes collected from the piscivorous bird definitive hosts. Some parasitologists, however identify the plerocercoids found in fish just as *Ligula* sp. *Ligula* sp. occurs as plerocercoids in the body cavity of fish, including Common Shiner *Luxilius cornutus* and White Sucker. Often several worms may be found in one fish, the total volume of the cestodes may be 25–50% of the total volume or weight of the host (Dence 1958). In larger hosts, the worms are usually larger, sometimes twice the length of the host. With such a cestode burden, infected fish are usually readily identified by the swollen abdomens and sluggish movement. Infected fish may not be able to keep up with uninfected fish, and may school together (Dence 1958), which might make the infected fish more vulnerable to predation, thus transferring the plerocercoid to the piscivorous bird definitive host. White Suckers infected with *Ligula* sp. were collected using long handled nets by one of the authors (Patrick M. Muzzall,

personal observation, 1999). *Ligula intestinalis* matures and become gravid in Common Mergansers *Mergus merganser* and Great Blue Herons *Ardea herodias*.

*Nematodes*

The life cycles of parasitic nematodes involve larval stages (or juveniles as called by some parasitologists) and are characterized by having four molts of the cuticle. The cuticle, which is an outer non-cellular covering and lines the mouth and rectum, is shed with each molt. The larvae are not infective to the final host until after the second molt, when they are called the third stage or infective larvae. Generally, there is not much difference in the appearance of the larval stages within a species except for size.

Parasitic nematodes of Michigan fish show a variety of life cycles. *Camallanus oxycephalus* and *Philometroides nodulosus* use copepods as intermediate hosts and fish as definitive hosts. *Sterliadochona ephemeridarum*, *Spinitectus* spp., and *Rhabdochona* spp. use mayfly larvae as intermediate hosts and fish as definitive hosts. Muzzall (1986) found that the maximum intensities of *S. ephemeridarum* in one Brook Trout and one Brown Trout were 278 and 195, respectively. *Hysterothylacium brachyurum* and *Raphidascaris acus* probably use invertebrates such as crustaceans as first intermediate hosts, several species of small fish as second intermediate hosts, and piscivorous fish as definitive hosts. The life cycle of *Contracaecum* sp. involves copepods as first intermediate hosts, several species of small fish as possible second intermediate hosts, and depending on the species, piscivorous fish or birds as definitive hosts. The life cycle of *Spiroxys* sp. involves copepods and possibly other arthropods as first intermediate hosts. Fish, amphibians, dragonfly nymphs, and mollusks may serve as second intermediate or as paratenic hosts, which are hosts not critical to the life history but keep the parasite alive, and turtles are the definitive hosts for *Spiroxys* sp. The life cycles of *Truttaedacnitis* sp. and *Truttaedacnitis clitellarius* are unknown. However, Pybus et al. (1978) reporting on the life cycle of *Truttaedacnitis stelmoides* involved larvae being eaten by the immature stages of lamprey hosts (ammocoetes) and remain in the intestine. After this, the larvae move to the liver and on metamorphosis of the American Brook Lamprey *Lampetra appendix*, the worms move to the intestine. The specific life cycles of *Capillaria salvelini* and *Haplonema hamulatum* are unknown at this time.

Adults of *H. brachyurum* and *R. acus* are large nematodes occurring in the digestive tract of fish, but their pathological effect in this site is unknown. Muzzall et al. (1987) reported that *Haplonema hamulatum* and *R. acus* had the highest intensities of 57 and 45, respectively in Burbot in the Upper Peninsula. Larvae of *Contracaecum* sp. (mesentery), *H. brachyurum* (liver), *Raphidascaris* sp. (liver, spleen, free and encapsulated in liver, mesentery, and intestinal wall), *Spiroxys* sp. (mesentery) can cause inflammation to the liver, viscera and other sites and possibly increase the fish's susceptibility to secondary infections by viruses, bacteria, and fungi (Williams 1967).

Poole and Dick (1984) demonstrated that larvae of *R. acus* migrating within a fish body caused distortion or destruction of blood vessels of Yellow Perch and found collagenous capsules around worms. Jilek and Crites (1982) reported that *Spinitectus carolini* caused simple infectious enteritis with inflammatory infiltration in the intestine of Bluegill, with the most

intense tissue reaction occurring when the larvae completely penetrated the gut wall. Dick et al. (1987) believed that efforts to establish a population of Rainbow Trout in an inland lake failed because of high numbers of *Contracaeum* spp. Anglers cleaning fish may observe the nematodes in the stomach or intestine if these organs are cut or in the body cavity or viscera during the cleaning process, depending on the parasite's length and activity.

*Acanthocephalans*

All acanthocephalans of fish have indirect life cycles, using some type of aquatic crustacean such as an ostracod, copepod, amphipod, or isopod as the intermediate host. Adult, gravid worms live in the intestine of the fish and eggs are released into the water with the feces of the infected fish. Eggs are eaten by the intermediate host. The egg hatches, and a larval stage called an acanthor hatches from the egg, moves through the intestinal wall to the body cavity of the intermediate host, and develops into the infective stage called a cystacanth. After a period of development, the cystacanth infects the fish after the infected crustacean is eaten. The cystacanth attaches with its hooks on the proboscis into the intestinal wall and develops into an adult. Examples of acanthocephalans with this life cycle in Michigan fish are *Acanthocephalus dirus* (isopods), *Neoechinorhynchus cristatus* (ostracods), and *Pomphorhynchus bulbocolli* and *Leptorhynchoides thecatus* (amphipods).

In some acanthocephalan species, such as *Neoechinorhynchus cylindratu*s, the life cycle involves a fish second intermediate host. It uses an ostracod as the first intermediate host, and Bluegill and other fish species as the second intermediate host. In the second intermediate host, the larval stage is encysted in the liver and other viscera. The infected fish second intermediate host is eaten by *Micropterus* spp., which serve as the final host. Muzzall and Gillilland (2004) reported that *N. cylindratus* had a maximum intensity of 367 in one Smallmouth Bass from Gull Lake.

Some acanthocephalans may encyst in vertebrates, including fish, amphibians, reptiles, birds, and mammals which do not serve as an intermediate or final host, and thus these animals are called paratenic or transport hosts. These hosts are not specifically needed in the life cycle but are believed to "bridge" an ecological gap between the animals that serve as intermediate and definitive hosts. Furthermore, some other acanthocephalan species may exhibit post-cyclical transmission. This occurs when young worms just obtained or attached to the intestine of one fish are eaten by another fish, such as a predator and these worms attach and survive in the predator fish.

Hooks on the proboscis of acanthocephalans attached to the intestinal wall can cause extensive tissue damage and are potentially fatal to fish, birds, and mammals in the wild as well as in confinement (Nickol and Crompton 1985). Extent of pathology caused by acanthocephalans depends on the depth of the proboscis penetration and the intensity of worms present in the intestine. Adults of many species, such as *A. dirus* (= *A. jacksoni*), *P. bulbocolli*, *L. thecatus*, and *Echinorhynchus salmonis* in fishes in Michigan and the Great Lakes, can cause inflammation and hemorrhaging of the intestinal wall that can reduce nutrient absorption (Venard and Warfel 1953; Bullock 1963; Schmidt et al. 1974; McDonough and Gleason 1981). Esch and Huffines (1973) reported that *L. thecatus* produced mucosal erosion, fibrosis, and chronic inflammation in the

intestine and ceca of Smallmouth Bass. *Leptorhynchoides thecatus* had a maximum intensity of 741 in one Smallmouth Bass from Gull Lake (Muzzall and Gillilland 2004). Muzzall (1982) found over 400 individuals of *P. bulbocolli* in one Rock Bass and in one White Sucker from the Red Cedar River. Muzzall (1984b) reported that Brown Trout and Rainbow Trout harboring more than 100 individuals of *A. dirus* appeared emaciated and the fish head size appeared large for the fish length. He also found that the proboscides and bulbs of several *P. bulbocolli* in two Brown Trout penetrated the intestinal wall and embedded in the swim bladder. The swim bladders of these fish were dark and the bladder walls appeared thicker in the areas where the worms were attached. Individuals of some species, such as *P. bulbocolli* and *L. thecatus*, may be found encysted in nonintestinal areas of the fish, damaging the mesentery, and destroying visceral tissue leading to the formation of connective tissue and fibrosis. John Hnath (Michigan Department of Natural Resources, personal communication, 1997) reported the larger and more numerous cysts in Bluegill from Lake Mitchell were host response cysts formed around the bulbs and or bodies of *P. bulbocolli*. Furthermore, John Hnath (Michigan Department of Natural Resources, personal communication, 1997) indicated the presence of parasites, including *P. bulbocolli*, trematode metacercariae, and larval *Proteocephalus* sp., in the gonadal tissue of one Bluegill examined from Lake Mitchell negatively influenced the reproductive potential of fish.

*Leeches*

Leeches have direct life cycles. Only six species of leeches in two families have been reported from fish in inland waters of Michigan. Faisal et al. (2011) found high prevalences of buccal ulcerations caused by *Myzobdella lugubris* in Largemouth Bass in Michigan lakes. The amount of necrotic areas and hemorrhage done to infected fish appears to be proportional to the number of leeches infesting the fish. Fish infected with leeches suffer directly from blood loss and can obtain secondary infections through the bite injury caused by the leech. Schulz et al. (2011) found that leech attachment caused extensive inflammation, muscle tissue necrosis, and edema in several fish species in Lake St. Clair. It is also possible that leeches could be transmission vectors for other pathogens as suggested for Viral Hemorrhagic Septicemia which was found in *Myzobdella lugubris* in Lake St. Clair by Faisal and Schulz (2009).

*Crustaceans*

Most, if not all parasitic copepods, have direct life cycles. Individuals of some parasitic species move freely on the fish surface; others attach themselves temporarily, leave the host, and then attach permanently to the fish; and others attach early and permanently to the fish. Besides host dynamics, juveniles and adults of parasitic copepod species demonstrate a wide diversity in their size, structure specialization, and morphology.

Individuals of *Ergasilus* spp. appear as small, elongated white spots and primarily occur on the gills of fish and may be found on other areas. Three species of *Ergasilus* have been reported from Rock Bass, Bluegill, Smallmouth Bass, and Largemouth Bass in Michigan. Muzzall et al. (1995) found that the maximum intensities of *Ergasilus centrarchidarum* on Rock Bass and Smallmouth Bass were 127 and 110, respectively from Gull Lake, and that of *Ergasilus megaceros* on Rock Bass was 86. Hoffman and Meyer (1974) and Roberts and Janovy (2009)

reported that high intensities (numbers not provided) of *Ergasilus* can severely damage gill tissue, cause adhesions between gill lamellae, interfere with respiration, open the way to secondary infections, fish may lose weight and refuse to feed, and lead to death.

Parasitic copepods of the genus *Lernaea* (also incorrectly spelled *Lernea*) are called anchor worms because the head of the copepod which is embedded into the flesh of the host resembles antlers or an anchor. Allison et al. (1977) indicated that *Lernaea cruciata* is the most common anchor worm infecting Michigan fishes. Muzzall (1982) found *L. cruciata* and *Lernaea cyprinacea* on three centrarchid species in Michigan. Anchor worms attach on the body surface, base of fins and fins, and may penetrate the eye and cause blindness. Attached anchor worms may cause hemorrhages and ulcerated areas at the point of attachment causing unsightly lesions, spoiling the fish's appearance. Loss of blood and openings in the skin of fish may create entry portals for other pathogens leading to secondary infections. Goodwin (1999) reported that massive infections of *L. cyprinacea* caused major losses of Channel Catfish *Ictalurus punctatus* in Arkansas fish farms. Hua et al. (2019) suggested that *L. cyprinacea* and *L. cruciata* may be synonyms based on molecular data analyses, with *L. cyprinacea* having priority.

*Lernaea* ( = *Lernaeocera*) *pectoralis* has only been reported in Michigan once, infecting the Common Shiner (Kellicott 1882) and nowhere else in the world. Hoffman (1999) suggested that *L. pectoralis* is "possibly an anomalous trianchored form of *L. cyprinacea*". We agree with Hoffman (1999) and have not included *L. pectoralis* in the numbers of parasite species reported from Common Shiner and total numbers of parasite species in Michigan.

*Achtheres* is a common parasitic copepod of many fish species. Species identification has been difficult to determine by some investigators (Shahady et al. 2007). *Achtheres pimelodi* was reported from three species of centrarchids from Gull Lake by Muzzall et al. (1995). Adult females range in length from 2–7 mm and are the stage usually observed on fish; adult males are approximately 1 mm in length. Egg sacs are produced shortly after mating. When the eggs hatch, stages called copepodids are released. These juveniles must then attach to a fish or die. The effects of *Achtheres* by causing direct or indirect mortality on the fish hosts is difficult to ascertain. Warren (1981) suggested that large numbers of larval stages may kill the fish by severely damaging the gills. Hoffman (1977) and Stepanova and Vjuskova (1985) suggested direct injury to the host caused by *Achtheres* is due to gill hyperplasia. Shahady et al. (2007) did not observe these pathologies, but suggested that as copepod numbers increase, it is possible that *Achtheres* increases respiration rates in Striped Bass *Morone saxatilis* thus contributing to summer fish kills during periods of high temperatures and low oxygen in southeastern reservoirs.

*Salmincola edwardsii* (gill louse) is host specific to Brook Trout and other *Salvelinus* spp. occurring on the gills, inner surface of the opercula, branchial rim, fins, and body surface. This copepod is commonly seen on Brook Trout in Michigan appearing as small (maybe 8 mm) white or yellow grub-like organisms. The life cycle is direct. The female, which is usually seen, bears a pair of long egg sacs on her posterior end within which the eggs undergo development. Eggs hatch and release free living young that swim for approximately 2 days. If they do not find a Brook Trout within 2 days, they die. The larval copepod attaches to the Brook Trout and is able to rasp a hole in the surface tissue by its mouthparts and attachment filament. The imbedded filament enlarges at its end forming a structure called a bulla, anchoring the copepod firmly in

place. This bulla makes it difficult to detach the gill louse intact. On the fish, the male and female copepods mate, the males die, and females develop into adults in approximately 30 days. The female usually produces 2 pairs of egg sacs twice during her lifetime and dies shortly after the second egg sacs are produced. The life cycle takes anywhere from 1 to 6 months depending on water temperature.

*Salmincola edwardsii* has caused mortalities of hatchery young Brook Trout due to extensive bleeding from the gills (Allison et al. 1977) but effects of these copepods on wild fish are unknown. However, Muzzall (1984b) reported that the distal portions of gill filaments of wild trout infected with *S. edwardsii* showed extreme hyperplasia and clubbing, absence of filaments on arches, and the operculum of some infected fish was folded underneath itself. It is also believed that infection of the gills by *S. edwardsii* impairs respiration, and attachment areas may provide portals of entry for secondary infections. Furthermore, Mitro (2016) suggested that a decline in the numbers of Brook Trout in a Wisconsin creek was due to environmental stressor factors, competition with Brown Trout, and infection with *S. edwardsii*. Similar Brook Trout population declines from *S. edwardsii* have been noted in Pennsylvania, which have led to stream trout communities having Brook Trout replaced, being dominated by Brown Trout (2018, Coja Yamashita, Pennsylvania Fish and Boat Commission, personal communication).

Some comments should be made on fish lice, *Argulus* spp. which are branchiuran crustacean parasites. Fish lice can be found on almost any part of the fish's body and can move from one area to another. Although there are no published articles of the fish louse infecting Michigan fish, Allison et al. (1977) in their manual of common parasites of Michigan fish report it found on Largemouth Bass, Yellow Perch, White Crappie *Pomoxis annularis*, and catfishes. Therefore, we believe it is a parasite of some fish species in Michigan inland waters. The fish louse is visible to the unaided eye and is dorsoventrally flattened with a shell and four pairs of swimming legs. Two prominent suckers located on the ventral surface and on each side of the mouth and stylet are used to attach to the fish. The thin and needlelike stylet pierces the fish and helps the parasite to ingest bodily fluids. Fish infested with large numbers of fish lice (numbers not provided) are characterized by erratic swimming, flashing, and reduced growth (Bowen and Putz 1966). Furthermore, the feeding sites can become ulcerated and hemorrhagic which may lead to bacterial, viral, and fungal secondary infections.

## SUMMARY AND CONCLUSIONS

There has been very little effort to synthesize and update information on the parasites of freshwater fish in the United States. Scholz and Choudhury (2014) presented their views on why they believed parasites of fish in North America are neglected. Furthermore, what work has been done has typically not been systematic or well planned, either from a temporal or spatial perspective. Little is known about the distribution of parasites across Michigan or most states in the United States or provinces of Canada and parasite ecology, including how infections and disease occurrence vary annually, is equally unknown. Most of the work has been done in a few areas close to university research facilities. The applicability of work in these waters to other Michigan waters is unknown at this time and additional surveys are needed to confirm the trends in other Michigan waters. The lack of knowledge on the distribution of potentially pathogenic organisms has large implications for fisheries agencies including: impairing the ability to use

wild broodstocks of fish for rehabilitation and recovery efforts; impairing the ability to manage mortality rates in key fish populations; increasing the risks of moving fish with pathogenic parasites to new waters with unknown outcomes to the receiving population; and increasing disease outbreaks in the wild and in aquaculture facilities that use surface water with potential significant economic effects.

There is a growing consideration of how to manage natural mortality in fish populations and parasites may be a manageable component of this mortality in the future. If managers can change natural mortality rates, the dynamics of the fishery is fundamentally changed. However, without a basic understanding of parasites and their ecology that could be used to influence natural mortality rates, this is simply unachievable, and the current state of wild fish health work will continue status quo.

Furthermore, it appears that the number of fish parasitologists and surveys on the parasites of freshwater fish in the United States are decreasing. This is because past and present fish parasitologists are not training as many fish parasitologists as they have in the past, those trained in fish parasitology have changed to other host-parasite systems which are better funded or they have completely left the field of parasitology for various reasons. Also, the art and science of processing the parasites and the techniques of fixing and staining the parasites properly and making permanent glass slides of them, and identification procedures are all being lost, which is going to increase the difficulties in properly identifying parasite species in the future. However, molecular taxonomy is very useful in parasite identification and taxonomy and will continue to be in the future. Unfortunately, it appears the only time that studies are performed currently is to investigate either a new invasive parasite such as *Myxobolus cerebralis*, causative agent of whirling disease, or in response to an epizootic or post-mortem event. This strategy makes it impossible to proactively manage a group of pathogens or understand their influence on fish stocks.

Ninety-one studies have reported on the parasites of 53 fish species out of 135 species from the Lower Peninsula of Michigan. In the Upper Peninsula, 11 studies and three grey literature sources have reported on the parasites of 18 fish species. There is little information known about the parasites of fish from Michigan's inland waters and we believe that the number of parasite species reported in Michigan fish is grossly underestimated. Of the helminths found, the trematodes were the most commonly reported parasites of Michigan fishes, followed by the cestodes. The number of ciliophorans, microsporans, and other single-celled parasites, and myxozoans infecting fish is generally low, and only a few species of disease importance have been found in Michigan. Individuals of many fish species have not been critically examined for single-celled parasites and myxozoans. There are no studies on the blood parasites of Michigan fish. It is clear that the present knowledge on all the groups of parasites of fish in Michigan is fragmentary and vastly understudied. Many of the reviewed published studies on the parasites of Michigan fish species are limited temporally as they were done 50 to 100 years ago; some examples are: Bowfin *Amia calva*, Bridle shiner *Notropis bifrenatus*, Lake Chubsucker, Trout-Perch, Northern Pike, Northern Longear Sunfish *Lepomis peltastes*, Greenside Darter *Etheostoma blennoides*, Logperch *Percina caprodes semifasciata*, and Walleye (Meinkoth 1947; Cooper 1918; Wallace 1941; Woodhead 1929, 1930; Hughes 1929; Dobrovolny 1939a; Fischthal 1943). Many of studies are also limited in that only one parasite species or group was studied.

Fish parasite research in Michigan is spatially limited with most studies centered in Douglas Lake and Gull Lake and their surrounding areas. Many of these studies are equally out-of-date. We are not aware of any studies published on the parasites of fish in nature from the inland waters of Michigan after 2011 except for Homola et al. (2014). Furthermore, of the 42 studies performed on the parasites of Michigan fish after 1980, 29 (69%) of these involved Muzzall and colleagues. Surveys are needed just to establish a taxonomic base of parasites of Michigan fish. Undoubtedly, more parasite species will be found when more studies are performed on the parasites of Michigan fish. The following key gaps should be addressed: 1) parasitological studies should be performed on fish species and waters that have not had their parasites reported on; 2) more surveys should be performed on those species and waters that already have been surveyed in the past; 3) specific waters should be targeted for systematic surveys conducted periodically to examine trends in fish parasites; and 4) targeted studies on the effects of parasites on fish populations need to be conducted. Future surveys and ecological studies on the parasites of fishes from Michigan will provide knowledge beyond the objectives of these studies.

There have not been many studies performed on the parasites of Michigan fish for several reasons, including: 1) the parasites of wild fish do not have much of an economic importance at least for what is known about them now, when compared to other fish pathogens; 2) there is little or no funding for properly designed surveys of fish parasites until an emergency situation or epizootic event occurs and then it is only for a specific species or geographical area; 3) many fish species no longer occur or are infrequent in the Michigan's inland waters or are not economically important to commercial or recreational fisheries, 4) the lack of fish parasitologists performing studies on fish parasites; and 5) there is no major impetus or a set of objectives that address the study of parasites of Michigan fish. These reasons bring us to the topic of "crisis fisheries health" as proposed by Muzzall (2000a) in referring to the control and prevention of parasites and diseases of fishes in culture in Michigan. He defined this as follows "Some state and university officials, extension specialists, aquaculture centers, and trout farmers are not apparently concerned with fish health in aquaculture and in nature unless there is a crisis health problem, then action takes place". This approach is understandable with so many interested parties having different motives and the low priority of funding for parasite and disease work. Even though "nature" is mentioned in this definition, it's worth repeating that crisis fisheries health also involves parasites and diseases of wild fish. The absence of parasitological studies of fish from the inland waters of Michigan since 2011, except for Homola et al. (2014), supports this observation.

A taxonomic base of parasites in Michigan fish is essential to understand and to have a comprehensive knowledge of ecosystem structure and function in the face of climate change, invasive species, emerging diseases, and the change in biodiversity of aquatic systems through time. The absence of trained and experienced fish parasitologists to identify the parasitic organisms collected by other biologists will impair future studies by increasing the misidentification of parasites. Bush et al. (2021) discuss the misidentifications of parasites, how this information occurs in peer-reviewed journals, the downstream consequences of them in articles, and suggest guidelines to guard against parasite misidentifications.

Furthermore, some authors of studies on the parasites of Michigan fish did not deposit specimens of the parasite species worked with and therefore, verification of species identified cannot be done by other parasitologists. We recommend that all investigators and authors submit voucher specimens of parasites found and identified to the United States National Museum (USNM), Smithsonian Institution, Washington, D.C., U.S.A. Also, all scientific journals publishing articles on parasites should require that authors submit voucher specimens of parasites before publication.

It is difficult to determine how many parasite species infecting fish from the inland waters of Michigan are nonnative species except for *Myxobolus cerebralis*. However, nonnative species have been reported from the surrounding Great Lakes, such as the microsporan *Heterosporis sutherlandae*, which has a widespread distribution in the Great Lakes region (Phelps et al. 2015) including a few Michigan inland lakes near Iron Mountain, Michigan documented from non-peer reviewed observations (Michigan Department of Natural Resources - Fisheries Division, unpublished data). Furthermore, the parasitic copepod, *Neoergasilus japonicus* and the cestode *Schyzocotyle* (= *Bothriocephalus*) *acheilognathi* have been found in fish from Lake St. Clair and Saginaw Bay, Lake Huron (Hudson and Bowen 2002; Muzzall et al. 2016). We believe it will only be a matter of time before these species occur in the inland waters of Michigan, since Great Lakes cyprinid baitfish and other fish are frequently harvested and sold for bait in inland waters. Future surveys must pay particular attention to determine if these parasite species have spread into and are infecting fish in Michigan's inland waters as it has significant policy implications for the management of the baitfish industry which is valued at over $10 million dollars in annual economic activity (Michigan Department of Natural Resources, unpublished data). Since Michigan borders lakes Michigan, Superior, and Huron, it is believed that it is just a matter of time that more invasive species will occur and be found in the Great Lakes and will make their way into the inland waters of Michigan.

This synopsis on the parasites of fish in the inland waters of Michigan is an invaluable resource and serves as a companion to the synopsis on the parasites of fish from the Great Lakes (Muzzall and Whelan 2011). However, it should be mentioned that the taxonomy and parasite species lists are from the original literature and information should be used with caution even though synonyms are presented for many parasite species. Therefore, future studies will likely reveal the existence of additional synonyms of parasite species in this synopsis and will invalidate taxonomy used.

We emphasize that the wide range of fisheries researchers in Michigan collaborate with one another in the field of fish pathogens, parasites, and diseases based on time and resource limitations. If fish are being collected for research purposes by fisheries biologists, fish parasitologists and disease experts should be engaged in these studies. A more comprehensive and statistical approach to sampling parasites and other pathogenic organisms, similar to and potentially a part of the standardized status and trends surveys done by the Michigan Department of Natural Resources on inland waters, should be conducted to better understand the entire aquatic ecosystem. Also, the use of morphological characteristics and modern techniques for parasite detection (eDNA screening, PCR analysis) and identification (molecular analyses) are needed to obtain an extensive overview of parasites infecting fish in the inland waters of Michigan.

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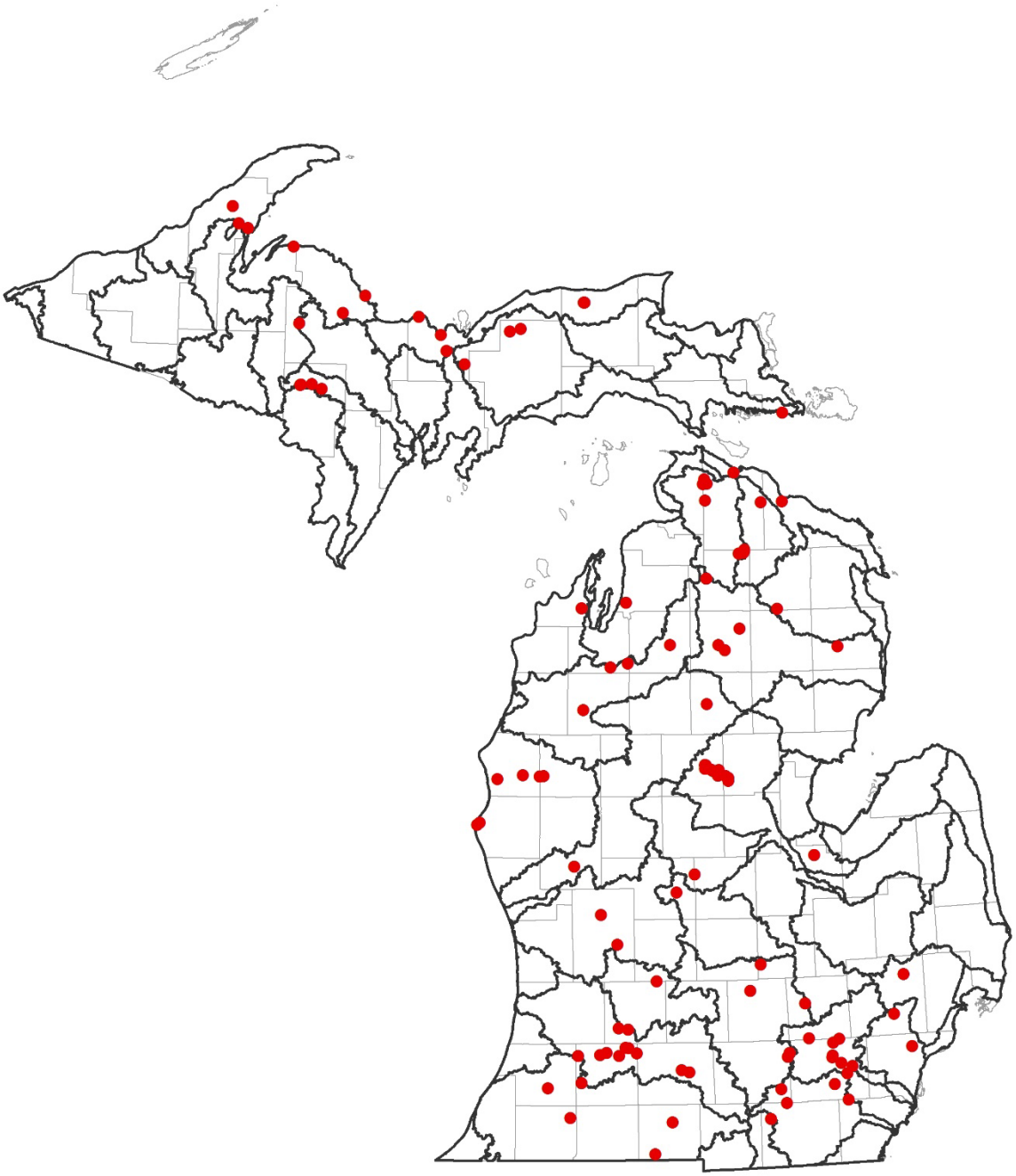

FIGURE 1. Map of the Lower and Upper peninsulas of Michigan with HUC-8 watershed and county boundaries delineated. Red dots indicate where parasitological studies were performed based on the latitude and longitude of each location.

TABLE 1. Scientific and common names of fish species used in this synopsis. These names are organized by family and follow the taxonomy in Bailey et al. (2004). * Indicates fish species known to occur in the inland waters of Michigan that have not had information published or reported on their parasites.

| **Family, scientific name** | **Common name** |
|---|---|
| **Petromyzontidae** | |
| *Ichthyomyzon castaneus* * | Chestnut Lamprey |
| *Ichthyomyzon fossor* * | Northern Brook Lamprey |
| *Ichthyomyzon unicuspis* * | Silver Lamprey |
| *Lampetra appendix* * | American Brook Lamprey |
| *Petromyzon marinus* | Sea Lamprey |
| **Acipenseridae** | |
| *Acipenser fulvescens* | Lake Sturgeon |
| **Lepisosteidae** | |
| *Lepisosteus oculatus* * | Spotted Gar |
| *Lepisosteus osseus* * | Longnose Gar |
| **Amiidae** | |
| *Amia calva* | Bowfin |
| **Anguillidae** | |
| *Anguilla rostrata* * | American Eel |
| **Clupeidae** | |
| *Alosa pseudoharengus* * | Alewife |
| *Dorosoma cepedianum* * | Gizzard Shad |
| **Cyprinidae** | |
| *Campostoma anomalum* | Central Stoneroller |
| *Carassius auratus* * | Goldfish |
| *Couesius plumbeus* * | Lake Chub |
| *Cyprinella spiloptera* * | Spotfin Shiner |
| *Cyprinus carpio* * | Common Carp |
| *Hybognathus hankisoni* * | Brassy Minnow |
| *Luxilus chrysocephalus* * | Striped Shiner |
| *Luxilus cornutus* | Common Shiner |
| *Lythrurus umbratilis* * | Redfin Shiner |
| *Macrhybopsis storeriana* * | Silver Chub |
| *Margariscus nachtriebi* * | Northern Pearl Dace |
| *Nocomis biguttatus* | Hornyhead Chub |
| *Nocomis micropogon* * | River Chub |
| *Notemigonus crysoleucas* * | Golden Shiner |
| *Notropis atherinoides* (*= Notropis delicatus*) * | Emerald Shiner |
| *Notropis bifrenatus* ( *= Notropis cayuga*) | Bridle Shiner |
| *Notropis buccatus* * | Silverjaw Minnow |
| *Notropis buchanani* * | Ghost Shiner |
| *Notropis dorsalis* * | Bigmouth Shiner |

TABLE 1. (continued)

| **Family, scientific name** | **Common name** |
|---|---|
| *Notropis heterodon* * | Blackchin Shiner |
| *Notropis heterolepis* * | Blacknose Shiner |
| *Notropis hudsonius* | Spottail Shiner |
| *Notropis photogenis* * | Silver Shiner |
| *Notropis rubellus* | Rosyface Shiner |
| *Notropis stramineus* (= *Notropis ludibundus,Notropis blennius*, *Notropis deliciosus*) | Bridle Shiner, Sand Shiner, Straw-Colored Minnow |
| *Notropis volucellus* | Mimic Shiner |
| *Phenacobius mirabilis* * | Suckermouth Minnow |
| *Phoxinus eos* * | Northern Redbelly Dace |
| *Phoxinus neogaeus* * | Finescale Dace |
| *Pimephales notatus* | Bluntnose Minnow |
| *Pimephales promelas* * | Fathead Minnow |
| *Rhinichthys cataractae* | Longnose Dace |
| *Rhinichthys obtusus* | Western Blacknose Dace |
| *Semotilus atromaculatus* | Creek Chub |
| **Cobitidae** | |
| *Misgurnus anguillicaudatus* * | Oriental Weatherfish |
| **Catostomidae** | |
| *Carpiodes cyprinus* * | Quillback |
| *Catostomus catostomus* * | Longnose Sucker |
| *Catostomus commersonii* | White Sucker |
| *Erimyzon claviformis* * | Western Creek Chubsucker |
| *Erimyzon sucetta* | Lake Chubsucker |
| *Hypentelium nigricans* | Northern Hog Sucker |
| *Ictiobus cyprinellus* * | Bigmouth Buffalo |
| *Ictiobus niger* * | Black Buffalo |
| *Minytrema melanops* * | Spotted Sucker |
| *Moxostoma anisurum* | Silver Redhorse |
| *Moxostoma carinatum* * | River Redhorse |
| *Moxostoma duquesnei* * | Black Redhorse |
| *Moxostoma erythrurum* * | Golden Redhorse |
| *Moxostoma macrolepidotum* * | Shorthead Redhorse |
| *Moxostoma valenciennesi* * | Greater Redhorse |
| **Ictaluridae** | |
| *Ameiurus melas* | Black Bullhead |
| *Ameiurus natalis* | Yellow Bullhead |
| *Ameiurus nebulosus* | Brown Bullhead |
| *Ameiurus* sp. | Bullhead |
| *Ictalurus punctatus* * | Channel Catfish |
| *Noturus flavus* * | Stonecat |

TABLE 1. (continued)

| **Family, scientific name** | **Common name** |
|---|---|
| *Noturus gyrinus* | Tadpole Madtom |
| *Noturus insignis* * | Margined Madtom |
| *Noturus miurus* * | Brindled Madtom |
| *Pylodictis olivaris* * | Flathead Catfish |
| Bullhead | Bullhead |
| **Esocidae** | |
| *Esox americanus* | Redfin Pickerel |
| *Esox lucius* | Northern Pike |
| *Esox masquinongy* * | Muskellunge |
| **Umbridae** | |
| *Umbra limi* | Central Mudminnow |
| **Osmeridae** | |
| *Osmerus mordax* * | Rainbow Smelt |
| **Salmonidae** | |
| *Coregonus artedi* | Lake Herring |
| *Coregonus clupeaformis* * | Lake Whitefish |
| *Coregonus hoyi* * | Bloater |
| *Coregonus kiyi* * | Kiyi |
| *Oncorhynchus gorbuscha* | Pink Salmon |
| *Oncorhynchus kisutch* | Coho Salmon |
| *Oncorhynchus mykiss* | Rainbow Trout |
| *Oncorhynchus tshawytscha* | Chinook Salmon |
| *Prosopium coulterii* * | Pygmy Whitefish |
| *Prosopium cylindraceum* * | Round Whitefish |
| *Salmo salar* * | Atlantic Salmon |
| *Salmo trutta* | Brown Trout |
| *Salvelinus fontinalis* | Brook Trout |
| *Salvelinus namaycush* * | Lake Trout |
| *Thymallus arcticus* | Arctic Grayling |
| **Percopsidae** | |
| *Percopsis omiscomaycus* | Trout-Perch |
| **Aphredoderidae** | |
| *Aphredoderus sayanus* * | Pirate Perch |
| **Gadidae** | |
| *Lota lota* | Burbot |
| **Fundulidae** | |
| *Fundulus diaphanus menona* * | Western Banded Killifish |
| *Fundulus dispar* * | Starhead Topminnow |
| *Fundulus notatus* * | Blackstripe Topminnow |
| **Atherinopsidae** | |
| *Labidesthes sicculus* * | Brook Silverside |
| **Gasterosteidae** | |

TABLE 1. (continued)

| **Family, scientific name** | **Common name** |
|---|---|
| *Culaea inconstans* | Brook Stickleback |
| *Gasterosteus aculeatus* * | Threespine Stickleback |
| *Pungitius pungitius* * | Ninespine Stickleback |
| **Cottidae** | |
| *Cottus bairdii* | Mottled Sculpin |
| *Cottus cognatus* | Slimy Sculpin |
| **Moronidae** | |
| *Morone americana* * | White Perch |
| *Morone chrysops* * | White Bass |
| **Centrarchidae** | |
| *Ambloplites rupestris* | Rock Bass |
| *Lepomis cyanellus* | Green Sunfish |
| *Lepomis gibbosus* | Pumpkinseed |
| *Lepomis gulosus* | Warmouth |
| *Lepomis humilis* * | Orangespotted Sunfish |
| *Lepomis macrochirus* | Bluegill |
| *Lepomis microlophus* | Redear Sunfish |
| *Lepomis peltastes* (= *megalotis*) | Northern Longear Sunfish |
| *Lepomis* sp. hybrid | Hybrid Sunfish |
| *Micropterus dolomieu* | Smallmouth Bass |
| *Micropterus salmoides* | Largemouth Bass |
| *Pomoxis annularis* * | White Crappie |
| *Pomoxis nigromaculatus* | Black Crappie |
| Other centrarchids | Centrarchids |
| **Percidae** | |
| *Ammocrypta clara* * | Western Sand Darter |
| *Etheostoma blennioides* | Greenside Darter |
| *Etheostoma caeruleum* * | Rainbow Darter |
| *Etheostoma exile* * | Iowa Darter |
| *Etheostoma flabellare flabellare* * | Barred Fantail Darter |
| *Etheostoma flabellare lineolatum* * | Striped Fantail Darter |
| *Etheostoma microperca* * | Least Darter |
| *Etheostoma nigrum* | Johnny Darter |
| *Etheostoma spectabile* * | Orangethroat Darter |
| *Etheostoma zonale* * | Banded Darter |
| *Gymnocephalus cernuus* * | Ruffe |
| *Perca flavescens* | Yellow Perch |
| *Percina caprodes semifasciata* | Northern Logperch |
| *Percina maculata* | Blackside Darter |
| *Sander vitreus* | Walleye |

TABLE 1. (continued)

| Family, scientific name | **Common name** |
|---|---|
| **Sciaenidae** | |
| *Aplodinotus grunniens* * | Freshwater Drum |
| **Gobiidae** | |
| *Neogobius melanostomus* * | Round Goby |
| *Proterorhinus marmoratus* * | Tubenose Goby |

TABLE 2. Fish species not considered in this synopsis because they are very infrequent or no longer occur in Michigan inland waters and whose parasites have never been reported on in Michigan.

| **Family, scientific name** | **Common name** |
|---|---|
| **Polyodontidae** | |
| *Polyodon spathula* | Paddlefish |
| **Hiodontidae** | |
| *Hiodon tergisus* | Mooneye |
| **Clupeidae** | |
| *Alosa chrysochloris* | Skipjack Herring |
| **Cyprinidae** | |
| *Clinostomum elongatus* | Redside Dace |
| *Notropis amblops* | Bigeye Chub |
| *Notropis chalybaeus* | Ironcolor Shiner |
| *Notropis texanus* | Weed Shiner |
| *Opsopoeodus emiliae* | Pugnose Minnow |
| *Phoxinus erythrogaster* | Southern Redbelly Dace |
| **Catostomidae** | |
| *Erimyzon oblongus* | Creek Chubsucker |
| **Ictaluridae** | |
| *Noturus stigmosus* | Northern Madtom |
| **Salmonidae** | |
| *Coregonus zenithicus* | Shortjaw Cisco |
| *Coregonus johannae* | Deepwater Cisco |
| *Coregonus nigipinnis* | Blackfin Cisco |
| *Coregonus reighardi* | Shortnoes Cisco |
| **Percidae** | |
| *Ammocrypta pellucida* | Eastern Sand Darter |
| *Percina shumardi* | River Darter |
| *Percina copelandi* | Channel Darter |
| *Sander vitreum glaucum* | Blue Pike |
| *Sander canadense* | Sauger |

TABLE 3. Number of studies (listed chronologically) performed on the parasites of fish from the inland waters of Michigan by 10-year periods. Number of studies are indicated in parentheses (Lower Peninsula, Upper Peninsula). Studies performed in the Upper Peninsula are indicated by UP. Personal observations by the authors and personal communications with other investigators are not included.

| **Period (Number of studies)** | **Studies** |
|---|---|
| 1880–1889 (1, 0) | Kellicott 1882 |
| 1900–1909 (0, 0) | - |
| 1910–1919 (3, 1) | Warthin 1912 UP; Cooper 1918; LaRue 1919; Van Cleave 1919. |
| 1920–1929 (17, 1) | Butler 1920; Cooper 1920; Van Haitsma 1925; LaRue et al. 1926; Hughes 1927, 1928a, 1928b, 1928c, 1929; Hunter 1927; Cort and Brooks 1928; Hughes and Piszczek 1928; Vergeer 1928 UP; Hughes and Berkhout 1929; Hughes and Hall 1929; Thomas 1929; Winfield 1929; Woodhead 1929. |
| 1930–1939 (11, 0) | Thomas 1930; Van Haitsma 1930a,1930b,1931; Woodhead 1930; LaRue 1932; Hedrick 1935; Dobrovolny 1938, 1939a, 1939b; Beaver 1939. |
| 1940–1949 (13, 1) | Fischthal and Allison 1940,1941,1942; Larsh 1941; Lundahl 1941; Wallace 1941; Fischthal 1942a,1942b, 1943,1949; Strandine 1943; Meyer 1946; Meinkoth 1947; Tompkins 1947 UP. |
| 1950–1959 (2, 0) | Fischthal 1952; Wood and Mizelle 1957. |
| 1960–1969 (1, 4) | Pynnonen 1960 UP; Taylor 1964 UP; Peters and LaBonte 1965 UP; Allison and Latta 1969; Kopenski 1969 UP. |
| 1970–1979 (8, 1) | Hnath 1970; Esch 1971; Klemm 1972; Spence and Peters 1971 UP; Yoder 1972; Esch and Huffines 1973; Esch et al. 1975, 1976; Fallon and Wallace 1977. |
| 1980–1989 (7, 2) | Baker 1980; Muzzall 1982, 1984a, 1984b, 1986; Muzzall and Buckner 1982; Muzzall and Peebles 1986 UP; Muzzall and Sweet 1986; Muzzall et al.1987 UP. |
| 1990–1999 (8, 4) | Carney and Brooks 1991; Muzzall et al. 1992 UP, 1995; Muzzall 1990 UP, 1993a, 1993b; LaBeau and Peters 1995 UP; Muzzall and Whelan 1995 UP; Wilson et al. 1996; Hernandez and Muzzall 1998; Muzzall and Peebles 1998; Collins et al. 1999. |
| 2000–2009 (12, 0) | Muzzall 2000b, 2002 ; Steinauer 2004; Gillilland and Muzzall 2004; Muzzall and Gillilland 2004; Muzzall and Hudson 2004; Steinauer et al. 2006, 2007; Muzzall and Kilroy 2007; Muzzall and Pracheil 2007; Elsayed and Faisal 2008; Pracheil and Muzzall 2009. |
| 2010–2019 (8, 0) | Pracheil and Muzzall 2010; Faisal et al. 2011; Homola et al. 2011, 2012a, 2012b, 2014; Ryan and Kohler 2011a, 2011b. |

TABLE 4. Studies performed on the parasites of fish by county (listed alphabetically) in the Lower and Upper Peninsulas of Michigan. Personal observations by the authors and personal communication with other investigators are not included.

| **Lower Peninsula, County (number of studies)** | **Studies** |
|---|---|
| Alcona (1) | Muzzall 1990. |
| Barry (3) | Wilson et al. 1996; Elsayed and Faisal 2008; Faisal et al. 2011. |
| Branch (2) | Elsayed and Faisal 2008; Faisal et al. 2011. |
| Calhoun (4) | Homola et al. 2011, 2012a, 2012b, 2014. |
| Cass (3) | Wood and Mizelle 1957; Elsayed and Faisal 2008; Faisal et al. 2011. |
| Cheboygan (29) | Cooper 1918, 1920; LaRue 1919, 1932; Van Cleave 1919; Butler 1920; Van Haitsma 1925, 1930a, 1930b, 1931; LaRue et al. 1926; Hughes 1927, 1928a, 1928b, 1928c, 1929; Hunter 1927; Cort and Brooks 1928; Hughes and Piszczek 1928; Hughes and Berkhout 1929; Thomas 1929, 1930; Hughes and Hall 1929; Winfield 1929; Hedrick 1935; Beaver 1939; Larsh 1941; Meinkoth 1947; Muzzall and Hudson 2004. |
| Clare (1) | Yoder 1972. |
| Crawford (4) | Muzzall 1986, 1990; Muzzall and Sweet 1986; Collins et al. 1999. |
| Grand Traverse (1) | Hedrick 1935. |
| Gratiot (1) | Muzzall 1984b. |
| Hillsdale (2) | Hedrick 1935; Allison and Latta 1969. |
| Ingham (1) | Muzzall 1982. |
| Jackson (3) | Wallace 1941; Elsayed and Faisal 2008; Faisal et al. 2011 |
| Kalamazoo (15) | Esch 1971; Esch and Huffines 1973; Esch et al. 1975, 1976; Muzzall et al. 1995; Gillilland and Muzzall 2004; Muzzall and Gillilland 2004; Steinauer 2004; Steinauer et al. 2006, 2007; Pracheil and Muzzall 2009, 2010; Ryan and Kohler 2011a, 2011b; Homola et al. 2014. |
| Kent (1) | Muzzall 1984b. |
| Lake (3) | Muzzall 1993a, 1993b; Hernandez and Muzzall 1998. |
| Leelanau (1) | Strandine 1943. |
| Lenawee (3) | Elsayed and Faisal 2008; Faisal et al. 2011; Homola et al. 2011 |
| Mason (1) | Muzzall 1993a. |
| Montcalm (1) | Muzzall 1984b. |
| Montmorency (1) | Muzzall 1984b. |
| Monroe (1) | Fischthal 1942a. |
| Muskegon (1) | Allison and Latta 1969. |
| Newago (2) | Homola et al. 2011, 2014. |
| Oakland (2) | Elsayed and Faisal 2008; Faisal et al. 2011. |
| Oceana (4) | Muzzall 2000b, 2002; Muzzall and Kilroy 2007; Muzzall and Pracheil 2007. |

TABLE 4. (continued)

| **Lower Peninsula, County (number of studies)** | **Studies** |
|---|---|
| Oscoda (1) | Allison and Latta 1969. |
| Otsego (2) | Allison and Latta 1969; Muzzall and Peebles 1998. |
| Roscommon (1) | Woodhead 1929. |
| Saginaw (1) | Baker 1980. |
| Shiawassee (3) | Kellicott 1882; Muzzall and Buckner 1982; Muzzall 1984a. |
| Washtenaw (18) | Woodhead 1929, 1930; Hedrick 1935; Dobrovolny 1938, 1939a, 1939b; Lundahl 1941; Fischthal 1942b, 1943, 1949, 1952; Fischthal and Allison 1940, 1941, 1942; Klemm 1972; Fallon and Wallace 1977; Elsayed and Faisal 2008; Faisal et al. 2011. |
| **Upper Peninsula, County (number of studies)** | **Studies** |
| Alger (3) | Muzzall and Peebles 1986; Muzzall et al. 1992; Labeau and Peters 1995. |
| Baraga (1) | Muzzall and Peebles 1986. |
| Chippewa (1) | Muzzall and Peebles 1986. |
| Dickinson (3) | Muzzall et al. 1987; Muzzall 1990; Muzzall and Whelan 1995. |
| Houghton (2) | Warthin 1912; Vergeer 1928. |
| Luce (1) | Muzzall et al. 1992. |
| Marquette (6) | Tompkins 1947; Pynnonen 1960; Taylor 1964; Peters and LaBonte 1965; Kopenski 1969; Muzzall and Peebles 1986. |
| Schoolcraft (1) | Spence and Peters 1971. |

TABLE 5. Parasites reported in fishes from inland waters of Michigan. In order, host species, citations, when observed (cdnp = collection data not provided), prevalence (p) defined as the percentage (%) of fish infected (pnp = prevalence not provided), mean intensity (mi) defined as mean number of parasites per infected fish (minp = mean intensity not provided), mean abundance (ma) defined as the mean number of parasites per examined fish and noted with an asterisk (*), water body, latitude and longitude (llnk = latitude and longitude not known), and location (lns = location not specified or incomplete). Studies performed in Upper Peninsula are indicated by UP, all other studies were performed in the Lower Peninsula and lack a designation. A parasite species infecting a fish species may have multiple references indicating this observation. The prevalences and mean intensities for some parasite species were combined from two or more locations in some original articles and are indicated with the word "and" in the entry. (?) before the scientific name in the parasitological literature indicates uncertainty among subject matter experts if these are recognized synonyms.

## Ciliophora (Ciliates)

**Epistylidae Kahl, 1935**
*Epistylis* sp.
Site of infection: Gills
Host:
*Salvelinus fontinalis*: Muzzall 1986, 1982–1984, 1%, minp, Au Sable River, 44.665922ºN, 84.626153ºW, Crawford County.
*Cottus bairdii*: Muzzall and Sweet 1986, 1982–1984, 39%, minp, Au Sable River, 44.665922ºN, 84.626153ºW, Crawford County.
*Rhinichthys cataractae*: Muzzall et al. 1992, 1983–1986, p varied from 28% to 51% for three localities, minp, Ford River, 46.104983ºN, 87.808578°W; 46.129319ºN, 87.889661°W; 46.127050ºN, 87.974389°W, Dickinson County, UP.
*Lota lota*: Muzzall et al. 1987, 1983, 1984, 38%, minp, Ford River, 46.104983ºN, 87.808578°W; 46.129319ºN, 87.889661°W; 46.127050ºN, 87.974389°W, Dickinson County. UP.
*Oncorhynchus tshawytscha* (parr): Muzzall 1993a, 1990, 1%, minp, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties.
*Oncorhynchus mykiss* (parr): Muzzall 1993a; 1983, 1989, 1990; 3%, minp, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties.

**Trichodinidae Raabe, 1959**
*Trichodina* sp.
Site of infection: Gills
Host:
*Salvelinus fontinalis*: Muzzall 1986, 1982–1984, 5%, minp, Au Sable River, 44.665922ºN, 84.626153ºW, Crawford County.
*Salmo trutta*: Muzzall 1986, 1982–1984, 1%, minp, Au Sable River, 44.665922ºN, 84.626153ºW, Crawford County.
*Lepomis macrochirus*: Muzzall and Peebles 1998, 1996, 3%, minp, Five Lakes, 45.041775ºN, 84.714017ºW, Otsego County; Pracheil and Muzzall 2009; 2003, 2004; p separated by host age and collection year, minp, Three Lakes II, 42.349472°N, 85.432708°W, Kalamazoo County; Pracheil and Muzzall 2010; 2003, 2004; same infection data and information as in Pracheil and Muzzall 2009.

TABLE 5. (continued)

*Cottus bairdii*: Muzzall and Sweet 1986, 1982–1984, 29%, minp, Au Sable River, 44.665922ºN, 84.626153ºW, Crawford County.

*Rhinichthys cataractae*: Muzzall et al. 1992, 1983–1986, p varied from 17% to 22% for three localities, minp, Ford River, 46.104983ºN, 87.808578°W; 46.129319ºN, 87.889661°W; 46.127050ºN, 87.974389°W; Dickinson County, UP.

*Lota lota*: Muzzall et al. 1987, 1983, 1984, 87%, minp, Ford River, 46.104983ºN, 87.808578°W; 46.129319ºN, 87.889661°W; 46.127050ºN, 87.974389°W; Dickinson County, UP.

*Oncorhynchus tshawytscha* (parr): Muzzall 1993a, 1990, p varied from 6–18% by location, minp, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties.

*Oncorhynchus mykiss* (parr): Muzzall 1993a; 1983, 1989, 1990; 6%, minp, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties.

*Noturus gyrinus*: Muzzall and Pracheil 2007, 2005, 55%, minp, Silver Creek, 43.657186°N, 86.525117°W, Oceana County.

**Trichophryidae Fraipont, 1878**

*Capriniana* sp.

Site of infection: Gills

Host:

*Thymallus arcticus*: Muzzall 1990, 1987–1988, 76%, minp, Ackerman Lake, 46.331311ºN, 86.797517ºW, Alger County, UP; Muzzall 1990, 1987–1988, 10%, minp, Kettlehole Lake, 46.255344°N, 86.649003°W, Alger County, UP.

## Microspora (Microsporidians)

**Glugeidae Thelohan, 1892**

*Glugea* sp.

Site of infection: xenomas of internal cells

Host:

*Cottus bairdii*: Homola et al. 2011, 87%, minp, Bigelow Creek, 43.420854°N, 85.771994°W, Newago County; 83%, minp, Rice Creek, 42.265875°N, 84.959981°W, Calhoun County; 83%, minp, Augusta Creek, 42.382406°N, 85.357836°W, Kalamazoo County; 73%, minp; Seven Mile Creek, 42.360596°N, 85.299165°W, Kalamazoo County; 53%, minp; Wilder Creek, 42.253931°N, 84.901368°W, Calhoun County; 3%, minp, Spring Brook, 42.356428°N, 85.576953°W, Kalamazoo County; 3%, minp, Sand Creek, 42.348370°N, 85.765292°W, Kalamazoo County; Ryan and Kohler 2011a, cdnp, pnp, minp, lns, Kalamazoo County; Ryan and Kohler 2011b, cdnp, 10–25%, minp, lns, Kalamazoo County; Homola et al. 2011, cdnp, pnp, minp, llnk, county not provided; Homola et al. 2012a, cdnp, pnp, minp, llnk, county not provided; Homola et al. 2012b, cdnp, pnp, minp, llnk, unknown county; Homola et al. 2014, 87%, minp, Bigelow Creek, 43.420854°N, 85.771994°W, Newago County; 83%, minp, Rice Creek, 42.265875°N, 84.959981°W, Calhoun County; 83%, Augusta Creek, 42.382406°N, 85.357836°W, Kalamazoo County; 73%, minp, Seven Mile Creek, 42.360596°N, 85.299165°W, Kalamazoo County; 53%,

TABLE 5. (continued)

minp, Wilder Creek, 42.253931°N, 84.901368°W, Calhoun County; 75%, minp, Silver Creek, 42.367436ºN, 85.527680ºW, Kalamazoo County.

**Myxozoa (Myxosporans)**

**Myxobolidae Thelohan, 1892**

*Myxobolus cerebralis* (Hofer, 1903) (Plehn, 1905)
Synonym: *Myxosoma cerebralis* according to Lom and Noble, 1984
Site of infection: Head bones, cartilage, gill arches
Host:

*Oncorhynchus mykiss*: Yoder 1972, 1968, 100%, minp, Tobacco River, 43.953444ºN, 84.656447ºW, Clare County.

*Salmo trutta*: Hnath 1970, 1968, pnp, minp, natural stream, county not provided; Yoder 1972, 1970, pnp, minp, Tobacco River, 43.953444ºN, 84.656447ºW, Clare County; Collins et al. 1999, 1996, 57%, minp, Au Sable River, 44.756161°N, 84.457861°W, North Branch, Crawford County.

*Salvelinus fontinalis*: Yoder 1972, 1970, pnp, minp, Tobacco River, 43.953444ºN, 84.656447ºW, Clare County; Collins et al. 1999, 1996, 87%, minp, Au Sable River, 44.756161°N, 84.457861°W, North Branch, Crawford County; Collins et al. 1999, 1996, 77%, minp, Manistee River, North Branch, 44.669853ºN, 85.007586ºW, Kalkaska County; Hnath 1970, 1968, pnp, minp, natural stream, county not provided.

*Myxobolus* sp.
Site of infection: Gills, mesentery
Host:

*Lepomis macrochirus*: Wilson et al. 1996, 1987, p was 56% in littoral zone fish and 11% in open water fish, minp, Holcomb Lake, 42.505917°N, 85.434589°W, Barry County; Muzzall and Peebles 1998, 1996, 2%, minp, Five Lakes, 45.041775°N, 84.714017°W, Otsego County; Pracheil and Muzzall 2009; 2003, 2004; p separated by host age and collection year, minp, Three Lakes II, 42.349472°N, 85.432708°W, Kalamazoo County; Pracheil and Muzzall 2010; 2003, 2004; same infection data and information for Three Lakes II, 42.349472°N, 85.432708°W, as in Pracheil and Muzzall 2009; Pracheil and Muzzall 2009; 2003, 2004; p separated by host age and collection year, minp, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Pracheil and Muzzall 2010; 2003, 2004; same infection data and information for Gull Lake as in Pracheil and Muzzall 2009.

*Rhinichthys cataractae*: Muzzall et al. 1992, 1983–1986, p varied from 4% to 7% for three localities, minp Ford River, 46.104983ºN, 87.808578°W; 46.129319ºN, 87.889661°W; 46.127050ºN, 87.974389°W; Dickinson County, UP.

*Lota lota*: Muzzall et al. 1987; 1983, 1984; 15%, minp, Ford River, 46.104983ºN, 87.808578°W; 46.129319ºN, 87.889661°W; 46.127050ºN, 87.974389°W; Dickinson County, UP.

TABLE 5. (continued)

**Unknown Family**
Unidentified myxozoan
Site of infection: Gonads, hemocoel, mesentery
Host:
*Cottus bairdii*: Muzzall and Sweet 1986, 1982–1984, 15%, minp, Au Sable River, 44.665922ºN, 84.626153ºW, Crawford County.

## Adult Digenea (Digenetic Trematodes)

**Allocreadiidae (Looss, 1899) Stossich, 1903**
*Allocreadium lobatum* Wallin, 1909
Synonym: *Allocreadium isoporum* (Looss, 1894)
Site of infection: Intestine
Host:
*Lepomis cyanellus*: Muzzall 1982, 1979–1981, 10%, minp, Red Cedar River, 42.708103ºN, 84.426361ºW, Ingham County.
*Luxilus cornutus*: Muzzall 1982, 1979–1981, 28%, minp, Red Cedar River, 42.708103ºN, 84.426361ºW, Ingham County.
*Semotilus atromaculatus*: Spence and Peters 1971, cdnp, pnp, minp Ross Creek, 46.456912ºN, 86. 192937ºW, Schoolcraft County, UP; Muzzall 1982, 1979–1981, 26%, minp, Red Cedar River, 42.708103ºN, 84.426361ºW, Ingham County.

*Bunodera luciopercae* (Muller, 1776) Stiles and Hassal, 1898
Synonym: None.
Site of infection: [Pyloric ceca, anterior intestine]
Host:
*Perca flavescens*, Peters and LaBonte 1965, cdnp, pnp, minp, Goose Lake, 46.471186°N, 88.002314°W, Marquette County, UP.

*Bunodera sacculata* (Van Cleave and Mueller, 1932) Yamaguti, 1958
Synonym: *Bunoderina sacculata* (Van Cleave and Mueller, 1932) Yamaguti, 1958
Site of infection: Pyloric ceca, anterior intestine
Host:
*Perca flavescens*: Muzzall 2002; 1997, 1998; 54%, 2, 1*; 1997, 50%, 8, 4*; 1998, Silver Creek, 43.657186ºN, 86.525117ºW, Oceana County; Muzzall 2002, 2000, 30%, 3, 1*, Silver Lake, 43.667486ºN, 86.502834ºW, Oceana County; Peters and LaBonte 1965, cdnp, pnp, minp, Goose Lake, 46.471186°N, 88.002314°W, Marquette County, UP.

*Crepidostomum cooperi* Hopkins, 1931
Synonym: *Crepidostomum ambloplitis* Hopkins, 1931; *Crepidostomum fausti* Hunninen and Hunter, 1933; *Crepidostomum solidum* Van Cleave and Mueller, 1932; *Crepidostomum laureatum* of Stafford (1904) and Cooper (1915) in part; *Bunodera nodulosa* of Stafford (1904)

TABLE 5. (continued)

in part; ?*Crepidostomum cooperi* of Cooper (1915) in part
Site of infection: Ceca, anterior intestine
Host:
*Micropterus dolomieu*: Muzzall 1982, 1979–1981, 40%, minp, Red Cedar River, 42.708103ºN, 84.426361ºW, Ingham County.
*Cottus bairdii*: Muzzall and Sweet 1986, 1982–1984, 1%, 5, Au Sable River, 44.665922ºN, 84.626153ºW, Crawford County.
*Salmo trutta*: Muzzall 1986, 1982–1984, 6%, 2, Au Sable River, 44.665922ºN, 84.626153ºW, Crawford County.
*Salvelinus fontinalis*: Muzzall 1984b, 1981–1982, 3%, minp, Fish Creek, 43.270656ºN, 84.979558ºW, Montcalm County; Muzzall 2007, 2003–2005, p and mi separated by several variables, Hunt Creek, 44.889397ºN, 84.120756ºW, Montmorency County; Muzzall 1986, 1982–1984, 14%, 3, Au Sable River, 44.665922ºN, 84.626153ºW, Crawford County.
*Oncorhynchus mykiss* (adult): Muzzall 1993a; 1983, 1989, 1990; 4%, 1, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties.

*Crepidostomum cornutum* (Osborn, 1903) Stafford, 1904
Synonym: None.
Site of infection: Ceca, anterior intestine
Host:
*Ambloplites rupestris*: Esch 1971, 1968–1969, 64%, minp, Gull Lake, 42.394775ºN, 85.361017ºW, Kalamazoo County; Muzzall 1982, 1979–1981, 7%, minp, Red Cedar River, 42.708103ºN, 84.426361ºW, Ingham County.
*Lepomis macrochirus*: Esch 1971, 1968–1969, 20%, minp, Gull Lake, 42.394775ºN, 85.361017ºW, Kalamazoo County; Muzzall and Peebles 1998, 1996, 13%, 2, <1*, Five Lakes, 45.041775°N, 84.714017°W; 53%, 9, 5*, North Porcupine Lake, 45.041775°N, 84.714017°W, Otsego County; Pracheil and Muzzall 2009; 2003, 2004; 7%, <1*, Three Lakes II, 42.349472°N, 85.432708°W, Kalamazoo County; Pracheil and Muzzall 2010; 2003, 2004; same infection data and information as in Pracheil and Muzzall 2009.
*Lepomis* sp. hybrid: Esch 1971, 1968–1969, 9%, minp, Wintergreen Lake, 42.397370°N, 85.384503°W, Kalamazoo County.
*Micropterus dolomieu*: Esch et al. 1975; 1967, 1968, 1972, 1973; 29%, minp, Gull Lake, 42.394775ºN, 85.361017ºW, Kalamazoo County; Muzzall 1982, 1979–1981, 30%, minp; Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Micropterus salmoides*: Esch 1971, 1968–1969, pnp, minp, Gull Lake, 42.394775ºN, 85.361017ºW, Kalamazoo County.
*Salmo trutta*: Muzzall 1984b, 1981–1982, 15%, minp, Pine River, 43.372081ºN, 84.835858°W, Gratiot County.
*Salvelinus fontinalis*: Muzzall 1984b, 1981–1982, 100%, minp, Pine River, 43.372081ºN, 84.835858°W, Gratiot County.

TABLE 5. (continued)

*Crepidostomum farionis* (Mueller, 1784) Nicoll, 1909
Synonym: *Crepidostomum laureatum* Cooper, 1915
Site of infection: Gall bladder, intestine
Host:
*Oncorhynchus gorbuscha* (adult): Muzzall and Peebles 1986, 1983–1984, 4%, 3, Carp River, 46.536517°N, 87.646667°W and Harlow Creek, 46.635762°N, 87.468470°W, Marquette County, UP.
*Lota lota*: Muzzall et al. 1987; 1983, 1984; 32%, 6, Ford River, 46.104983ºN, 87.808578°W; 46.129319ºN, 87.889661°W; 46.127050ºN, 87.974389°W; Dickinson County, UP.
Remarks: It is believed *Oncorhynchus gorbuscha* became infected in the Carp River and Harlow Creek (tributaries of Lake Superior).

*Crepidostomum isostomum* Hopkins, 1931
Synonym: *Crepidostomum laureatum* of Cooper (1915) in part; *Crepidostomum canadensis* Hopkins, 1931
Site of infection: Anterior intestine
Host:
*Etheostoma nigrum*: Muzzall 1982, 1979–1981, 4%, minp, Red Cedar River, 42.708103ºN, 84.426361ºW, Ingham County.

*Crepidostomum* sp.
Site of infection: Anterior intestine
Host:
*Salvelinus fontinalis*: Muzzall, personal observation, 1984, pnp, minp, Ford River, 46.104983°N, 87.808578°W, Dickinson County, UP.
*Thymallus arcticus*: Muzzall 1990, 1987–1988, 5%, 2, Ackerman Lake, 46.331311ºN, 86.797517ºW, Alger County, UP.

**Azygiidae Luhe, 1909**
*Azygia angusticauda* (Stafford, 1904) Manter, 1926
Synonym: *Mimodistomum angusticaudum* Stafford 1904; *Azygia loossi* Marshall and Gilbert, 1905; *Ptychogonimus fontanus* Lyster, 1939
Site of infection: Stomach
Host:
*Perca flavescens*: Spence and Peters 1971, cdnp, 100%, 1, lns, Schoolcraft and Luce Counties, UP.

*Azygia* sp.
Site of infection: Intestine
Host:
*Micropterus salmoides*: Esch 1971, 3%, minp, Gull Lake, 42.394775ºN, 85.361017ºW, Kalamazoo County

TABLE 5. (continued)

*Lepomis macrochirus*: Pracheil and Muzzall 2009; 2003, 2004; p and ma separated by host age and collection year, Three Lakes II, 42.349472°N, 85.432708°W, Kalamazoo County; Pracheil and Muzzall 2010; 2003, 2004; same infection data and information as in Pracheil and Muzzall 2009.

*Proterometra autraini* Labeau and Peters, 1995
Synonym: None
Site of infection: Esophagus, intestine
Host:
*Ambloplites rupestris*: LaBeau and Peters 1995; 1992, 1993; 26%, 1.3, <1*, Au Train River, 46.421311ºN, 86.844850ºW, Alger County, UP.
*Cottus bairdii*: LaBeau and Peters 1995; 1992, 1993; 75% 7, 5*, Au Train River, 46.421311ºN, 86.844850ºW, Alger County, UP.
*Micropterus dolomieu*: LaBeau and Peters 1995; 1992, 1993; 25%, 4, 1*, Au Train River, 46.421311ºN, 86.844850ºW, Alger County, UP.
*Lota lota*: LaBeau and Peters 1995; 1992, 1993; 46% 1.4, <1*, Au Train River, 46.421311ºN, 86.844850ºW, Alger County, UP.
*Perca flavescens*, LaBeau and Peters 1995; 1992, 1993; 7%, 1, <1*, Au Train River, 46.421311ºN, 86.844850ºW, Alger County, UP.

**Bucephalidae Poche, 1907**
*Bucephalus elegans* Woodhead 1930
Synonym: None
Site of infection: Ceca
Host:
*Ambloplites rupestris*: Woodhead 1930, 1927, 60%, <3, Huron River, 42.323522ºN, 83.810808ºW, Washtenaw County.

*Prosorhynchoides pusilla* (Stafford, 1904) Eckman, 1932
Synonym: *Bucephalopsis pusilla* (Stafford, 1904); *Bucephalus pusillus* Cooper 1915; *Bucephalus pusilla* (Stafford, 1904); *Gasterostomum pusillum* Stafford, 1904 *Bucephalus papillosus* Woodhead 1929
Site of infection: Stomach, ceca, intestine
Host:
*Micropterus dolomieu*: Woodhead 1929, cdnp, 11%, 8, Huron River, 42.323522ºN, 83.810808ºW, Washtenaw County.
*Micropterus salmoides*: Woodhead 1929, cdnp, 100%, 8, Huron River, 42.323522ºN, 83.810808ºW, Ann Arbor, Washtenaw County.
*Esox lucius*: Woodhead 1929, cdnp, 29%, 6, Huron River, 42.323522ºN, 83.810808ºW, Washtenaw County.
*Sander vitreus*: Woodhead 1930, 1927, pnp, minp, Houghton Lake, 44.331667°N, 84. 725811°W, Roscommon County.

TABLE 5. (continued)

**Cryptogonomidae (Ward, 1917) Ciurea, 1933**
*Acetodextra amiuri* (Stafford, 1904) Pearse, 1924
Synonym: *Monostomum amiuri* Stafford, 1900
Site of infection: Body cavity
Host:
*Noturus gyrinus*: Muzzall and Pracheil 2007, 2005, 2%, 1, <1*, Silver Creek, 43.657186ºN, 86.525117ºW, Oceana County.

*Caecincola parvulus* Marshall and Gilbert, 1905
Synonym: None.
Site of infection: Stomach, ceca, anterior intestine
Host:
*Micropterus salmoides*: Lundahl 1941, cdnp, pnp, minp, Huron River, 42.323522ºN, 83.810808ºW, Ann Arbor, Washtenaw County.
*Micropterus dolomieu*: Esch and Huffines 1973; 1967, 1968; pnp, minp, Gull Lake, 42.394775ºN, 85.361017ºW, Kalamazoo County.

*Cryptogonimus chili* Osborn, 1903
Synonym: None
Site of infection: Pyloric ceca, anterior intestine
Host:
*Ambloplites rupestris*: Muzzall 1982, 1979–1981, 67%, minp, Red Cedar River, 42.708103ºN, 84.426361ºW, Ingham County.
*Micropterus dolomieu*: Esch and Huffiness 1973; 1967, 1968; pnp, minp, Gull Lake, 42.394775ºN, 85.361017ºW, Kalamazoo County.
Remarks: The species name, *chili*, is sometimes misspelled *chyli*.

Unknown cryptogonomid
Site of infection: Not provided
Host:
*Ambloplites rupestris*: Esch 1971; 1968–1969; 58%, minp, Gull Lake, 42.394775ºN, 85.361017ºW, Kalamazoo County.
*Micropterus dolomieu*: Esch 1971; 1968–1969; 59%, minp, Gull Lake, 42.394775ºN, 85.361017ºW, Kalamazoo County.
*Micropterus salmoides*: Esch 1971; 1968–1969; pnp, minp, Gull Lake, 42.394775ºN, 85.361017ºW, Kalamazoo County.

**Gorgoderidae Looss, 1901**
*Phyllodistomum brevicecum* Steen, 1938
Synonym: None
Site of infection: [Urinary bladder]
Host:
*Umbra limi*: Spence and Peters 1971; cdnp, pnp, minp, Worchester Lake, 46.443772ºN, 86.281989ºW, Schoolcraft County, UP.

TABLE 5. (continued)

*Phyllodistomum etheostomae* Fischthal, 1943
Synonym: None.
Site of infection: Urinary bladder
Host:
*Etheostoma blennioides*: Fischthal 1942b, cdnp, 15%, minp, Honey Creek, 42.373369ºN, 83.200513ºW, Washtenaw County; Fischthal 1943, 1941, 11%, 2, Huron River, 42.323522ºN, 83810808ºW, and Saline River, 42.170725ºN, 83799158ºW, Washtenaw County.
*Percina maculata*: Fischthal 1942b, cdnp, 5%, minp, Honey Creek, 42.373369ºN, 83.200513ºW, Washtenaw County; Fischthal 1943, 1941, 5%, 1, Honey Creek, 42.373369ºN, 83.200513ºW, Washtenaw County.
*Percina caprodes*: Fischthal 1942b, cdnp, 4%, minp, Honey Creek, 42.373369ºN, 83.200513ºW, Washtenaw County; Fischthal 1943, 1941, 4%, 1, Honey Creek, 42.373369ºN, 83.200513ºW, Washtenaw County.

*Phyllodistomum lysteri* Miller, 1940
Synonym: None.
Site of infection: Ureters, urinary bladder
Host:
*Catostomus commersonii*: Fischthal 1952, 1940–1942, pnp, minp, Huron River, 42.323522ºN, 83810808ºW, Washtenaw County.

*Phyllodistomum undulans* Steen, 1938
Synonym: None.
Site of infection: Urinary bladder
Host:
*Cottus bairdii*: Fallon and Wallace 1977, 1977, > 49%, 1–2, Fleming Creek, 42.270038ºN, 83.659661ºW; T2S, R7E, section 17, Superior Township, Washtenaw County.

**Lepocreadiidae (Odhner, 1905) Nicoll, 1935**
*Megalogonia ictaluri* Surber, 1928
Synonym: *Crepidostomum ictaluri* (Surber, 1928) Van Cleave and Mueller, 1934
Site of infection: Anterior intestine
Host:
*Ameiurus natalis*: Muzzall 1982, 1979–1981, 60%, minp, Red Cedar River, 42.708103ºN, 84.426361ºW, Ingham County.

**Lissorchiidae (Poche, 1926) Yamaguti, 1971**
*Lissorchis hypentelii* Fischthal, 1942
Synonym: None
Site of infection: Small intestine
Host:
*Hypentelium nigricans*: Fischthal 1942a, 1941, 22%, 4, Saline River, 42.170725ºN, 83799158ºW, Monroe and Washtenaw Counties.

TABLE 5. (continued)

*Lissorchis mutabile* (Cort, 1919) Smith, 1968
Synonym: *Triganodistomum mutabile* (Cort, 1919)
Site of infection: Intestine
Host:
*Erimyzon sucetta*: Wallace 1941, cdnp, pnp, 3, Waterloo Lake, 42.353611°N, 84.136667°W, Jackson County.
Remarks: Cort (1918) described this species as *Cercariaeum mutabile* from the cercarial stage.

**Macroderoididae McMullen, 1957**
*Alloglossidium corti* (Lamont, 1921) Van Cleave and Mueller, 1934
Synonym: *Parasitotrema ottawanensis* Miller, 1940
Site of infection: Intestine
Host:
*Noturus gyrinus*: Carney and Brooks 1991, cdnp, pnp, minp, unknown County; Muzzall and Pracheil 2007, 2005, 87%, 5, 4*, Silver Creek, 43.657186ºN, 86. 525117ºW, Oceana County.

*Macroderoides typicus* (Winfield, 1929) Van Cleave and Mueller, 1932
Synonym: *Plesiocreadium typicum* Winfield, 1929
Site of infection: Intestine
Host:
*Amia calva*: Winfield 1929, cdnp, pnp, minp, Douglas Lake, 45.576219ºN, 84.697675ºW, Cheboygan County.

**Microphallidae (Ward, 1901) Travassos, 1920**
*Microphallus opacus* (Ward, 1894) Ward, 1901
Synonym: *Distomum opacum* Ward, 1894
Site of infection: Anterior intestine
Host:
*Amia calva*: Strandine 1943, 1931, pnp, minp, Lake Leelanau; 44.879997ºN, 85.706761ºW, Leelanau County.
*Micropterus dolomieu*: Strandine 1943, 1931, pnp, minp, Lake Leelanau, 44.879997ºN, 85.706761ºW, Leelanau County; Muzzall 1982, 1979–1981, 10%, minp, Red Cedar River, 42.394775ºN, 84.426361ºW, Ingham County.
*Notropis rubellus*: Muzzall 1982, 1979–1981, 10%, minp; Red Cedar River, 42.394775ºN, 84.426361ºW, Ingham County.
*Ameiurus nebulosus*: Muzzall 1982, 1979–1981, 50%, minp, Red Cedar River, 42.394775ºN, 84.426361ºW, Ingham County.

Unidentified microphallid
Site of infection: Not provided
Host:
*Ambloplites rupestris*: Esch 1971, 1968–1969, pnp, minp, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.

TABLE 5. (continued)

**Opecoelidae Ozaki, 1925**
*Podocotyle* sp.
Site of infection: Pyloric ceca, anterior intestine
Host:
*Etheostoma nigrum*: Muzzall 1982, 1979–1981, 17%, minp, Red Cedar River, 42.394775ºN, 84.426361ºW, Ingham County.
*Percina maculata*: Muzzall 1982, 1979–1981, 57%, minp, Red Cedar River, 42.394775ºN, 84.426361ºW, Ingham County.

*Plagioporus sinitsini* Mueller, 1934
Synonym: None.
Site of infection: Intestine, gall bladder
Host:
*Lepomis peltastes*: Dobrovolny 1938, cdnp, pnp, minp, Huron River, 42.333747°N, 83.808919°W, Washtenaw County; Dobrovolny 1939a, cdnp, pnp, minp, Huron River, 42.333747°N, 83.808919°W, Washtenaw County.
Other centrarchids: Dobrovolny 1939a, cdnp, pnp, minp, Huron River, 42.333747°N, 83.808919°W, Washtenaw County.
*Luxilus cornutus*: Dobrovolny 1939b, cdnp, 25%, minp, Huron River "above Ann Arbor", 42.333747ºN,83.808919ºW, Washtenaw County.
*Nocomis biguttatus*: Dobrovolny 1939b, cdnp, 51%, minp, Huron River "above Ann Arbor", 42.333747ºN,83.808919ºW, Washtenaw County.
*Notropis rubellus*: Dobrovolny 1939b, cdnp, 16%, minp, Huron River "above Ann Arbor", 42.333747ºN,83.808919ºW, Washtenaw County.
*Notropis volucellus*: Dobrovolny 1939b, cdnp, 23%, minp, Huron River "above Ann Arbor", 42.333747ºN,83.808919ºW, Washtenaw County.
*Pimephales notatus*: Dobrovolny 1939b, cdnp, 6%, minp, Huron River "above Ann Arbor", 42.333747ºN,83.808919ºW, Washtenaw County.
*Campostoma anomalum*: Dobrovolny 1939b, cdnp, 17%, 7.3, Huron River "above Ann Arbor", 42.333747ºN,83.808919ºW, Washtenaw County.
*Hypentellium nigricans*: Dobrovolny 1939b, cdnp, 5%, minp, Huron River "above Ann Arbor", 42.333747ºN,83.808919ºW, Washtenaw County.

**Sanguinicolidae Graaff, 1907**
*Sanguinicola occidentalis* Van Cleave and Mueller, 1932
Synonym: None
Site of infection: Bulbous arteriosus, gill filaments, body cavity washings, eye
Host:
*Perca flavescens*: Muzzall 2000b, 1997–1998, 48%, 1997; 50%; 1998; mi separated by three months for 1997 and 1998, Silver Creek, 43.657186ºN, 86.525117ºW, Oceana County.

*Sanguinicola huronis* Fischthal 1949
Synonym: None
Site of infection: Ureter

TABLE 5. (continued)

Host:
*Micropterus salmoides*: Fischthal 1949, 1940, pnp, minp, Huron River, 42.323522ºN, 83.810808ºW, Washtenaw County.
Remarks: Fischthal (1949) reported finding one triangular egg of *Sanguinicola* in *Micropterus salmoides* and suggested it was *Sanguinicola huronis*.

*Sanguinicola* sp.
Site of infection: Gonadal venous circulation
Host:
*Micropterus dolomieu*: Esch and Huffines 1973; 1967, 1968; pnp, minp, Gull Lake, 42.394775ºN, 85.361017ºW, Kalamazoo County.

## Larval/Immature Digenea (Digenetic Trematodes)

**Azygiidae Luhe, 1909**
*Azygia* sp.
Site of infection: Stomach
Host:
*Lota lota*: Muzzall et al. 1987; 1983, 1984; 1%, 1, Ford River, 46.104983°N, 87.808578°W; 46.129319°N, 87.889661°W; 46.127050°N, 87. 974389°W; Dickinson County, UP.
*Noturus gyrinus*: Muzzall and Pracheil 2007, 2005, 9%, 5, 4*, Silver Creek, 43.657186°N, 86.525117°W, Oceana County.

**Clinostomidae Luhe, 1901**
*Clinostomum complanatum* (Rudolphi, 1819)
Synonym: *Clinostomum marginatum*
Site of infection: Fins, palate
Host:
*Ameiurus melas*, Taylor 1964; 1963, 1964; 65%, minp; Muehrcke Lake, 46.259787°N, 87.473224°W; Marquette County, UP.

*Clinostomum* sp.
Site of infection: Muscle, fins
Host:
*Lepomis macrochirus*, Wilson et al. 1996, 1987, p was 7% and mi was 3.3 in littoral zone fish; Holcomb Lake, 42.505917°N, 85.434589°W, Barry County; Muzzall and Peebles 1998, 1996, 2%, 1, <1*, Five Lakes, 45.041775°N, 84.714017°W, Otsego County; Pracheil and Muzzall 2009, 2003, 2%, <1*, Three Lakes II, 42.349472°N, 85.432708°W, Kalamazoo County; Pracheil and Muzzall 2010; 2003, 2004; same infection data and information as in Pracheil and Muzzall 2009.
*Perca flavescens*: Pynnonen 1960; cdnp, p and minp, llnk, Marquette County, UP.

TABLE 5. (continued)

**Cryptogonimidae (Ward, 1917) Ciurea, 1933**
*Cryptogonimus* sp.
Site of infection: Muscle
Host:
*Lepomis macrochirus*; Pracheil and Muzzall 2009; 2003, 2004; p and ma separated by host age and collection year, Three Lakes II, 42.349472°N, 85.432708°W, Kalamazoo County, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Pracheil and Muzzall 2010; 2003, 2004; same infection data and information as in Pracheil and Muzzall 2009.

**Diplostomidae Poirier, 1886**
*Crassiphiala bulboglossa* Van Haitsma, 1925
Synonym: *Cercaria* sp. of Cooper (1915), *Neascus bulboglossa* (Van Haitsma, 1925)
Site of infection: Integument, myotomes, gill arches
Host:
*Notropis stramineus*: Van Haitsma 1925, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Perca flavescens*: Hughes 1928a, 1927, 94%, 75, Bessey Creek, 45.601467°N, 84.715997°W, tributary of Douglas Lake, Cheboygan County; Pynnonen 1960, cdnp, pnp, minp, llnk, Marquette County, UP.
Remarks: Van Haitsma (1925) experimentally infected a belted kingfisher *Ceryle alcyon* by feeding naturally infected *Notropis stramineus* with metacercariae of *Crassiphiala bulboglossa* to determine trematode species identification.

*Diplostomum flexicaudum* (Cort and Brooks, 1928) Van Haitsma, 1931
Synonym: *Diplostomulum flexicaudum* (Cort and Brooks, 1928); *Diplostomum spathaceum indistinctum* (Guberlet, 1923) Hughes, 1929; a synonym of
*Diplostomum spathaceum* according to Shigin (1986) and other authors
Site of infection: Eye
Host:
*Catostomus commersonii*: La Rue et al. 1926; 1918, 1919, 1925; 94%, 30, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; Van Haitsma 1931; 1926, 1927; pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
Remarks: Van Haitsma (1931) experimentally infected herring-gulls *Larus argentatus* by feeding naturally infected *Catostomus commersonii* with metacercariae of *Diplostomum flexicaudum* from Douglas Lake to determine trematode species identification.

*Diplostomum huronense* (La Rue, 1927) Hughes and Hall 1929
Synonym: *Diplostomulum huronense* Hughes and Hall 1929; considered a synonym of
*Diplostomum spathaceum* by Dubois and Mahon (1959) and other authors
Site of infection: Vitreous humor
Host:
*Percopsis omiscomaycus*: Hughes and Hall 1929; 1926, 1927; pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.

TABLE 5. (continued)

*Perca flavescens*: Hughes and Hall 1929, 1927, 100%, 60, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
Remarks: Hughes and Hall (1929) indicated that individuals of *Diplostomum* sp. found in the eyes of *Percopsis omiscomaycus* by LaRue (1927) and Van Haitsma (unpublished information) were *Diplostomum huronense*.

*Diplostomum spathaceum* (Rudolphi, 1819) Olsson, 1876
Synonym: *Diplostomulum spathaceum* (Rudolphi, 1819); *Diplostomum volvens* Nordmann, 1833 of Cooper (1915); probably *Diplostomum emarginatae* Olivier, 1942; *Diplostomum flexicaudum* (Cort and Brooks, 1928); *Diplostomum indistinctum*; *Diplostomum gigas* Hughes and Berkhout 1929; *Diplostomulum gigas* Hughes and Berkhout 1929
Site of infection: Eye
Host:
*Catostomus commersonii*: Hughes and Berkhout 1929, 1926, pnp, minp; 1927, 100%, 52, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Cottus bairdii*: Muzzall and Sweet 1986, 1982–1984, 1%, 5, Au Sable River, 43.930856°N, 86.039375°W, Crawford County.

*Diplostomum* spp.
Site of infection: Eye
Host:
*Ambloplites rupestris*: Butler 1920, 1917, 60%, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; LaRue et al. 1926; 1918, 1919, 1925; 5%, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Ameiurus nebulosus*: LaRue et al. 1926; 1918, 1919, 1925; 40%, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Ameiurus* sp.: Butler 1920, 1917, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Catostomus commersonii*: Butler 1920, 1917, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; LaRue et al. 1926; 1918, 1919, 1925; 94%, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Lepomis gibbosus*: Butler 1920, 1917, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; LaRue et al. 1926; 1918, 1919, 1925; 6%, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Lepomis macrochirus*: Muzzall and Peebles 1998, 1996, 13%, 2, <1*, North Porcupine Lake, 45.041775°N, 84.714017°W, Otsego County; Pracheil and Muzzall 2009; 2003, 2004; p and ma separated by host age and collection year; Three Lakes II, 42.349472°N, 85.432708°W, Kalamazoo County; Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Pracheil and Muzzall 2010; 2003, 2004; same infection data and information as in Pracheil and Muzzall 2009.
*Lota lota*: LaRue et al. 1926; 1918, 1919, 1925; 100%, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.

TABLE 5. (continued)

*Luxilis cornutus*: Butler 1920, 1917, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; LaRue et al. 1926; 1918, 1919, 1925; pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.

*Notropis hudsonius*: LaRue et al. 1926; 1918, 1919, 1925; 94%, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.

*Perca flavescens*: Butler 1920, 1917, 72%, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; LaRue et al. 1926; 1918, 1919, 1925; 42%, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.

*Percopsis omiscomaycus*: Butler 1920, 1917, 72%, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; LaRue et al. 1926; 1918, 1919, 1925; 42%, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.

*Thymallus arcticus*: Muzzall 1990, 1987–1988, 84%, 4, Ackerman Lake, 46.331311°N, 86.797517°W, Alger County, UP; Muzzall 1990, 1987–1988, 5%, 6, Deer Lake, 46.606006°N, 85.674211°W, Luce County, UP.; Muzzall 1990, 1987–1988, 10%, 2, Kettlehole Lake, Alger County, UP; Muzzall 1990, 1987–1988, 33%, 2, Reid Lake, 44.642367°N, 83.684967°W, Alcona County.

Remarks: The presence of *Diplostomum* sp. in fish species reported by Butler (1920) also involved concurrent infections with *Tetracotyle* sp. Butler (1920) did not separate infection values for *Diplostomum* sp. and *Ichthyocotylurus* sp. (=*Tetracotyle* sp.) in infected fish. Also, the date of Butler's article is sometime cited as 1919. Furthermore LaRue et al. (1926) stated (p. 285) "The forms there (reported by Butler (1920) called *Tetracotyle* have since been determined to be *Diplostomum* von Nordmann and those called *Diplostomulum* are *Tylodelphys* Diesing." However, LaRue et al. (1926) stated (page 285) "A specific determination of the parasites found has not yet been completed.", in referring to *Diplostomum* and *Tylodelphys* found by Butler 1920.

*Diplostomum* sp.
Site of infection: Mesentery
Host:

*Lepomis macrochirus*: Wilson et al. 1996, 1987, p was 5% and mi was 1.5 in littoral zone fish, Holcomb Lake, 42.505917°N, 85.434589°W, Barry County.

*Cottus bairdii*: Muzzall and Sweet 1986, 2%, 4, Au Sable River, 43.930856°N, 86.039375°W, Crawford County.

*Cercaria flexicauda* Cort and Brooks 1928
Synonym: ?*Diplostomulum flexicaudum* (Cort and Brooks, 1928) Van Haitsma, 1931; a synonym of *Diplostomum spathaceum* according to Shigin (1986).
Site of infection: Eye
Host:

"several different species of fish": Cort and Brooks 1928, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.

TABLE 5. (continued)

Remarks: Metacercariae were similar to the diplostomum type. Van Haitsma (1931) reported that individuals of *Cercaria flexicauda* developed into metacercariae of *Diplostomum flexicaudum*.

*Cercaria laruei* Cort and Brooks 1928
Synonym: Unknown if exists
Site of infection: Eye
Host:
"several different species of fish": Cort and Brooks 1928, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
Remarks: Metacercariae were similar to the diplostomum type.

*Cercaria modicella* Cort and Brooks 1928
Synonym: Unknown, if exists
Site of infection: Eye
Host:
"several different species of fish": Cort and Brooks 1928, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
Remarks: Metacercariae were similar to the diplostomum type.

*Neascus* sp.
Site of infection: Muscle, branchiostegal rays, operculum, skin
Host:
*Lepomis macrochirus*: Wilson et al. 1996, 1987, p and mi were 88% and 14.1, and 60% and 3.5 in littoral zone and open water fish, respectively, Holcomb Lake, 42.505917°N, 85.434589°W, Barry County; Muzzall and Peebles 1998, 1996, 18%, 3, <1*, Five Lakes, 45.041775°N, 84.714017°W; 93%, 7, 7*, North Porcupine Lake, 45.041775°N, 84.714017°W, Otsego County; Pracheil and Muzzall 2009; 2003, 2004; p and ma separated by host age and collection year, Three Lakes II, 42.349472°N, 85.432708°W; Kalamazoo County, Gull Lake, 42.394775°, 85.361017°W, Kalamazoo County; Pracheil and Muzzall 2010; 2003, 2004; same infection data and information as in Pracheil and Muzzall 2009.
*Cottus bairdii*: Muzzall and Sweet 1986, 1982–1984, 2%, 1, Au Sable River, 44.665922°N, 84.626153°W, Crawford County.
*Salvelinus fontinalis*: Muzzall 1986, 1982–1984, 6%, 3, Au Sable River, 44.665922°N, 84.626153°W, Crawford County.
*Salmo trutta*: Muzzall 1986, 1982–1984, 1%, 1, Au Sable River, 44.665922°N, 84.626153°W, Crawford County.
*Rhinichthys cataractae*: Muzzall et al. 1992, 1983–1986, p varied from 64% to 87%, mi varied from 4.0 to 7.9 for three localities; Ford River; 46.104983°N, 87.808578°W; 46.129319°N, 87.889661°W, 46.127050°N, 87. 974389°W; Dickinson County, UP.

TABLE 5. (continued)

*Ornithodiplostomum* sp.
Site of infection: Brain
Host:
*Thymallus arcticus*: Muzzall 1990, 1987–1988, 95%, 11, Kettlehole Lake, 46.255344°N, 86.649003°W, Alger County, UP.

*Posthodiplostomum minimum* (MacCallum, 1921) (Dubois, 1936)
Synonym: *Diplostomum minimum* MacCallum, 1921; *Neascus* (*Diplostomum*) *vancleavi* (Agersborg, 1926); *Diplostomum cuticola* (Nordmann, 1832) Diesing, 1850 of Stafford (1904) and Cooper (1915); *Neodiplostomum minimum* (MacCallum, 1921); *Neodiplostomum orchilongum* Noble, 1935; *Posthodiplostomum cuticola* (Nordmann, 1832) Dubois, 1936 of Margolis and Arthur (1979)
Site of infection: Gonads, kidney, liver, mesentery
Host:
*Ambloplites rupestris*: Hughes 1928b, 1926, pnp, minp, Huron River near Ann Arbor, 42.323522°N, 83.810808°W, Washtenaw County.
*Lepomis gibbosus*: Hughes 1928b, 1926, pnp, minp, Huron River near Ann Arbor, 42.323522°N, 83.810808°W, Washtenaw County.
*Lepomis macrochirus*: Hughes 1928b, 1926, pnp, minp, Huron River near Ann Arbor, 42.323522°N, 83.810808°W, Washtenaw County; cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; cdnp, pnp, minp, Fife Lake, 44.566461°N, 85.344808°W, Grand Traverse County; cdnp, pnp, minp, Gilead Lake, 41.792897°N, 85.165°W,
Branch County; Wilson et al. 1996, p and mi were 100% and 226.5, and 91% and 40.1 in littoral and open water fish, respectively, Holcomb Lake, 42.505917°N, 85.434589°W, Barry County; Pracheil and Muzzall 2009; 2003, 2004; p and ma separated by host age and collection year, Three Lakes II, 42.349472°N, 85.432708°W, Kalamazoo County; Gull Lake, 42.394775°, 85.361017°W, Kalamazoo County; Pracheil and Muzzall 2010; 2003, 2004; same infection data and information as in Pracheil and Muzzall 2009.
*Lepomis megalotis*: Hughes 1928b, 1926, pnp, minp, Huron River, Ann Arbor, 42.323522°N, 83.810808°W, Washtenaw County.
*Rhinichthys cataractae*: Muzzall et al. 1992, 1983–1986, p varied from 80% to 97%, mi varied from 15.7 to 40.6 for three localities, Ford River; 46.104983°N, 87.808578°W; 46.129319°N, 87.889661°W; 46.127050°N, 87. 974389°W; Dickinson County, UP.

*Posthodiplostomum* sp.
Site of infection: Heart, gonads, liver, mesentery, spleen, stomach, intestine
Host:
*Lepomis macrochirus*: Muzzall and Peebles 1998, 1996, 98%, 49, 47*, Five Lakes, 45.041775°N, 84.714017°W; 100%, 812, 812*, North Porcupine Lake, 45.041775°N, 84.714017°W, Otsego County; John Hnath 1997, personal communication, 100%, minp, Clear Lake, 42.3319°N, 84.1475°W, Jackson County.

TABLE 5. (continued)

*Lota lota*: Muzzall et al. 1987; 1983, 1984; 1%, 32, Ford River, 46.104983°N, 87.808578°W; 46.129319°N, 87.889661°W; 46.127050°N, 87. 974389°W; Dickinson County, UP.
Remarks: Muzzall et al. (1987) suggested that *Lota lota* became infected with *Posthodiplostomum* sp. in the intestine by ingestion of infected cyprinids.

*Tylodelphys scheuringi* (Hughes, 1929) Dubois, 1936
Synonym: *Diplostomulum scheuringi* Hughes, 1929; *Diplostomum scheuringi* (Hughes, 1929), Bangham and Hunter, 1939
Site of infection: Eye
Host:
*Ambloplites rupestris*: Butler 1920, 1917, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Lepomis gibbosus*: Butler 1920, 1917, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Micropterus dolomieu*: Butler 1920, 1917, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Luxilus cornutus*: Butler 1920, 1917, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Esox lucius*: Butler 1920, 1917, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Ameiurus nebulosus*: Butler 1920, 1917, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Perca flavescens*: Butler 1920, 1917, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; Hughes 1929, 1927, 20%, 1, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Percopsis omiscomaycus*: Butler 1920, 1917, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Umbra limi*: Muzzall and Kilroy 2007, 2005, 42%, 7, 4*, Silver Creek, 43.657186°N, 86.525117°W, Oceana County.
Remarks: The presence of *Tetracotyle* sp. in fish species reported by Butler (1920) also involved concurrent infections with *Diplostomum* sp. Butler (1920) did not separate infection values for *Diplostomum* sp. and *Ichthyocotylurus* sp. (=*Tetracotyle* sp.) in infected fish. Also, the date of Butler's article is sometimes cited as 1919. Furthermore LaRue et al. (1926) stated (p. 285) "The forms there (reported by Butler (1920) called *Tetracotyle* have since been determined to be *Diplostomum* von Nordmann and those called *Diplostomulum* are *Tylodelphys* Diesing." However, LaRue et al. (1926) stated (page 285) "A specific determination of the parasites found has not yet been completed.", in referring to *Diplostomum* and *Tylodelphys* found by Butler 1920.

TABLE 5. (continued)

*Tylodelphys* sp.
Site of infection: [Brain, eye]
Host:
*Notropis stramineus*: Van Haistma 1925, 1922, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.

*Uvulifer ambloplitis* (Hughes, 1927) Dubois, 1938
Synonym: *Neascus ambloplitis* Hughes, 1927; *Crassiphiala ambloplitis* (Hughes, 1927) Hunter and Hunter, 1931; *Neascus wardi* Hunter, 1928
Site of infection: Fins, skin, muscle
Host:
*Ambloplites rupestris*: Hughes 1927, 1926, 86%, 25, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; Hughes 1928b, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Micropterus dolomieu*: Hughes 1927, 1926, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; Hughes 1928b, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; Pynnonen 1960, cdnp, pnp, minp, llnk, Marquette County, UP.
Remarks: It is not sure if Hughes (1928b) collected *Uvulifer ambloplitis* (=*Neascus van-cleavi*) from *Ambloplitis rupestris* and *Microperus dolomieu* in this study, or if specimens of this species were from the study of Hughes (1927).

*Neascus* of *Ornithodiplostomum ptychocheilus* (Hughes and Piszczek 1928) Dubois, 1936
Synonym: *Cercaria ptychocheilus* (Faust, 1917); *Neascus ptychocheilus* (Faust); *Paradiplostomum ptychocheilus* (Faust)
Site of infection: Peritoneum, mesentery, viscera, free in the ovaries
Host:
*Notropis straminueus*: Hughes and Piszczek 1928; 1926, 1927; 88%, 32, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; Van Haitsma 1930a, 1929, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
Remarks: Van Haitsma (1930a) stated (p. 147) “This feeding experiment, therefore, clearly indicated the correctness of my hypothesis that *Neascus ptycocheilus* (Faust) is the metacercaria of my adults. Consequently, the present species is *ptychocheilus*, but the genus to which this species belongs still requires consideration.”

**Heterophyidae Odhner, 1914**
*Apophallus imperator* Lyster, 1940
Site of infection: [In or beneath skin]
Host:
*Salvelinius fontinalis*: Pynnonen 1960, cdnp, pnp, minp, llnk, Marquette County, UP.

TABLE 5. (continued)

**Macroderoididae McMullen, 1957**
*Macroderoides* sp.
Site of infection: Brain, eyes, gills, liver, mesentery, muscle, spleen
Host:
*Noturus gyrinus*: Muzzall and Pracheil 2007, 2005, 100%, minp, Silver Creek, 43.657186°N, 86.525117°W, Oceana County.

**Microphallidae (Ward, 1901) Travassos, 1920**
*Maritreminoides* sp.
Site of infection: Intestine
Host:
*Noturus gyrinus*: Muzzall and Pracheil 2007, 2005, 14%, 12, 2*, Silver Creek, 43.657186°N, 86.525117°W, Oceana County.

**Opecoelidae Ozaki, 1925**
*Podocotyle* sp.
Site of infection: Anterior intestine
Host:
*Pimephales notatus*: Muzzall 1982, 1979–1981, 6%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

**Psilostomidae Looss, 1904**
*Ribeiroia ondatrae* (Price 1931) Price 1942, Yamaguti 1958
Synonym: *Psilostomum ondatrae* Price, 1931 of Beaver 1939; *Cercaria thomasi* (McMullen 1938) (Price, 1931) Price, 1932
Site of infection: Lateral line canal
Host:
*Ameiurus* sp.: Beaver 1939, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Perca flavescens*: Beaver 1939, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
"Sunfish": Beaver 1939, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.

**Strigeidae Railliet, 1919**
*Ichthyocotylurus pileatus* (Rudolphi, 1802) Odening, 1962
Synonym: *Tetracotyle diminuta* Hughes 1928
Site of infection: On and about the heart
Host:
*Perca flavescens*: Hughes 1928c, 1927, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; pnp, minp, Wampler Lake, 42.071025°N, 84.165608°W, Lenawee County.
*Percopsis omiscomaycus*: Hughes 1928c, 1927, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.

TABLE 5. (continued)

*Ichthyocotylurus platycephalus* (Creplin, 1825) Odening, 1969
Synonym: *Tetracotyle communis* Hughes, 1928c; *Cotylurus communis* (Hughes, 1928c) La Rue, 1932; *Strigea michiganensis* Van Haitsma, 1930; *Cotylurus michiganensis* (La Rue)
Site of infection: Adipose tissue, eyeball, eye socket, heart
Host:
*Catostomus commersonii*: Hughes 1928c, 1927, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; Van Haitsma 1930b; 1926, 1927; pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Percopsis omiscomaycus*: Hughes 1928c, 1927, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; La Rue 1932, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
Remarks: LaRue et al. (1932) questioned that *Strigea michiganensis* and *Cotylurus michiganensis* are synonyms of *Ichthyocotylurus platycephalus*. Olivier and Cort (1942) questioned that Van Haitsma (1930b) worked with *Ichthyocephalus platycephalus* ( = *Cotylurus communis*).

*Ichthyocotylurus* sp. Odening, 1969
Site of infection: Muscle, mesentery, eye orbit, surface of gonads, heart, kidney, liver, urinary bladder
Host:
*Ambloplites rupestris*: Butler 1920, 1917, 60%, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Ameiurus* sp.: Butler 1920, 1917, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Catostomus commersonii*: Butler 1920, 1917, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Lepomis gibbosus*: Butler 1920, 1917, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Luxilis cornutus*: Butler 1920, 1917, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Perca flavescens*: Butler 1920, 1917, 72%, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Percopsis omiscomaycus*: Butler 1920, 1917, 50%, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Cottus bairdii*: Muzzall and Sweet 1986, 1982–1984, 30%, 6, Au Sable River, 44.665922°N, 84.626153°W, Crawford County.
Remarks: Butler (1920) did not separate infection values for *Ichthyocephalus* sp. ( = *Tetracotyle*) and *Diplostomum* sp. in infected fish. Furthermore, La Rue (1926) stated (p. 285) “These forms there (reported by Butler (1920)) called *Tetracotyle* have since been determined to be *Diplostomum* von Nordmann and those called *Diplostomulum* are *Tylodelphys* Diesing.”

TABLE 5. (continued)

Unidentified Strigeidae
Site of infection: Skin, muscle
Host:
*Lepomis macrochirus*: Tompkins 1947, 1946, 69%, mi varied from 1 to over 30, Big Shag Lake, 46.2705172°N, 87.4995752°W, Marquette County, UP.
*Perca flavescens*: Tompkins 1947, 1946, 86%, mi varied from 1 to over 30, Big Shag Lake, 46.2705172°N, 87.4995752°W, Marquette County, UP.

**Unknown Family**
Visceral trematode metacercariae
Site of infection: gonads, liver, viscera
Host:
*Ambloplites rupestris*: Esch 1971, 1968–1969, pnp, 1–10 parasites per host, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.
*Lepomis macrochirus*: Esch 1971, 1968–1969; pnp, 1–10 parasites per host; Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; John Hnath, personal communication, 1997, pnp, minp, Lake Mitchell, 44.544833°N, 85.480133°W, Wexford County.
*Lepomis* sp. hybrid: Esch 1971, 1968–1969, pnp, 10 or more parasites per host Wintergreen Lake, 42.397370°N, 85.384503°W, Kalamazoo County; Esch 1971, 1968–1969, pnp, 10 or more parasites per host, Duck Lake, 42.198908°N, 85.719344°W, Kalamazoo County.
*Micropterus dolomieu*: Esch 1971, 1968–1969, pnp, 1–10 parasites per host, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.
*Micropterus salmoides*: Esch 1971, 1968–1969, pnp, 1–10 parasites per host, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Esch 1971, 1968–1969, pnp, 10 or more parasites per host, Wintergreen Lake, 42.397370°N, 85.384503°W, Kalamazoo County; Esch 1971, 1968–1969, pnp, minp, Duck Lake, 42.198908°N, 85.719344°W, Kalamazoo County.

**Unknown Family**
External trematode metacercariae
Site of infection: Unknown
Host:
*Ambloplites rupestris*: Esch 1971, 1968–1969, pnp, 1–10 parasites per host, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.
*Lepomis macrochirus*: Esch 1971, 1968–1969, pnp, 1–10 parasites per host, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.
*Lepomis* sp. hybrid: Esch 1971, 1968–1969, pnp, 10 or more parasites per host, Wintergreen Lake, 42.397370°N, 85.384503°W, Kalamazoo County; Esch 1971, 1968–1969, 10 or more parasites per host, Duck Lake, 42.198908°N, 85.719344°W, Kalamazoo County.
*Micropterus dolomieu*: Esch 1971, 1968–1969, pnp, 1–10 parasites per host, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.
*Micropterus salmoides*: Esch 1971, 1968-1969, pnp, 1–10 parasites per host, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Esch 1971, 1968–1969, pnp, 10 or

TABLE 5. (continued)

more parasites per host, Wintergreen Lake, 42.397370°N, 85.384503°W, Kalamazoo County; Esch 1971, 1968–1969, pnp, minp, Duck Lake, 42.198908°N, 85.719344°W, Kalamazoo County.

**Adult Monogenea (Monogeneans)**

**Ancyrocephalidae Bykhovski and Nagibina, 1978**
*Actinocleidus* sp.
Site of infection: Gills
Host:
*Lepomis macrochirus*: Pracheil and Muzzall 2009; 2003, 2004; p separated by host age and collection year, minp, Three Lakes II, 42.349472°N, 85.432708°W, Kalamazoo County; Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Pracheil and Muzzall 2010; 2003, 2004; same infection data and information as in Pracheil and Muzzall 2009.

*Anchoradiscus* sp.
Site of infection: Gills
Host:
*Lepomis macrochirus*: Pracheil and Muzzall 2009; 2003, 2004; p separated by host age and collection year, minp, Three Lakes II, 42.349472°N, 85.432708°W, Kalamazoo County; Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Pracheil and Muzzall 2010; 2003, 2004; same infection data and information as in Pracheil and Muzzall 2009.

*Ligictaluridus* sp.
Site of infection: Gills
Host:
*Noturus gyrinus*: Muzzall and Pracheil 2007, 2005, 42%, minp, Silver Creek, 43.657186°N, 86.525117°W, Oceana County.

**Dactylogyridae Bykhovski, 1933**
*Acolpenteron catostomi* Fischthal and Allison, 1942
Synonym: None
Site of infection: Ureters
Host:
*Catostomus commersonii*: Fischthal and Allison 1942, 1940, pnp, minp, Fleming Creek, 42.270038°N, 83.659661°W; Honey Creek, 42.373369°N, 83.200513°W, Washtenaw County.
*Hypentelium nigricans*: Fischthal and Allison 1942, 1940, pnp, minp, Fleming Creek 42.270038°N, 83.659661°W; Honey Creek, 42.373369°N, 83.200513°W, Washtenaw County.

TABLE 5. (continued)

*Acolpenteron ureteroectes* Fischthal and Allison, 1940
Synonym: None
Site of infection: Ureters and urinary bladder
Host:
*Micropterus dolomieu*: Fischthal and Allison 1940, cdnp, pnp, minp, Huron River, 42.323522°N, 83.810808°W, Washtenaw County; Fischthal and Allison 1941, cdnp, Huron River, 42.323522°N, 83.810808°W, 36%, minp; Whitmore Lake, 42.426406°N, 83.754561°W, 63%, minp, Washtenaw County.
*Micropterus salmoides*: Fischthal and Allison 1940, cdnp, pnp, minp, Huron River, 42.323522°N, 83.810808°W, Washtenaw County; Fischthal and Allison 1941, 1939, Huron River, 42.323522°N, 83.810808°W, 58%, minp; Honey Creek, 42.373369°N, 83.200513°W, 10%, minp; Whitmore Lake, 42.426406°N, 83.754561°W, 23%, minp; West Lake, 42.639539°N, 84.007947°W, 100%, minp, Washtenaw County.

*Dactylogyrus semotilus* Wood and Mizelle, 1957
Synonym: *Neodactylogyrus semotilus* Kimpel, 1939
Site of infection: [Gills]
Host:
*Semotilus atromaculatus*: Wood and Mizelle 1957, cdnp, pnp, minp, Pickeral Lake Outlet, 41.999906°N, 85.805378°W, Cass County.

*Dactylogyrus* sp.
Site of infection: Gills
Host:
*Lepomis macrochirus*: Wilson et al. 1996, 1987, p and mi were 2% and 1.0, and 2% and 1.0 in littoral zone and open water fish, respectively, Holcomb Lake, 42.505917°N, 85.434589°W, Barry County.

**Gyrodactylidae Cobbold, 1864**
*Gyrodactylus bairdi* Wood and Mizelle, 1957
Synonym: *Gryodactylus labradorius* Hanek and Threlfall, 1970
Site of infection: Gills
Host:
*Cottus bairdii*: Muzzall and Sweet 1986, 1982–1984, 6%, minp, Au Sable River, 44.665922°N, 84.626153°W, Crawford County.

*Gyrodactylus* sp.
Site of infection: Gills
Host:
*Rhinichthys cataractae*: Muzzall et al. 1992, 1983–1986, p varied from 1% to 3% for three localities, minp; Ford River, 46.104983°N, 87.808578°W, 46.129319°N, 87.889661°W, 46.127050°N, 87.974389°W, Dickinson County, UP.

TABLE 5. (continued)

*Oncorhynchus mykiss* (parr): Muzzall 1993a; 1983, 1989, 1990; 1%, minp, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties.

**Adult Cestoda (Cestodes)**

**Caryophyllaeidae Leuckhart, 1878**
*Glaridacris catostomi* (Cooper, 1920) Mackiewicz, 1965
Synonym: *Caryophyllaeus terebrans* of Bangham and Adams, 1954 (partim); *Glaridacris laruei* of Bangham and Venard, 1946
Site of infection: Intestine
Host:
*Catostomus commersonii*: Cooper 1920, 1917, pnp, minp, Maple River, 45.574897°N, 84.727981°W; Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; Hunter 1927, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; Muzzall 1982, 1979–1981, 40%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

*Glaridacris laruei* (Lamont, 1921) G. W. Hunter, 1927
Synonym: *Glaridacris intermedius* Lyster, 1940
Site of infection: Digestive tract
Host:
*Catostomus commersonii*: Hunter 1927, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.

*Isoglaridacris folius* Fredrickson and Ulmer, 1965
Synonym: None
Site of infection: Anterior intestine
Host:
*Hypentelium nigricans*: Muzzall 1982, 1979–1981, 22%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

*Isoglaridacris* sp.
Site of infection: Anterior intestine
Host:
*Catostomus commersonii*: Muzzall 1982, 1979–1981, 20%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

**Amphicotylidae Ariola, 1899**
*Eubothrium crassum* (Bloch, 1779) Nybelin, 1922
Synonym: *Abothrium crassum* (Bloch, 1779) *Eubothrium oncorhynchi* Wardle, 1932
Host:
*Salvelinus fontinalis*: Cooper 1918, cdnp, pnp, minp, likely Slagle Creek near Harietta, 44.305450°N, 85.695267°W, Wexford County.

TABLE 5. (continued)

Remarks: This identification by Cooper (1918) is questioned, and the specimens maybe *Eubothrium salvelini*.

*Eubothrium salvelini* (Schrank, 1790) Nybelin, 1922
Synonym: None
Site of infection: Pyloric ceca, anterior intestine
Host:
*Oncorhynchus tshawytscha* (adult): Muzzall 1993a, 1983, 11%, 3, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties; Muzzall and Peebles 1986; 1983, 1984; 20%, 1, Albany Creek, 45.70019°N, 84.076400°W, Chippewa County, UP.
*Oncorhynchus kisutch* (adult): Muzzall 1993a, 1983, 33%, 2, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties; Muzzall and Peebles 1986; 1983, 1984; 25%, 12, Huron River, 46.90365°N, 88.063317°W, Baraga County, UP, and Harlow Creek, 46.635762°N, 87.468470°W, Marquette County, UP.
*Oncorhynchus mykiss* (adult): Muzzall 1993a, 1983, 48%, 14, Pere Marquette River system, 43.930856°N, 86.039375°W, Lake and Mason Counties.
*Salvelinus fontinalis*: Pynnonen 1960, cdnp, pnp, minp, llnk, Marquette County, UP; Muzzall 1993b; 1983, 1991; 24%, 4, 1983, 83%, 2, 1991, Sweetwater Creek, 43.932547°N, 85.986358°W, Lake County; Hernandez and Muzzall 1998; 1995, 1996; 48%, 3, 1*, Sweetwater Creek, 43.932547°N, 85.986358°W, Lake County.
*Oncorhynchus gorbuscha* (adult): Muzzall and Peebles 1986; 1983, 1984; 79%, 29, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP, and Huron River, 46.90365°N, 88.063317°W, Baraga County, UP, and Carp River, 46.536517°N, 87.646667°W, Marquette County, UP, and Albany Creek, 45.970019°N, 84.076400°W, Chippewa County, UP.
Remarks: It is likely *Oncorhynchus gorbuscha* became infected in Lake Superior and in Lake Huron, *Oncorhynchus kisutch* became infected in Lake Superior, and *Oncorhynchus tshawytscha* became infected in Lake Huron.

**Bothriocephalidae Blanchard, 1849**
*Bothriocephalus claviceps* Goeze, 1782) Rudolphi, 1810
Synonym: None
Site of infection: [Intestine]
Host:
*Micropterus salmoides*: Esch 1971, 1968–1969, 29%, minp, Wintergreen Lake, 42.397370°N, 85.384503°W, Kalamazoo County.

*Bothriocephalus cuspidatus* Cooper, 1917
Synonym: None
Site of infection: [Pyloric ceca, intestine]
Host:
*Sander vitreus*: Pynnonen 1960, cdnp, pnp, minp, llnk, Marquette County, UP.

TABLE 5. (continued)

*Bothriocephalus formosus* Mueller and Van Cleave, 1932
Synonym: None
Site of infection: Pyloric ceca
Host:
*Etheostoma nigrum*: Muzzall 1982, 1979–1981, 42%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

*Bothriocephalus* sp. Rudolphi, 1808
Site if infection: Pyloric ceca, intestine
Host:
*Sander vitreus*: Tompkins 1947, 1946, 48%, 23, Big Shag Lake, 46.2705172°N, 87.4995752°W; Marquette County, UP.
*Lepomis macrochirus*: Tompkins 1947, 1946, 8%, 1, Big Shag Lake, 46.2705172°N, 87.4995752°W; Marquette County, UP.
*Perca flavescens*: Tompkins 1947, 1946, 3%, 1, Big Shag Lake, 46.2705172°N, 87.4995752°W; Marquette County, UP.

**Cyathocephalidae Nybelin, 1922**
*Cyathocephalus truncatus* (Pallas, 1781) Kessler, 1868
Synonym: *Cyathocephalus americanus* Cooper, 1917
Site of infection: Pyloric ceca
Host:
*Oncorhynchus tshawytscha* (adult): Muzzall 1993a, 1983, 5%, 1, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties.
*Oncorhynchus gorbuscha* (adult): Muzzall and Peebles 1986; 1983, 1984; 68%, 16, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP, and Carp River 46.536517°N, 87.646667°W, Marquette County, UP, and Harlow Creek, 46.635762°N, 87.468470°W, Marquette County, UP.
Remarks: It is likely that *Oncorhynchus tshawytscha* became infected in Lake Michigan, and *Oncorhychus gorbuscha* became infected in Lake Superior.

**Haplobothriidae Meggitt, 1924**
*Haplobothrium globuliforme* Cooper, 1914
Synonym: None
Site of infection: [Intestine]
Host:
*Amia calva*: Thomas 1930, 1928, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; Thomas 1930, 1929, pnp, minp, Burt Lake, 45.576219°N, 84.697675°W, Cheboygan County; Meinkoth 1947, 1941, pnp, minp, Burt Lake, 45.576219°N, 84.697675°W, Cheboygan County.

TABLE 5. (continued)

**Proteocephalidae LaRue, 1911**
*Corallobothrium fimbriatum* Essex, 1927
Synonym: None
Site of infection: Anterior intestine
Host:
*Ameiurus melas*: Taylor 1964; 1963, 1964; 12%, minp; Muehrcke Lake, 46.259787°N, 87.473224°W; Marquette County, UP.
*Ameiurus natalis*: Muzzall 1982, 1979–1981, 20%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Ameiurus nebulosus*: Muzzall 1982, 1979–1981, 50%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

*Corallobothrium parvum* Larsh 1941
Synonym:
Site of infection: Small intestine
Host:
*Ameiurus nebulosus*: Larsh 1941, 1939, pnp, minp, Black Lake (in the Douglas Lake region), 45.465753ºN, 84.266389ºW, Cheboygan County.

*Megathylacoides giganteum* (Essex, 1928) Frese, 1965
Synonyms: *Corallobothrium giganteum* Essex, 1928; *Corallobothrium megathylacoides giganteum* (Essex, 1928) Jones, Kerley, and Sneed, 1956
Site of infection: Anterior intestine
Host:
*Ameiurus melas*: Muzzall 1982, 1979–1981, 50%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

*Proteocephalus ambloplitis* (Leidy, 1887) Benedict, 1900
Synonym: *Proteocephalus micropteri* (Leidy, 1891)
Site of infection: Pyloric ceca, anterior intestine
Host:
*Micropterus dolomieu*: Pynnonen 1960, cdnp, pnp, minp, llnk, Marquette County, UP;
Esch 1971, 1968–1969, 43%, minp, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Esch et al. 1975; 1967, 1968, 1972, 1973; p and density of cestodes separated by several variables, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Gillilland and Muzzall 2004; 2000, 2001; p and mi separated by several variables; Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.
*Micropterus salmoides*: Esch 1971, 1968–1969, 12%, minp, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Gillilland and Muzzall 2004; 2000, 2001; p and mi separated by several variables, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.

TABLE 5. (continued)

*Proteocephalus buplanensis* Mayes, 1976
Synonym: None
Site of infection: Intestine
Host:
*Semotilus atromaculatus*: Muzzall 1982, 1979–1981, 5%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

*Proteocephalus fluviatilis* Bangham, 1925
Synonym: None
Site of infection: [Intestine]
Host:
*Micropterus dolomieu*: Esch et al. 1975; 1967, 1968, 1972, 1973; pnp, minp, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.

*Proteocephalus parallacticus*
Synonym: None
Host:
*Oncorhynchus gorbuscha* (adult): Muzzall and Peebles 1986; 1983, 1984; 41%, 23, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP, and Carp River, 46.536517°N, 87.646667°W, Marquette County, UP, and Harlow Creek, 46.635762°N, 87.468470°W, Marquette County, UP.
*Oncorhynchus kisutch* (adult): Muzzall and Peebles 1986; 1983, 1984; 38%, 5, Harlow Creek, 46.635762°N, 87.468470°W, Marquette County, UP, and Huron River, 46.90365°N, 88.063317°W, Baraga County, UP.
*Oncorhynchus tshawytscha* (adult): Muzzall and Peebles 1986; 1983, 1984; 40%, 2, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP.
Remarks: It is believed that *Oncorhynchus* spp. became infected in Lake Superior.

*Proteocephalus pearsei* La Rue, 1919
Synonym: None
Site of infection: Intestine
Host:
*Ambloplites rupestris*: LaRue 1919, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Perca flavescens*: LaRue 1919, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.

*Proteocephalus pinguis* La Rue, 1911
Synonym: None
Site of infection: Intestine
Host:
*Esox lucius*: Pynnonen 1960, cdnp, pnp, minp, llnk, Marquette County, UP.
*Esox americanus*: Muzzall 1982, 1979–1981, 50%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

TABLE 5. (continued)

*Proteocephalus* sp.
Site of infection: Intestine
Host:
*Micropterus salmoides*: Tompkins 1947, 1946, 14%, 2, Big Shag Lake, 46.2705172°N, 87.4995752°W; Marquette County, UP.
*Perca flavescens*: Tompkins 1947, 1946, 3%, 2, Big Shag Lake, 46.2705172°N, 87.4995752°W; Marquette County, UP.
*Sander vitreus*: Tompkins 1947, 1946, 30%, 93, Big Shag Lake, 46.2705172°N, 87.4995752°W; Marquette County, UP.

**Larval/immature Cestoda (Larval Cestodes)**

**Amphicotylidae Ariola, 1899**
*Eubothrium salvelini* (Schrank, 1790) Nybelin, 1922
Synonym: None
Site of infection: Anterior small intestine
Host:
*Cottus cognatus*: Muzzall 1993b; 1983, 1991; 20%, 3, Sweetwater Creek, 43.932547°N, 85.986358°W, Lake County; Hernandez and Muzzall 1998; 1995, 1996; 17%, 1, <1*, Sweetwater Creek, 43.932547°N, 85.986358°W, Lake County.

*Eubothrium* sp.
Site of infection: Pyloric ceca
Host:
*Salvelinus fontinalis*: Muzzall 1984b, 1981–1982, 2%, minp, Honey Creek, 42.979617°, 85.4419°W, Kent County; Muzzall 1986, 1982–1984, 1%, 1, Au Sable River, 44.665922°N, 84.626153°W, Crawford County

**Bothriocephalidae Blanchard, 1849**
*Bothriocephalus cuspidatus* Cooper, 1917
Synonym: None
Site of infection: [intestine]
Host:
*Percina caprodes*: Cooper 1918, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
Remarks: It is not known if the specimens found by Cooper (1919) were larvae or immatures.

**Diphyllobothriidae Luhe, 1910**
*Diphyllobothrium latum* (Linnaeus, 1758) Cobbold, 1858
Synonym: *Dibothriocephalus latus*
Site of infection: Flesh, adipose tissue among viscera, gonads, wall of digestive tract

TABLE 5. (continued)

Host:
*Esox lucius*: Warthin 1912, cdnp, pnp, minp, Portage Lake, 47.122586°N, 88.575281°W; 47.026583°N, 88.520103°W, Houghton County, UP; Vergeer 1928, 1927, pnp, minp, Portage Lake, 47.122586°N, 88.575281°W; 47.026583°N, 88.520103°W, Houghton County, UP.
*Lota lota*: Warthin 1912, cdnp, pnp, minp, Portage Lake, 47.122586°N, 88.575281°W; 47.026583°N, 88.520103°W, Houghton County, UP.
*Sander* spp.: Vergeer 1928, 1927, pnp, minp, Portage Lake, 47.122586°N, 88.575281°W; 47.026583°N, 88.520103°W, Houghton County, UP.

*Diphyllobothrium* sp.
Site of infection: Encysted around pyloric ceca
Host:
*Oncorhynchus tshawytscha* (adult): Muzzall 1993a, 1983, 70%, 5, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties; Muzzall and Peebles 1986; 1983, 1984; 80%, 12, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP, and Albany Creek, 45.970019°N, 84.076400°W, Chippewa County, UP.
*Oncorhynchus kisutch* (adult): Muzzall 1993a, 1983, 50%, 3, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties; Muzzall and Peebles 1986; 1983, 1984; 100%, 15, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP, and Huron River, 46.90365°N, 88.063317°W, Baraga County, UP, and Harlow Creek, 46.635762°N, 87.468470°W, Marquette County, UP.
*Oncorhynchus mykiss*: Pynnonen 1960, cdnp, pnp, minp, llnk, Marquette County, UP; (adult): Muzzall 1993a, 1983, 4%, 1, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties.
*Oncorhynchus gorbuscha* (adult): Muzzall and Peebles 1986; 1983, 1984; 83%, 7, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP, and Carp River, 46.536517°N, 87.646667°W, Marquette County, UP, and Harlow Creek, 46.635762°N, 87.468470°W, Marquette County, UP.
Remarks: *Oncorhynchus* spp. except for *O. mykiss* from Marquette County became infected in Lake Michigan, Lake Superior or Lake Huron.

*Ligula intestinalis* (Linnaeus, 1758) Gmelin, 1790
Synonym: None
Site of infection: Body cavity
Host:
*Rhinichthys cataractae*: Muzzall et al. 1992; 1983–1986; p varied from 3% to 7%, mi varied from 1.0 to 1.4 for three localities, Ford River; 46.104983°N, 87.808578°W, 46.129319°N, 87.889611°W, 46.127050°N, 87.974389°W; Dickinson County, UP.

TABLE 5. (continued)

*Ligula* sp.
Site of infection: [Body cavity]
Host:
*Ambloplites rupestris*: Cooper 1918, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan Lake, Cheboygan County.
*Catostomus commersonii*: Cooper 1918, cdnp, pnp, minp, Walnut Lake, 42.559942°N, 83.332397°W, Oakland County; Cooper 1918, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Perca flavescens*: Cooper 1918, cdnp, pnp, minp, Walnut Lake, 42.559942°N, 83.332397°W, Oakland County.
*Notropis bifrenatus*: Cooper 1918, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Notropis hudsonius*: Cooper 1918, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.

*Schistocephalus solidus* (Mueller, 1776)
Synonym: None
Site of infection : [Body cavity]
Host:
*Salvelinus fontinalis*: Pynnonen 1960, cdnp, pnp, minp, llnk, Marquette County, UP.

**Haplobothriidae Meggitt, 1924**
*Haplobothrium globuliforme* Cooper, 1914
Synonym: None
Site of infection: Body cavity
Host:
*Lepomis macrochirus*: Pracheil and Muzzall 2009; 2003, 2004; p and mi separated by host age and collection year, Three Lakes II, 42.349472°N, 85.432708°W, Kalamazoo County; Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Pracheil and Muzzall 2010; 2003, 2004; same infection data and information as in Pracheil and Muzzall 2009.

**Proteocephalidae LaRue, 1911**
*Proteocephalus ambloplitis* (Leidy, 1887) Benedict, 1900
Synonym: *Proteocephalus micropteri* (Leidy, 1891)
Site of infection: Liver, spleen, mesentery
Host:
*Lepomis macrochirus*: Wilson et al. 1996, 1987, p and mi were 83% and 15.3, and 98% and 20.5 in littoral and open water fish, respectively, Holcomb Lake, 42.505917°N, 85.434589°W, Barry County; Pracheil and Muzzall 2009; 2003, 2004; p and mi separated by host age and collection year, Three Lakes II, 43.349472°N, 84.426361°W, Kalamazoo County; Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Pracheil and Muzzall 2010; 2003, 2004; same infection data and information as in Pracheil and Muzzall 2009.
*Micropterus dolomieu*: Gillilland and Muzzall 2004; 2000, 2001; p and mi separated by infection site, Gull Lake, 42.394775°N, 85.361017°W, Barry and Kalamazoo Counties.

TABLE 5. (continued)

*Micropterus salmoides*: Esch and Huffines 1973; 1967, 1968; pnp, minp Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Gillilland and Muzzall 2004; 2000, 2001; p and mi separated by infection site, Gull Lake, 42.394775°N, 85.361017°W, Barry and Kalamazoo Counties; Elsayed and Faisal 2008, 2002; 88%; 17, Randall Lake, 41.973333°N, 85.031389°W, Branch County; 55%, 2, Orion Lake, 42.782222°N, 83.250278°W, Oakland County; 78%, 20, Independence Lake, 42.405833°N, 83.802778°W, Washtenaw County; 10%, 39, Devils Lake, 41.983511°N, 84.286944°W, Lenawee County; 90%, 4; Eagle Lake, 42.17°N, 85.975556°W, Cass County; 10%, 35, Jordan Lake, 42.77°N, 85.140833°W, Barry County; 10%, <1, Norvell Lake, 42.150833°N, 84.203333°W, Jackson County.

*Proteocephalus* spp.
Site of infection: Intestine, gonads, liver, mesentery, viscera
Host:
*Ambloplites rupestris*: Esch 1971, 1968–1969, pnp, minp, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Muzzall 1982, 1979–1981, 40%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Ameiurus natalis*: Muzzall 1982, 1979–1981, 20%, minp, Red Cedar River, 44.665922°N, 84.626153°W, Ingham County.
*Campostoma anomalum*: Muzzall 1982, 1979–1981, 50%, minp, Red Cedar River, 44.665922°N, 84.626153°W, Ingham County.
*Cottus bairdii*: Muzzall and Sweet 1986, 1982–1984, 2%, 1, Au Sable River, 44.665922°N, 84.626153°W, Crawford County.
*Lepomis cyanellus*: Muzzall 1982, 1979–1981, 10%, minp, Red Cedar River, 44.665922°N, 84.626153°W, Ingham County.
*Lepomis macrochirus*: Esch 1971, 1968–1969, pnp, minp, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; John Hnath 1997, personal communication, 100%, minp, Clear Lake, 42.3319°N, 84.1475°W, Jackson County; John Hnath 1997, personal communication, pnp, minp, Lake Mitchell, 44.544833°N, 85.480133°W, Wexford County; Muzzall and Peebles 1998, 1996, 15%, 2, <1*, Five Lakes, 45.041775°N, 84.714017°W, 20%; 2, <1*, North Porcupine Lake, 45.041775°N, 84.714017°W, Otsego County.
*Lepomis megalotis*: Muzzall and Peebles 1998; Five Lakes, 45.041775°N, 84.714017°W, North Porcupine Lake, 45.041775°N, 84.714017°W, Otsego County.
*Lepomis microlophus*: John Hnath, personal communication; 1997; 100%; minp; Clear Lake, 42.3319°N, 84.1475°W, Jackson County.
*Micropterus dolomieu*: Esch 1971, 1968–1969, pnp, minp, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Muzzall 1982, 1979–1981, 50%, minp, Red Cedar River, 44.665922°N, 84.626153°W, Ingham County.
*Micropterus salmoides*: Esch 1971, 1968–1969, pnp, minp, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Muzzall 1982, 1979–1981, 50%, minp, Red Cedar River, 44.665922°N, 84.626153°W, Ingham County.

TABLE 5. (continued)

*Micropterus* sp.: John Hnath 1997, personal communication, pnp, minp, Clear Lake, 42.3319°N, 84.1475°W, Jackson County.
*Nocomis biguttatus*: Muzzall 1982, 1979–1981, 23%, minp, Red Cedar River, 44.665922°N, 84.626153°W, Ingham County.
*Luxilus cornutus*: Muzzall 1982, 1979–1981, 23%, minp, Red Cedar River, 44.665922°N, 84.626153°W, Ingham County.
*Notropis rubellus*: Muzzall 1982, 1979–1981, 18%, minp, Red Cedar River, 44.665922°N, 84.626153°W, Ingham County.
*Notropis stramineus*: Muzzall 1982, 1979–1981, 20%, minp, Red Cedar River, 44.665922°N, 84.626153°W, Ingham County.
*Perca flavescens*: Muzzall 1982, 1979–1981, 75%, minp, Red Cedar River, 44.665922°N, 84.626153°W, Ingham County.
*Pimephales notatus*: Muzzall 1982, 1979–1981, 75%, minp, Red Cedar River, 44.665922°N, 84.626153°W, Ingham County.
*Pomoxis nigromaculatus*: Muzzall 1982, 1979–1981, 25%, minp, Red Cedar River, 44.665922°N, 84.626153°W, Ingham County.
*Rhinichthys cataractae*: Muzzall et al. 1992, 1983–1986, p varied from 2% to 6%, mi varied from 1.3 to 2.3 for three localities, Ford River; 46.104983°N, 87.808578°W, 46.129319°N, 87.889611°W, 46.127050°N, 87.974389°W; Dickinson County, UP
*Noturus gyrinus*: Muzzall and Pracheil 2007, 2005, 19%, 1, <1*, Silver Creek, 43.657186°N, 86.525117°W, Oceana County.
*Salmo trutta*: Muzzall 1984b, 1981–1982, 3%, minp, Fish Creek, 43.270656°N, 84.979558°W, Montcalm County; Muzzall 1986, 1982–1984, 1%, 1, Au Sable River, 44.665922°N, 84.626153°W, Crawford County.
*Salvelinus fontinalis*: Muzzall 1984b, 1981–1982, 8%, minp, Fish Creek, 43.270656°N, 84.979558°W, Montcalm County; Muzzall 1986, 1982–1984, 3%, 2, Au Sable River, 44.665922°N, 84.626153°W, Crawford County.
*Thymallus arcticus*: Muzzall 1990, 1987–1988, 3%, 1, Ackerman Lake, 46.331311°N, 86.797517°W, Alger County, UP.
*Oncorhynchus tshawytscha* (adult): Muzzall 1993a, 1983, 15%, 2, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties.
*Oncorhynchus kisutch* (adult): Muzzall 1993a, 1983, 83%, 29, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties.
*Oncorhynchus mykiss* (adult): Muzzall 1993a, 1983, 4%, 1, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties.
Remarks: It is not known if *Oncorhychus* spp. became infected in the Pere Marquette River or in Lake Michigan.

**Triaenophoridae Loennberg, 1889**
*Triaenophorus* sp.
Site of infection: Muscle

TABLE 5. (continued)

Host:
*Coregonus artedi*: Cooper 1918, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.

**Unknown Family**
Unidentified plerocercoid
Site of infection: muscle
Host:
*Sander vitreus*: Tompkins 1947, 1946, 5%, 14, Big Shag Lake, 46.2705172°N, 87.4995752°W, Marquette County, UP.

**Adult Nematoda (Nematodes)**

**Anisakidae Skrjabin and Karokhin, 1945**
Synonym: Heterocheilidae Railliet and Henry, 1905 (partim)

*Hysterothylacium brachyurum* Ward and Magath, 1917
Synonym: *Contracaecum brachyurum* Van Cleave and Mueller, 1934; *Thynnascaris brachyurum* Margolis and Arthur, 1979.
Site of infection: Stomach, anterior intestine
Host:
*Ambloplites rupestris*: Muzzall 1982, 1979–1981, 20%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

*Raphidascaris acus* (Bloch, 1779) Railliet and Henry, 1915
Synonym: *Ascaris lucii* Pearse, 1924; *Hysterothylacium cayugensis* Wigdor, 1918; *Raphidascaris canadense* Smedley, 1933; *Raphidascaris cayugensis* (Wigdor, 1918) Yorke and Maplestone, 1926; *Raphidascaris laurentianus* Richardson, 1937; *Raphidascaris alius* Lyster, 1940, according to J. D. Smith (1984)
Site of infection: Intestine
Host:
*Lota lota*: Muzzall et al. 1987; 1983, 1984; 41%, 7, Ford River, 46.104983°N, 87.808578°W; 46.129319°N, 87.889611°W; 46.127050°N, 87.974389°W, Dickinson County, UP.

**Camallanidae Railliet and Henry, 1913**
*Camallanus oxycephalus* Ward and Magath, 1917
Synonym: None
Site of infection: Posterior intestine
Host:
*Lepomis macrochrius*: Wilson et al. 1996, 1987, p and mi were 10% and 1.8 in littoral zone fish, Holcomb Lake, 42.505917°N, 85.434589°W, Barry County
*Pomoxis nigromaculatus*: Muzzall 1982, 1979–1981, 75%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

TABLE 5. (continued)

*Camallanus* sp.
Site of infection: [Intestine]
Host:
*Lepomis gibbosus*: Esch 1971, 1968–1969, pnp, minp, Wintergreen Lake, 42.397370°N, 85.384503°W, Kalamazoo County.
*Lepomis* sp. hybrid: Esch 1971, 1968–1969, pnp, minp, Duck Lake, 42.198908°N, 85.719344°W, Kalamazoo County.
*Micropterus salmoides*: Esch 1971, 1968–1969, pnp, minp, Wintergreen Lake, 42.397370°N, 85.384503°W, Kalamazoo County.

**Capillariidae Neuve-Lemaire, 1936**
*Capillaria salvelini* Polyanskii, 1952
Synonym: *Capillaria baicalensis* Ryzhikov and Sudarikov, 1953; *Capillaria coregoni* Shulman-Albova 1953; *Capillaria curilica* Zhukov, 1960; *Capillaria brevispicula* sensu Moravec and Ergens, 1970, nec Linstow, 1873; *Capillaria bakeri* sensu Meyer, 1954, nec Mueller and Van Cleave, 1932
Site of infection: Pyloric ceca
Host:
*Oncorhynchus tshawytscha* (adult): Muzzall and Peebles 1986; 1983, 1984; 40%, 6, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP, and Albany Creek, 45.970019°N, 84.076400°W, Chippewa County, UP; Muzzall 1993a, 1983, 23%, 6, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties
*Oncorhynchus gorbucha* (adult): Muzzall and Peebles 1986; 1983, 1984; 3%, 1, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP, and Carp River, 46.536517°N, 87.646667°W, Marquette County, UP.
*Oncorhynchus kisutch* (adult): Muzzall and Peebles 1986; 1983, 1984; 25%, 2, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP, and Harlow Creek, 46.635762°N, 87.468470°W, Marquette County, UP.
Remarks: *Oncorhynchus* spp. became infected in Lake Michigan, Lake Superior or Lake Huron.

**Cystidicolidae (as in Anderson et al. 1975)**
*Cystidicola farionis* Fischer, 1798
Synonym: *Cystidicola canadensis* Skinker, 1939; *Cystidicola stigmatura* of Skinker (1931) *not* (Leidy, 1886); *Cystidicola stigmatura* of Ko and Anderson 1969 *not* (Leidy, 1886)
Site of infection: Swim bladder
Host:
*Oncorhynchus mykiss* (adult): Muzzall 1993a, 1983, 3%, 1, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties.
*Oncorhynchus gorbuscha* (adult): Muzzall and Peebles 1986; 1983, 1984; 92%, 89, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP, and Huron River, 46.90365°N, 88.063317°W, Baraga County, UP, and Carp River, 46.536517°N, 87.646667°W, Marquette County, UP, and Harlow Creek, 46.635762°N, 87.468470°W,

TABLE 5. (continued)

Marquette County, UP, and Albany Creek, 45.970019°N, 84.076400°W, Chippewa County, UP.

*Oncorhynchus kisutch* (adult): Muzzall and Peebles 1986; 1983, 1984; 100%, 208, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP, and Huron River, 46.90365°N, 88.063317°W, Baraga County, UP, and Harlow Creek, 46.635762°N, 87.468470°W, Marquette County, UP.

*Oncorhynchus tshawytscha* (adult): Muzzall and Peebles 1986; 1983, 1984; 40%, 453, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP, and Albany Creek, 45.970019°N, 84.076400°W, Chippewa County, UP.

Remarks: All *Oncorhynchus* spp. became infected in Lake Michigan, Lake Superior or Lake Huron.

S*terliadochona ephemeridarum* (Linstow, 1872)
Synonym: *Filaria ephemeridarum* Leidy, 1872; *Cystidicoloides tenuissima* (Zeder, 1800) Rasheed, 1965; *Cystidicoloides harwoodi* Chandler, 1931; *Metabronema canadense* Skinker, 1931; *Metabronema salvelini* Fujita, 1920; *Cystidicoloides ephemeridarum* (Linstow, 1872) Moravec, 1981
Site of infection: Stomach
Host:

*Salmo trutta*: Muzzall 1986, 1982–1984, 61%, 18, Au Sable River, 44.665922°N, 84.626153°W, Crawford County.

*Salvelinus fontinalis*: Muzzall 1984, personal observation, 1984, pnp, minp, Ford River, 46.104983°N, 87.808578°W, Dickinson County, UP; Muzzall 1986, 1982–1984, 73%, 16, Au Sable River, 44.665922°N, 84.626153°W, Crawford County; Muzzall 2007, 2003–2005, p and mi separated by several variables, Hunt Creek, 44.889397°N, 84.120756°W, Montmorency County.

*Oncorhynchus gorbuscha* (adult): Muzzall and Peebles 1986; 1983, 1984; 1%, 6, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP.

*Oncorhynchus kisutch* (adult): Muzzall and Peebles 1986; 1983, 1984; 38%, 16, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP, and Harlow Creek, 46.635762°N, 87.468470°W, Marquette County, UP.

Remarks: *Oncorhynchus gorbuscha* and *Oncorhynchus kisutch* likely became infected in the river.

*Spinitectus carolini* Holl, 1928
Synonym: None
Site of infection: Intestine
Host:

*Ambloplites rupestris*: Muzzall 1982, 1979–1981, 33%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

*Micropterus salmoides*: Muzzall 1982, 1979–1981, 10%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

TABLE 5. (continued)

*Spinitectus gracilis* Ward and Magath, 1917
Synonym: None
Site of infection: Esophagus, stomach, intestine
Host:
*Acipenser fulvescens*: Baker 1980, 1979, 100%, 23, Saginaw River, 43.467683ºN, 83.910564ºW; Saginaw County.
*Salvelinus fontinalis*: Muzzall 1986, 1982–1984, 12%, 9, Au Sable River, 44.665922°N, 84.626153°W, Crawford County.
S*almo trutta*: Muzzall 1986, 1982–1984, 30%, 6, Au Sable River, 44.665922°N, 84.626153°W, Crawford County.
*Oncorhynchus gorbuscha* (adult): Muzzall and Peebles 1986; 1983, 1984; 1%, 3, Harlow Creek, 46.635762°N, 87.468470°W, Marquette County, UP.
*Oncorhynchus kisutch* (adult): Muzzall and Peebles 1986; 1983, 1984; 63%, 5, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP, and Huron River, 46.90365°N, 88.063317°W, Baraga County, UP, and Harlow Creek, 46.635762°N, 87.468470°W, Marquette County, UP.
*Oncorhynchus tshawytscha* (adult): Muzzall and Peebles 1986; 1983, 1984; 20%, 21, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP; (parr): Muzzall 1993a, 1983, p varied from 6–18%, mi varied from 2–6 by location, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason County.
*Cottus bairdii*: Muzzall and Sweet 1986, 1982–1984, 8%, 3, Au Sable River, 44.665922°N, 84.626153°W, Crawford County.
*Lepomis macrochirus*: Pracheil and Muzzall 2009; 2003, 2004; p and ma separated by host age and collection year, Three Lakes II, 42.349472°N, 85.432708°W, Kalamazoo County; Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Pracheil and Muzzall 2010; 2003, 2004; same infection data and information as in Pracheil and Muzzall 2009.
Remarks: It is likely *Oncorhynchus gorbuscha* became infected in Harlow Creek (tributary of Lake Superior), *Oncorhynchus kisutc*h became infected in the Laughing Whitefish River, Huron River and Harlow Creek (tributaries of Lake Superior); and *Oncorhynchus tshawytscha* became infected in the Laughing Whitefish River (tributary of Lake Superior).

*Spinitectus micracanthus* Christian, 1972
Synonym: None
Site of infection: Anterior intestine
Host:
*Lepomis cyanellus*: Muzzall 1982, 1979–1981, 18%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Lepomis gulosus*: Muzzall 1982, 1979–1981, 100%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Lepomis macrochirus*: Muzzall 1982, 1979–1981, 50%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County; Muzzall and Peebles 1998, 1996, 88%, 8, 7*, Five Lakes,

TABLE 5. (continued)

45.041775°N, 84.714017°W, 100%; 11; 11*, North Porcupine Lake, 45.041775°N, 84.714017°W, Otsego County.
*Micropterus dolomieu*: Muzzall 1982, 1979–1981, 80%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Micropterus salmoides*: Muzzall 1982, 1979–1981, 50%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

*Spinitectus* sp.
Site of infection: Intestine
Host:
*Ambloplites rupestris*: Esch 1971, 1968–1969, 73%, minp, Gull Lake, 42.39475°N, 85.361017°W, Kalamazoo County.
*Lepomis macrochirus*: Esch 1971, 1968–1969, 69%, minp, Gull Lake, 42.39475°N, 85.361017°W, Kalamazoo County.
*Lepomis gibbosus*: Esch 1971, 1968–1969, 16%, minp, Gull Lake, 42.39475°N, 85.361017°W, Kalamazoo County.
*Lepomis* sp. hybrid: Esch 1971, 1968–1969, 9%, minp, Gull Lake, 42.39475°N, 85.361017°W, Kalamazoo County.
*Micropterus dolomieu*: Esch 1971, 1968–1969, 10%, minp, Gull Lake, 42.39475°N, 85.361017°W, Kalamazoo County.
*Micropterus salmoides*: Esch 1971, 1968–1969, pnp, minp, Gull Lake, 42.39475°N, 85.361017°W, Kalamazoo County; Esch 1971, 1968–1969, 19%, minp, Wintergreen Lake, 42.397370°N, 85.384503°W, Kalamazoo County.

**Philometridae Baylis and Daubney, 1926**
*Philometroides nodulosa* (Thomas, 1939) Dailey, 1967
Synonym: *Philometra nodulosa* (Thomas, 1929) Dailey, 1967
Site of infection: Upper lip
Host:
*Catostomus commersonii*: Thomas 1929, 1927, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.

**Quimperidae Baylis, 1930**
Synonym: Haplonematidae Sudarikov and Ryzhikov, 1952
*Haplonema hamulatum* Moulton, 1931
Synonym: None
Site of infection: Intestine
Host:
*Lota lota*: Muzzall et al. 1987; 1983, 1984; 27%, 9, Ford River, 46.104983°N, 87.808578°W; 46.129319°N, 87.889611°W; 46.127050°N, 87.974389°W; Dickinson County, UP.

**Rhabdochonidae Skrjabin, 1946**
*Rhabdochona canadensis* Moravec and Arai, 1971

TABLE 5. (continued)

Synonym: None
Site of infection: Intestine
Host:
*Rhinichthys cataractae*: Muzzall et al. 1992, 1983–1986, p varied from 14% to 49%, mi varied from 2.4 to 4.0 for three localities, Ford River; 46.104983°N, 87.808578°W; 46.129319°N, 87.889611°W; 46.127050°N, 87.974389°W; Dickinson County, UP.
*Salvelinus fontinalis*: Muzzall 1986, 1982–1984, 1%, 1, Au Sable River, 44.665922°N, 84.626153°W, Crawford County.
*Salmo trutta*: Muzzall 1986, 1982–1984, 2%, 12, Au Sable River, 44.665922°N, 84.626153°W, Crawford County.
*Oncorhynchus gorbuscha* (adult): Muzzall and Peebles 1986; 1983, 1984; 3%, 2 Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP, and Carp River, 46.536517°N, 87.646667°W, Marquette County, UP, and Harlow Creek, 46.635762°N, 87.468470°W, Marquette County, UP.
*Oncorhynchus kisutch* (adult): Muzzall and Peebles 1986; 1983, 1984; 13%, 2, Harlow Creek, 46.635762°N, 87.468470°W, Marquette County, UP.
Remarks: It is likely *Oncorhynchus gorbuscha* became infected in the Laughing Whitefish River, Carp River, and Harlow Creek (tributaries of Lake Superior); and *Oncorhynchus kisutch* became infected in Harlow Creek (tributary of Lake Superior).

*Rhabdochona cascadilla* Wigdor, 1918
Synonym: *Rhabdochona pellucida* Gustafson, 1949, *Rhabdochona* sp. of Bangham, 1941 (partim) and of Bangham and Venard, 1946 (partim)
Site of infection: Intestine
Host:
*Nocomis biguttatus*: Muzzall 1982, 1979–1981, 3%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Luxilus cornutus*: Muzzall 1982, 1979–1981, 64%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

*Rhabdochona cotti* Gustafson, 1949
Synonym: None
Site of infection: Intestine
Host:
*Cottus bairdii*: Muzzall and Sweet 1986, 1982–1984, 21%, 4, Au Sable River, 44.665922°N, 84.626153°W, Crawford County.
*Cottus bairdii*: Muzzall and Whelan 1995, 1983–1986, p varied from 12% to 37%, mi varied from 1.3 to 2.0 for three localities, Ford River, 46.104983°N, 87.808578°W; 46.129319°N, 87.889611°W; 46.127050°N, 87.974389°W; Dickinson County, UP.

TABLE 5. (continued)

## Larval/Immature Nematoda (Nematodes)

**Anisakidae Skrjabin and Karokhin, 1945**
Synonym Heterocheilidae, in part
*Contracaecum* sp.
Site of infection: Intestine
Host:
*Lepomis macrochirus*: Muzzall and Peebles 1998, 1996, 3%, 1, <1*, Five Lakes, 45.041775°N, 84.714017°W, Otsego County.

*Raphidascaris acus* (Bloch, 1779) Railliet and Henry, 1915
Synonym: *Ascaris lucii* Pearse, 1924; *Hysterothylacium cayugensis* Wigdor, 1918; *Raphidascaris canadense* Smedley, 1933; *Raphidascaris cayugensis* (Wigdor, 1918) Yorke and Maplestone, 1926; *Raphidascaris laurentianus* Richardson, 1937; *Raphidascaris alius* Lyster, 1940, according to J. D. Smith (1984)
Site of infection: Intestine, liver
Host:
*Rhinichthys cataractae*: Muzzall et al. 1992, 1983–1986, p varied from 0.2% to 1%, mi varied from 1.0 to 2.0 for three localities, Ford River, 46.104983°N, 87.808578°W; 46.129319°N, 87.889611°W; 46.127050°N, 87.974389°W; Dickinson County, UP.

**Camallanidae Railliet and Henry, 1913**
*Camallanus oxycephalus* Ward and Magath, 1917
Synonym: None
Site of infection: Rectum
Host:
*Nocomis biguttatus*: Muzzall 1982, 1979–1981, 3%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Semotilus atromaculatus*: Muzzall 1982, 1979–1981, 5%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

*Camallanus* sp.
Site of infection: Posterior intestine
Host:
*Lepomis macrochirus*: Pracheil and Muzzall 2009; 2003, 2004; p and ma separated by host age and collection year, Three Lakes II, 42.349472°N, 85.432708°W, Kalamazoo County; Pracheil and Muzzall 2010; 2003, 2004; same infection data and information as in Pracheil and Muzzall 2009.

**Capillariidae Neuve-Lemaire, 1936**
*Capillaria* sp.
Site of infection: Stomach

TABLE 5. (continued)

Host:
*Lepomis macrochirus*: Wilson et al. 1996, 1987, p and mi were 2% and 1.8 in littoral fish, Holcomb Lake, 42.505917°N, 85.434589°W, Barry County.

**Cucullanidae Cobbold, 1864**
*Truttaedacnitis clitellarius* (Ward and Magath, 1916) Petter, 1974
Synonym: *Cucullanus clitellarius* Ward and Magath 1916
Site of infection: Esophagus
Host:
*Acipenser fulvescens*: Baker 1980, 1979, 100%, 1, Saginaw River, 43.467683ºN, 83.910564ºW; Saginaw County.
Remarks: Baker (1980) misspelled *clitellarius* as *chitellarius*.

*Truttaedacnitis* sp.
Site of infection: Intestine
Host:
*Salvelinus fontinalis*: Muzzall 1984b,1981–1982, 100%, minp, Pine River, 43.372081°N, 84.835858°W, Gratiot County.
*Salmo trutta*: Muzzall 1986, 1982–1984, 1%, 1, Au Sable River, 44.665922°N, 84.626153°W, Crawford County.

**Cystidicolidae (as in Anderson et al. 1975)**
*Sterliadochona ephemeridarum* (Linstow, 1872) Moravec, 1981
Synonym: *Filaria ephemeridarum* Leidy, 1872; *Cystidicoloides tenuissima* (Zeder, 1800) Rasheed, 1965; *Cystidicoloides harwoodi* Chandler, 1931; *Metabronema canadense* Skinker, 1931; *Metabronema salvelini* Fujita, 1920; *Cystidicoloides ephemeridarum* (Linstow, 1872) Moravec, 1981
Site of infection: Stomach
Host:
*Cottus bairdii*: Muzzall and Sweet 1986, 1982–1984, 1%, 1, Au Sable River, 44.665922°N, 84.626153°W, Crawford County.
*Lota lota*: Muzzall et al. 1987; 1983, 1984; 6%, 6, Ford River, 46.104983°N, 87.808578°W; 46.129319°N, 87.889611°W; 46.127050°N, 87.974389°W, Dickinson County, UP.
*Rhinichthys cataractae*; Muzzall et al. 1992, 1983–1986, 2%, 1.6, Ford River, 46.104983°N, 87.808578°W, Dickinson County, UP.
*Thymallus arcticus*: Muzzall 1990, 1987–1988, 100%, 4, Au Sable River, 44.665922°N, 84.626153°W, Crawford County.

*Spinitectus* sp.
Site of infection: Mesentery
Host:
*Lepomis macrochirus*: Wilson et al. 1996, 1987, p and mi were 7% and 1.0, and 2% and 1.0 in littoral zone and open water fish, respectively, Holcomb Lake, 42.505917°N, 85.434589°W, Barry County.

TABLE 5. (continued)

**Gnathostomatidae Lane, 1923**
*Spiroxys* sp.
Site of infection: In/on stomach wall, mesentery
Host:
*Lepomis macrochirus*: Wilson et al. 1996; 1987 p and mi were 2% and 1.0 in littoral zone fish, Holcomb Lake, 42.505917°N, 85.434589°W, Barry County; Muzzall and Peebles 1998, 1996, 38%, 11, 4* Five Lakes, 45.041775°N, 84.714017°W, 87%; 3, 3*, North Porcupine Lake, 45.041775°N, 84.714017°W, Otsego County; Pracheil and Muzzall 2009; 2003, 2004; p and ma separated by host age and collection year, Three Lakes II, 42.349472°N, 85.432708°W, Kalamazoo County; Pracheil and Muzzall 2010; 2003, 2004; same infection data and information as in Pracheil and Muzzall 2009.
*Ameiurus nebulosus*: Hedrick 1935, cdnp, pnp, minp, pools adjacent to Elk Lake – estimated location, 44.908778°N, 85.352764°W, Antrim and Grand Traverse Counties
*Ameiurus* sp.: Hedrick 1935, cdnp, pnp, minp, Fife Lake, 44.566461°N, 85.344808°W, Grand Traverse County.
*Noturus gyrinus*: Muzzall and Pracheil 2007, 2005, 1%, 1, <1*, Silver Creek, 43.657186°N, 86.525117°W, Oceana County.
*Thymallus arcticus*: Muzzall 1990, 1987–1988, 5%, 2, Ackerman Lake,46.331311°N, 86.797517°W, Alger County, UP; Muzzall 1990, 1987–1988, 32%, 1, Deer Lake, 46.606006°N, 85.674211°W, Luce County, UP; Muzzall 1990, 1987–1988, 8%, 2, Sid Lake, 46.604772°N, 85.680092°W, Luce County, UP.
*Umbra limi*: Hedrick 1935, cdnp, pnp, minp, Fontinalis Run, 45.519725°N, 84.638461°W, Cheboygan County; cdnp, pnp, minp, pools adjacent to Elk Lake – estimated location, 44.908778°N, 85.352764°W, Antrim and Grand Traverse Counties; Hedrick 1935, cdnp, pnp, minp, Mill Race near Ann Arbor, 42.290725°N, 83.743669°W, Hillsdale County; Hedrick 1935, cdnp, pnp, minp, pool near village of Platt – location unknown, Washtenaw County.

**Quimperidae Baylis, 1930**
Synonym: Haplonematidae Sudarikov and Ryzhikov, 1952
*Haplonema hamulatum* Moulton, 1931
Synonym: None
Site of infection: Intestine, liver
Host:
*Rhinichthys cataractae*: Muzzall et al. 1992, 1983–1986, p varied from 7% to 12%, mi varied from 1.7 to 3.2 for three localities, Ford River; 46.104983°N, 87.808578°W; 46.129319°N, 87.889611°W; 46.127050°N, 87.974389°W; Dickinson County, UP.
*Oncorhynchus tshawytscha* (adult): Muzzall 1993a, 1983, 3%, 1, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties.
Remarks: *Oncorhynchus tshawytscha* likely became infected in Lake Michigan.

TABLE 5. (continued)

*Haplonema* sp.
Site of infection: Anterior intestine
Host:
*Oncorhynchus kisutch* (adult): Muzzall and Peebles 1986; 1983, 1984; 25%, 1, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP, and Harlow Creek, 46.635762°N, 87.468470°W, Marquette County, UP.
*Oncorhynchus tshawytscha* (adult): Muzzall and Peebles 1986; 1983, 1984; 20%, 3, Albany Creek, 45.970019°N, 84.076400°W, Chippewa County, UP.
Remarks: It is likely *Oncorhynchus kisutch* became infected in Lake Superior and *Oncorhynchus tshawytscha* became infected in Lake Huron.

**Rhabdochonidae Skrjabin, 1946**
*Rhabdochona* sp.
Site of infection: Intestine
Host:
*Campostoma anomalum*: Muzzall 1982, 1979–1981, 50%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Moxostoma anisurum*: Muzzall 1982, 1979–1981, 25%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Notropis rubellus*: Muzzall 1982, 1979–1981, 18%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Notropis stramineus*: Muzzall 1982, 1979–1981, 7%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Pimephales notatus*: Muzzall 1982, 1979–1981, 3%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Rhinichthys obtusus*: Muzzall 1982, 1979–1981, 14%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Salvelinus fontinalis*: Muzzall 1984b, 1981–1982, 4%, minp, Fish Creek, 43.270656°N, 84.979558°W, Montcalm County.

**Unknown Family**
Unidentified nematode larva
Site of infection: Not provided
Host:
*Ameiurus melas*: Taylor 1964; 1963, 1964; 6%, minp, Muehrcke Lake, 46.259787°N, 87.473224°W, Marquette County, UP.

TABLE 5. (continued)

**Adult Acanthocephala (Acanthocephalans)**

**Echinorhynchidae Cobbold, 1876**

*Acanthocephalus dirus* (Van Cleave, 1931) Van Cleave and Townsend, 1936
Synonym: *Echinorhynchus dirus* Van Cleave, 1931; *Acanthocephalus jacksoni* Bullock, 1962; *Acanthocephalus dirus* Amin, 1975.
Site of infection: Intestine
Host:

*Oncorhynchus mykiss*: Muzzall 1993a, 1983, 2%, 3, Lichte Creek, 43.915519°N, 86.366633°W, Mason County; Muzzall 1984b, 1981–1982, 96%, minp, Rogue River, 43.146439°N, 85.564503°W, Kent County; Muzzall 1993a, 1983, 2%, 3, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties.

*Oncorhynchus tshawytscha* (parr): Muzzall 1993a, p varied from 51–55%, mi varied from 3–5, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties.

*Salmo trutta*: Muzzall 1984b, 1981–1982, 64%, minp, Rogue River, 43.146439°N, 85.564503°W, Kent County.

*Salvelinus fontinalis*: Muzzall 2007, 2003–2005, p and mi separated by several variables, Hunt Creek, 44.889397°N, 84.120756°W, Montmorency County.

*Echinorhynchus salmonis* (Muller, 1784) Petrochenko, 1956
Synonym: *Echinorhynchus coregoni* Linkins in Van Cleave, 1919; *Echinorhynchus pachysomus*, *Echinorhynchus phoenix*, *Echinorhynchus inflatus*, *Echinorhynchus maraenae*, *Echinorhynchus murenae*, *Metechinorhynchus alpinus*, *Metechinorhynchus salmonis* (Muller, 1784) Petrochenko, 1956
Site of infection: Intestine
Host:

*Oncorhynchus gorbuscha* (adult): Muzzall and Peebles 1986; 1983, 1984; 98%, 41, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP, and Huron River, 46.90365°N, 88.063317°W, Baraga County, UP, and Carp River, 46.536517°N, 87.646667°W, Marquette County, UP, and Harlow Creek, 46.635762°N, 87.468470°W, Marquette County, UP, and Albany Creek, 45.970019°W, 84.076400°W, Chippewa County, UP.

*Oncorhynchus kisutch* (adult): Muzzall and Peebles 1986; 1983, 1984; 100%, 301, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP, and Harlow Creek, 46.635762°N, 87.468470°W, Marquette County, UP, and Huron River, 46.90365°N, 88.063317°W, Baraga County, UP; (adult): Muzzall 1993a, 1983, 100%, 91, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties

*Oncorhynchus tshawytscha* (adult): Muzzall and Peebles 1986; 1983, 1984; 100%, 343, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP, and Albany Creek, 45.970019°W, 84.076400°W, Chippewa County, UP; (adult): Muzzall 1993a, 1983, 100%, 303, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties.

TABLE 5. (continued)

*Oncorhynchus mykiss* (adult): Muzzall 1993a, 1983, 96%, 28, Pere Marquette River, 43.930856°N, 86.039375°W, Lake and Mason Counties.
Remarks: *Oncorhynchus* spp. became infected in Lake Michigan, Lake Superior, or Lake Huron.

**Fessisentidae Van Cleave, 1931**
*Fessisentis tichiganensis* Amin, 1980
Synonym: None
Site of infection: Intestine
Host:
*Umbra limi*: Muzzall 1984a; 1979–1982; 7%, 2, Looking Glass River, 42.856422°N, 84.344131°W, Shiawassee County.

**Neoechinorhynchidae Ward, 1917**
Synonym: Hebesomidae Van Cleave, 1928; Hebesomatidae Yamaguti, 1963

*Neoechinorhynchus crassus* Van Cleave, 1919
Synonym: None
Site of infection: Intestine
Host:
*Catostomus commersonii*: Van Cleave 1919, 1912, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
Remarks: Some of the information in Van Cleave (1919) is difficult to interpret if the acanthocephalan species infecting Douglas Lake fish were gravid or not.

*Neoechinorhynchus cristatus* Lynch, 1936
Synonym: *Neoechinorhynchus venustus* Lynch, 1936
Site of infection: Middle and posterior intestine
Host:
*Catostomus commersonii*: Muzzall 1982, 1979–1981, 50%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

*Neoechinorhynchus cylindratus* (Van Cleave, 1913) Van Cleave, 1919
Synonym: *Neorchynchus cylindratus* Van Cleave, 1913; *Eorhynchus cylindratus* (Van Cleave, 1913) Van Cleave, 1914.
Site of infection: Intestine
Host:
*Micropterus dolomieu*: Esch et al. 1975; 1967, 1968, 1972, 1973; pnp, minp, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Muzzall and Gillilland 2004, 2000–2001, p and min separated by yrs; Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.
*Micropterus salmoides*: Muzzall 1982, 1979–1981, 50%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County; Muzzall and Gillilland 2004, 2000–2001, p and mi separated by yrs, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.

TABLE 5. (continued)

*Neoechinorhynchus limi* Muzzall and Buckner, 1982
Synonym: None
Site of infection: Intestine
Host:
*Umbra limi*: Muzzall and Buckner 1982, 1979–1981, 17%, 4, Looking Glass River, 42.856422°N, 84.344131°W, Shiawassee County; Muzzall 1984a, 1979–1982, 17%, 4, Looking Glass River, 42.856422°N, 84.344131°W, Shiawassee County.

*Neoechinorhynchus pungitius* Dechtiar, 1971
Synonym: None
Site of infection: Intestine
Host:
*Lota lota*: Muzzall et al. 1987; 1983, 1984; 12%, 5, Ford River; 46.104983°N, 87.808578°W; 46.129319°N, 87.889611°W; 46.127050°N, 87.974389°W; Dickinson County, UP.

*Neoechinorhynchus saginatus* Van Cleave and Bangham, 1949
Synonym: None
Site of infection: Intestine
Host:
*Rhinichthys cataractae*: Muzzall et al. 1992, 1983–1986, 1%, 1, Ford River; 46.129319°N, 87.889611°W; Dickinson County, UP.
*Semotilus atromaculatus*: Muzzall 1982, 1979–1981, 3%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

*Neoechinorhynchus* sp.
Site of infection: Intestine
Host:
*Micropterus dolomieu*: Esch 1971, 1968–1969, 30%, minp, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.
*Micropterus salmoides*: Esch 1971, 1968–1969, pnp, minp, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Esch 1971, 1968–1969, 88%, minp, Wintergreen Lake, 42.397370°N, 85.384503°W, Kalamazoo County; Elsayed and Faisal 2008, 2002, 25%, 2, Randall Lake, 41.973333°N, 85.031389°W, Branch County; 55%, 13, Orion Lake, 42.782222°N, 83.250278°W, Oakland County; 33%, 4, Independence Lake, 42.405833°N, 83.802778°W, Washtenaw County; 27%, 1, Devils Lake, 41.983611°N, 84.286944°W, Lenawee County; 90%, 9, Eagle Lake, 42.17°N, 85.975556°W, Cass County; 70%, 9, Jordan Lake, 42.77°N, 85.140833°W, Barry County; 60%, 2, Norvell Lake, 42.150833°N, 84.203333°W, Jackson County.

*Octospinifer macilentus* Van Cleave, 1919
Synonym: *Octospinifer* sp. *sensu* Arai and Mudry, 1973; *Octospinifer* sp. *sensu* Mudry and Anderson, 1976.
Site of infection: Intestine

TABLE 5. (continued)

Host:
*Catostomus commersonii*: Van Cleave 1919, 1912, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.

*Paulisentis missouriensis* Keppner, 1974
Synonym: none.
Site of infection: Intestine
Host:
*Semotilus atromaculatus*: Muzzall 1982, 1979–1981, 37%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

**Pomphorhynchidae Yamaguti, 1939**
*Pomphorhynchus bulbocolli* Linkins in Van Cleave, 1919
Synonym: None
Site of infection: Pyloric ceca, intestine
Host:
*Catostomus commersonii*: Van Cleave 1919, 1912, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; Muzzall 1982, 1979–1981, 50%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Hypentelium nigricans*: Muzzall 1982, 1979–1981, 11%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Ambloplites rupestris*: Van Cleave 1919, 1912, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; Muzzall 1982, 1979–1981, 33%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Lepomis macrochirus*: Esch et al. 1976, 1973–1974, p and mi varied depending on experimental protocol, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Pracheil and Muzzall
2009; 2003, 2004; p and ma separated by host age and collection year, Three Lakes II, 42.349472°N, 85.432708°W, Kalamazoo County; Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Pracheil and Muzzall 2010; 2003, 2004; same infection data and information as in Pracheil and Muzzall 2009.
*Micropterus dolomieu*: Van Cleave 1919, 1912, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Percina caprodes*: Van Cleave 1919, 1912, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Oncorhynchus mykiss*: Muzzall 1984b, 1981–1982, 100%, minp, Pine River, 43.372081°N, 84.835858°W, Gratiot County; Muzzall 1984b, 1981–1982, 5%, minp, Rogue River, 43.146439°N, 85.564503°W, Kent County.
*Salmo trutta*: Muzzall 1984b, 1981–1982, 25%, minp, Pine River, 43.372081°N, 84.835858°W, Gratiot County.
*Thymallus arcticus*: Muzzall 1990; 1987, 1988; 73%, 4, Kneff Lake 44.635486°N, 84.576625°W, Crawford County.

TABLE 5. (continued)

*Nocomis biguttatus*: Muzzall 1982, 1979–1981, 10%, minp Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
Remarks: It is not known if the specimens of *Pomphorhynchus bulbocolli* found in *Percina caprodes* by Van Cleave (1919) were gravid.

*Pomphorhynchus* sp.
Site of infection: [pyloric ceca, intestine]
Host:
*Amblolites rupestris*: Esch 1971, 1968–1969, 18%, minp, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.
*Lepomis macrochirus*: Esch 1971, 1968–1969, 61%, minp, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.

**Rhadinorhynchidae Travassos, 1923**
*Leptorhynchoides thecatus* (Linton, 1891) Kostylew, 1924
Synonym: *Echinorhynchus thecatus* Linton, 1891; *Echinorhynchus oricola* Linstow, 1901
Site of infection: Pyloric ceca, anterior intestine, stomach
Host:
*Catostomus commersonii*: Van Cleave 1919, 1912, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Ambloplites rupestris*: Van Cleave 1919, 1912, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; Muzzall 1982, 1979–1981, 20%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Lepomis cyanellus*: Muzzall 1982, 1979–1981, 20%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Lepomis gulosus*: Muzzall 1982, 1979–1981, 100%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Lepomis macrochirus*: Esch et al. 1976, 1973–1974, p and mi varied depending on experimental protocol, Gull Lake; 42.394775°N, 85.361017°W, Kalamazoo County;
Muzzall and Peebles 1998, 1996, 35%, 9, 4*, Five Lakes, 45.041775°N, 84.714017°N, 87%; 3, 3*, North Porcupine Lake, 45.041775°N, 84.714017°W, Otsego County.
*Micropterus dolomieu*, Van Cleave 1919, 1912, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; Esch et al. 1975; 1967, 1968, 1972, 1973; pnp, minp Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Esch and Huffines 1973; 1967, 1968; pnp, minp, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Muzzall 1982, 1979–1981, 10%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County; Muzzall and Gillilland III, 2004, 2000–2001, p and mi separated by yr, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Steinauer 2004, cdnp, pnp, minp Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Steinauer et al. 2006, cdnp, pnp, minp, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Steinauer et al. 2007, cdnp, pnp, minp, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.

TABLE 5. (continued)

*Micropterus salmoides*: Van Cleave 1919, 1912, cdnp, pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County; Muzzall and Gillilland III 2004, 2000–2001, p and mi separated by yr, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.
*Perca flavescens*: Pynnonen 1960, cdnp, pnp, minp, llnk, Marquette County, UP.

*Leptorhynchoides* sp.
Site of infection: Not provided
Host:
*Ambloplites rupestris*: Esch 1971, 1968–1969, 73%, minp, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.
*Lepomis macrochirus*: Esch 1971, 1968–1969, 24%, minp, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.
*Micropterus dolomieu*: Esch 1971, 1968–1969, 92%, minp, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.
*Micropterus salmoides*: Esch 1971, 1968–1969, pnp, minp, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Elsayed and Faisal 2008, 2002, 38%, 6, Randall Lake, 41.973333°N, 85.031389°W, Branch County; 55%, 1, Orion Lake, 42.782222°N, 83.250278°W, Oakland County; 22%, 1, Independence Lake, 42.405833°N, 83.802778°W, Washtenaw County; 82%, 11, Devils Lake, 41.983611°N, 84.286944°W, Lenawee County, ; 40%, 1, Jordan Lake, 42.77°N, 85.140833°W, Barry County.

## Immature Acanthocephala (Acanthocephalans)

### Echinorhynchidae Cobbold, 1876

*Echinorhynchus* sp.
Host:
*Oncorhynchus gorbuscha* (adult): Muzzall and Peebles 1986; 1983, 1984; 1%, 1, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP.
*Oncorhynchus kisutch* (adult): Muzzall and Peebles 1986; 1983, 1984; 63%, 8, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP, and Huron River, 46.90365°N, 88.063317°W, Baraga County, UP.
*Oncorhynchus tshawytscha* (adult): Muzzall and Peebles 1986; 1983, 1984; 80%, 9, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP, and Albany Creek, 45.970019°N, 84.076400°W, Chippewa County, UP.
Remarks: *Oncorhynchus* spp. became infected in Lake Michigan, Lake Superior, or in Lake Huron.

### Neoechinorhynchidae Ward, 1917

*Neoechinorhynchus cristatus* Lynch, 1936
Synonym: *Neoechinorhynchus venustus* Lynch, 1936
Site of infection: Intestine

TABLE 5. (continued)

Host:
*Salmo trutta*: Muzzall 1984b, 1981–1982, 1%, minp, Fish Creek, 43.270656°N, 84.979558°W, Montcalm County.

*Neoechinorhynchus cylindratus* (Van Cleave, 1913) Van Cleave, 1919
Synonym: *Neorhynchus cylindratus* Van Cleave, 1913; *Eorhynchus cylindratus* (Van Cleave, 1913) Van Cleave, 1914.
Site of infection: Liver, spleen
Host:
*Lepomis macrochirus*: Wilson et al. 1996, 1987, p and mi were 12% and 2.6 and 6% and 1.7 in littoral and open water fish, Holcomb Lake, 42.505917°N, 85.434589°W, Barry County; Pracheil and Muzzall 2009; 2003, 2004; p and ma separated by host age and collection year, Three Lakes II, 42.349472°N, 85.432708°W, Kalamazoo County; Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Pracheil and Muzzall 2010; 2003, 2004; same infection data and information as in Pracheil and Muzzall 2009.
*Pimephales notatus*: Muzzall 1982, 1979–1981, 3%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

*Neoechinorhynchus limi* Muzzall and Buckner, 1982
Synonym: None
Site of infection: Intestine
Host:
*Culaea inconstans*: Muzzall and Buckner 1982, 1979–1981, 17%, minp, Looking Glass River, 42.856422°N, 84.344131°W, Shiawassee County; Muzzall 1984a, 1979–1982, 10%, 1, Looking Glass River, 42.856422°N, 84.344131°W, Shiawassee County.
*Lepomis macrochirus*: Muzzall 1984a, 1979–1982, 6%, 1, Looking Glass River, 42.856422°N, 84.344131°W, Shiawassee County.
*Moxostoma* sp.: Muzzall 1984a, 1979–1982, 50%, 1, Looking Glass River, 42.856422°N, 84.344131°W, Shiawassee County.

*Neoechinorhynchus saginatus* Van Cleave and Bangham, 1949
Synonym: None
Site of infection: Intestine
Host:
*Salvelinus fontinalis*: Muzzall 1984b, 1981–1982, 3%, minp, Fish Creek, 43.270656°N, 84.979558°W, Montmorency County.
*Lota lota*: Muzzall et al. 1987; 1983, 1984; 6%, 4, Ford River; 46.104983°N, 87.808578°W; 46.129319°N, 87.889611°W; 46.127050°N, 87.974389°W; Dickinson County, UP.

*Neoechinorhynchus tumidus* Van Cleave and Bangham, 1949
Synonym: None
Site of infection: Intestine

TABLE 5. (continued)

Host:
*Oncorhynchus gorbuscha* (adult): Muzzall and Peebles 1986; 1983, 1984; 1%, 1, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP.
*Oncorhynchus kisutch* (adult): Muzzall and Peebles 1986; 1983, 1984; 13%, 1, Harlow Creek, 46.635762°N, 87.468470°W, Marquette County, UP.
*Oncorhynchus tshawytscha* (adult): Muzzall and Peebles 1986; 1983, 1984; 60%, 2, Laughing Whitefish River, 46.520856°N, 87.028475°W, Alger County, UP, and Albany Creek, 45.970019°N, 84.076400°W, Chippewa County, UP.
Remarks: *Oncorhynchus* spp. likely became infected in Lake Superior or Lake Huron.

*Neoechinorhynchus* sp.
Site of infection: Intestine
Host:
*Noturus gyrinus*: Muzzall and Pracheil 2007, 2005, 1%, 1, <1*, 43.657186°N, 86.525117°W, Silver Creek, Oceana County.

**Pomphorhynchidae Yamaguti, 1939**
*Pomphorhynchus bulbocolli* Linkins in Van Cleave, 1919
Synonym: None
Site of infection: Pyloric ceca, anterior intestine, intestinal wall, gonads, viscera
Host:
*Ameiurus nebulosus*: Van Cleave 1919, 1912, 100%, 2, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Lepomis gulosus*: Muzzall 1982, 1979–1981, 100%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Luxilus cornutus*: Muzzall 1982, 1979–1981, 15%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Lepomis macrochirus*: John Hnath 1997, personal communication, pnp, minp Lake Mitchell, 44.544833°N, 85.480133°W, Wexford County.
*Micropterus dolomieu*: Muzzall 1982, 1979–1981, 40%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County; Muzzall and Gillilland III 2004, 2000–2001, p and mi separated by yrs, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.
*Micropterus salmoides*: Muzzall and Gillilland III 2004, 2000–2001, p and mi separated by yrs, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.
*Moxostoma anisurum*: Muzzall 1982, 1979–1981, 25%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Notropis rubellus*: Muzzall 1982, 1979–1981, 9%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Notropis stramineus*: Muzzall 1982, 1979–1981, 7%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

TABLE 5. (continued)

*Pimephales notatus*: Muzzall 1982, 1979–1981, 6%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Semotilus atromaculatus*: Muzzall 1982, 1979–1981, 16%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Ameiurus melas*: Muzzall 1982, 1979–1981, 50%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Ameiurus natalis*: Muzzall 1982, 1979–1981, 20%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Etheostoma nigrum*: Muzzall 1982, 1979–1981, 4%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Percina maculata*: Muzzall 1982, 1979–1981, 14%, minp, Red Cedar River; 42.708103°N, 84.426361°W, Ingham County.
*Umbra limi*: Muzzall 1982, 1979–1981, 33%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

**Rhadinorhynchidae Travassos, 1923**
*Leptorhynchoides thecatus* (Linton, 1891) Kostylew, 1924
Synonym: *Echinorhynchus thecatus* Linton, 1891; *Echinorhynchus oricola* Linstow, 1901
Site of infection: Intestine
Host:
*Percina caprodes*: Van Cleave 1919, 1912, pnp, minp, Douglas Lake 45.576219°N, 84.697675°W, Cheboygan County.
*Esox lucius*: Van Cleave 1919, 1912, 20%, 5, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.
*Etheostoma nigrum*: Muzzall 1982, 1979–1981, 8%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Lepomis gulosus*: Muzzall 1982, 1979–1981, 100%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Lepomis macrochirus*: Pracheil and Muzzall 2009; 2003, 2004; p and ma separated by collection yr, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County; Pracheil and Muzzall 2010; 2003, 2004; same infection data and information as in Pracheil and Muzzall 2009.
*Perca flavescens*: Van Cleave 1919, 1912 pnp, minp, Douglas Lake, 45.576219°N, 84.697675°W, Cheboygan County.

*Leptorhynchoides* sp.
Site of infection: Intestine
Host:
*Micropterus salmoides*: Elsayed and Faisal 2008, 2002, 38%, 6, Randall Lake, Branch County; 55%, 1, Orion Lake; 42.782222°N, 83.250278°W, Oakland County; 22%, 1, 41.973333°N, 85.031389°W, Independence Lake. 42.405833°N, 83.802778°W, Washtenaw County; 82%, 11, Devils Lake, 41.983611°N, 84.286944°W, Lenawee County; 40%, 1, Jordan Lake, 42.77°N, 85.140833°W, Barry County.

TABLE 5. (continued)

## Hirudinea (Leeches)

**Glossiphonidae Vaillant, 1890**
*Actinobdella inequiannulata* Moore, 1901
Synonym: *Actinobdella triannulata* Moore, 1924
Site of infection: [Gills]
Host:
*Catostomus commersonii*: Klemm 1971, cdnp, pnp, minp, Washtenaw County.

**Piscicolidae Johnston, 1865**
*Myzobdella lugubris* Leidy, 1851
Synonym: *Cystobranchus virginicus* Paperna and Zwerner, 1974; *Ichthyobdella funduli* Verrill, 1872; *Ichthyobdella rapax* Wass, 1972; *Ichthyobdella richardsoni* Meyer, 1940; *Illinobdella alba* Meyer, 1940; *Illinobdella elongata* Meyer, 1940; *Illinobdella moorei* Meyer, 1940; *Myzobdella alba* Meyer, 1940; *Myzobdella lugubris* Pearse, 1948; *Myzobdella moorei* (Meyer, 1940) Meyer and Moore, 1954
Site of infection: Body surface, buccal cavity, fins
Host:
*Micropterus salmoides*: Faisal et al. 2011; 2002, 2003; 29%, minp, Devils Lake, 41.983611°N, 84.286944°W, Lenawee County; 23%, minp, Eagle Lake, 42.17°N, 85.975556°W, Cass County; 18%, minp, Independence Lake, 42.405833°N, 83.802778°W, Washtenaw County; 22%, minp, Jordan Lake, 42.77°N, 85.140833°W, Barry County; 21%, minp, Norvell Lake, 42.150833°N, 84.203333°W, Jackson County; 34%, minp, Lake Orion, 42.782222°N, 83.250278°W, Oakland County; 13%, minp, Randall Lake, 41.973333°N, 85.031389°W, Branch County.
*Lota lota*: Muzzall et al. 1987; 1983, 1984; 16%, minp, Ford River, 46.104983°N, 87.808578°W; 46.129319°N, 87.889611°W; 46.127050°N, 87.974389°W, Dickinson County, UP.
*Ambloplites rupestris*: Klemm 1971, cdnp, pnp, minp, Little Portage Creek, Lewingston County.
*Perca flavescens*: Kopenski 1969, 1961–1966, pnp, minp, Marquette County, UP.

*Piscicola geometra* (Linnaeus, 1872)
Synonym: None
Site of infection: Body, fins
Host:
*Lepomis gibbosus*: Klemm 1971, cdnp, pnp, minp, Washtenaw County.

*Piscicola milneri* (Verrill, 1872)
Synonym: None
Site of infection: Body
Host:
*Catostomus commersonii*: Klemm 1971, cdnp, pnp, minp, Washtenaw County.
Remarks: The infested *Catostomus commersonii* was dead.

TABLE 5. (continued)

*Piscicola punctata* (Verrill, 1871)
Synonym: *Ichthyobdella punctata*
Site of infection: Fins
Host:
*Perca flavescens*: Klemm 1971, cdnp, pnp, minp, llnk, Washtenaw County.
*Salvelinus fontinalis*: Meyer 1946, cdnp, pnp, minp, llnk, unknown County.

*Piscicola* sp.
Site of infection: Fin
Host:
*Perca flavescens*: Tompkins 1947, 1946, 7%, 2, Big Shag Lake, 46.2705172°N, 87.4995752°W; Marquette County, UP.

*Piscicolaria reducta* (Meyer, 1940)
Synonym: None
Site of infection: Gills, fins
Host:
*Lepomis cyanellus*: Klemm 1971, cdnp, pnp, minp, llnk, Washtenaw County.

**Copepoda (Copepods)**

**Ergasilidae Nordmann, 1832**
*Ergasilus caeruleus* Wilson, 1911
Synonym: *Ergasilus confusus* Bere, 1931; *Ergasilus skrjabini* Mueller, 1936
Site of infection: Gills
Host:
*Lepomis macrochirus*: Muzzall and Peebles 1998, 1996, 70%, 4, 3*, Five Lakes, 44.635486°N, 84.576625°W, Otsego County.

*Ergasilus centrarchidarum* Wright, 1882
Synonym: *Ergasilus nigratus* C. B. Wilson, 1916.
Site of infection: Gills
Host:
*Ambloplites rupestris*: Muzzall et al. 1995; 1990, 1993; p and mi separated by yrs, 1999–100%, 30; 1993–98%, 29, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.
*Micropterus dolomieu*: Muzzall et al. 1995; 1990, 1993; p and mi separated by yrs, 1990, 1993; 1990–28%, 40; 1993–100%, 56, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.
*Micropterus salmoides*: Muzzall et al. 1995; 1990, 1993; p and mi separated by yrs, 1990–100%, 17; 1993–100%, 14, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.

TABLE 5. (continued)

*Ergasilus megaceros* Wilson, 1916
Synonym: *Ergasilus fragilis* Mueller, 1936
Site of infection: Gills, olfactory sac
Host:
*Ambloplites rupestris*: Muzzall et al. 1995; 1990, 1993; p and mi separated by ys, 1990–71%, 13; 1993–8%, 3, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.
*Micropterus salmoides*: Muzzall et al. 1995; 1990, 1993; 1990–43%, 6, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.
*Petromyzon marinus*: Muzzall and Hudson 2004, 2002, 2%, 9, Cheboygan River, 45.636064°N, 84.479944°W, Cheboygan County.
Remarks: It is not known if *Ergasilus megaceros* infected *Petromyzon marinus* in the Cheboygan River or Lake Huron.

**Lernaeidae Cobbold, 1879**
*Lernaea cruciata* (LeSeuer, 1824)
Synonym: *Lernaeocerca cruciata*
Site of infection: External surface, fins
Host:
Unknown fish species: Allison et al. 1977, cdnp, pnp, minp, lns, unknown County.
*Ambloplites rupestris*: Muzzall 1982, 1979–1981, 13%, minp, Red Cedar River; 42.708103°N, 84.426361°W, Ingham County; Muzzall 1984, personal observation, 30%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.
*Lepomis cyanellus*: Muzzall 1982, 1979–1981, 10%, minp, Red Cedar River; 42.708103°N, 84.426361°W, Ingham County.
*Lepomis macrochirus*: Muzzall 1982, 1979–1981, 50%, minp, Red Cedar River; 42.708103°N, 84.426361°W, Ingham County.

*Lernaea cyprinacea* (Linnaeus, 1758)
Synonym: None
Site of infection: Axilla, external surface
Host:
*Luxilus cornutus*: Kellicott 1882, cdnp, pnp, minp, Shiawassee River, llnk, Shiawassee County.
*Lepomis cyanellus*: Muzzall 1982, 1979–1981, 20%, minp, Red Cedar River, 42.708103°N, 84.426361°W, Ingham County.

**Lernaeopodidae Olsson, 1869**
*Achtheres pimelodi* Kroyer, 1863
Synonym: *Achtheres ambloplites* Kellicott, 1880; *Achtheres micropteri* Wright, 1882;
Site of infection: Gill arch, gill raker, gill filament, buccal cavity
Host:
*Ambloplites rupestris*: Kellicott 1882, cdnp, pnp, minp, Shiawassee River, llnk; Shiawassee County.

TABLE 5. (continued)

*Ambloplites rupestris*: Muzzall et al. 1995; 1990, 1993; p and mi separated by yrs, 1990–43%, 2; 1993–78%, 2, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.
*Micropterus dolomieu*, Muzzall et al. 1995; 1990, 1993; p and mi separated by yrs, 1990–6%, 2; 1993–71%, 5, Gull Lake, 85.361017°W, 42.394775°N, Kalamazoo County.
*Micropterus salmoides*: Muzzall et al. 1995; 1990, 1993; p and mi separated by yrs, 1990–29%, 2; 1993–60%, 3, Gull Lake, 42.394775°N, 85.361017°W, Kalamazoo County.

*Salmincola edwarsdsii* (Olsson, 1869) Wilson, 1915
Synonym: *Lernaeopoda edwardsii* Olsson, 1869; *Lernaeopoda fontinalis* Smith, 1874; *Lernaeopoda arcturi* Miers, 1877; *Salmincola exsanguinata* Sandeman and Pippy, 1967.
Site of infection: Gills, inner surface of opercula, branchial rim, fins
Host:
*Salvelinus fontinalis*: Allison and Latta 1969, 1964, p and mi presented by host year class and month; North Twin Lake, 44.530786°N, 84.146175°W, Oscoda County; West Lost Lake, 45.192115°N, 84.411283°W, Otsego County; South Twin Lake, 43.365961°N, 86.171267°W, Muskegon County; Hemlock Lake, 41.894356°N, 84.792367°W, Hillsdale County; Lost Lake, 45.193294°N, 84.407214°W, Otsego County; Ford Lake, 45.179458°N, 84.450855°W, Pigeon River area, Vanderbilt, Otsego County; Muzzall 1984b, 1981–1982, 76%, minp, Honey Creek, 42.979617°N, 85.4419°W, Kent County; Muzzall 1984b, 1981–1982, 63%, minp, Fish Creek, 43.270656°N, 84.979558°W, Kent County; Muzzall 1986, 1982–1984, 49%, 2, Au Sable River, 44.665922°N, 84.626153°W, Crawford County; Muzzall 2007, 2003–2005, p and mi separated by several variables, Hunt Creek, 44.889397°N, 84.120756°W, Montmorency County.

## Mollusca

**Unionidae Rafinesque, 1820**
Glochidia of *Elliptio* sp.
Site of infection: Gills
Host:
*Lota lota*: Muzzall et al. 1987; 1983, 1984; 87%, minp, Ford River; 46.104983°N, 87.808578°W, 46.129319°N, 87.889611°W, 46.127050°N, 87.974389°W; Dickinson County, UP.

TABLE 6. List of Michigan fish species and the parasites that have been reported from them. The material on which the list is based is derived from the material in TABLE 5. Studies performed in the Upper Peninsula are indicated by UP, all other studies were performed in the Lower Peninsula. The families and scientific and common names are based on Bailey et al. (2004).

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## PETROMYZONTIDAE

***Petromyzon marinus* (Sea Lamprey)**
Copepoda: *Ergasilus megaceros*, (Muzzall and Hudson 2004)

## ACIPENSERIDAE

***Acipenser fulvescens* (Lake Sturgeon)**
Adult Nematoda: *Spinitectus gracilis*, (Baker 1980)
Larval/Immature Nematoda: *Truttaedacnitis clitellarius*, (Baker 1980)

## AMIIDAE

***Amia calva* (Bowfin)**
Adult Digenea: *Macroderoides typicus*, (Winfield 1929); *Microphallus opacus*, (Strandine 1943)
Adult Cestoda: *Haplobothrium globuliforme*, (Thomas 1930; Meinkoth 1947)

## CYPRINIDAE

***Campostoma anomalum* (Central Stoneroller)**
Adult Digenea: *Plagioporus sinitsini*, (Dobrovolny 1939b)
Larval/Immature Cestoda: *Proteocephalus* sp., (Muzzall 1982)
Larval/Immature Nematoda: *Rhabdochona* sp., (Muzzall 1982)

***Luxilus cornutus* (Common Shiner)**
Adult Digenea: *Allocreadium lobatum*, (Muzzall 1982); *Plagioporus sinitsini*, (Dobrovolny 1939b; Muzzall 1982)
Larval/Immature Digenea: *Diplostomum* sp., (Butler 1920; LaRue et al. 1926); *Ichthyocotylurus* sp., (Butler 1920)
Larval/Immature Cestoda: *Proteocephalus* sp., (Muzzall 1982)
Adult Nematoda: *Rhabdochona cascadilla*, (Muzzall 1982)
Immature Acanthocephala: *Pomphorhynchus bulbocolli*, (Muzzall 1982)
Copepoda: *Lernaea cyprinacea*, (Kellicott 1882)

***Nocomis biguttatus* (Hornyhead Chub)**
Adult Digenea: *Plagioporus sinitsini*, (Dobrovolny 1939b; Muzzall 1982)
Larval/Immature Cestoda: *Proteocephalus* sp., (Muzzall 1982)
Adult Nematoda: *Rhabdochona cascadilla*, (Muzzall 1982)
Larval/Immature Nematoda: *Camallanus oxycephalus*, (Muzzall 1982)
Adult Acanthocephala: *Pomphorhynchus bulbocolli*, (Muzzall 1982)

TABLE 6. (continued)

***Notropis bifrenatus* (Bridle Shiner)**
Larval/Immature Cestoda: *Ligula* sp., (Cooper 1919)

***Notropis hudsonius* (Spottail Shiner)**
Larval/Immature Digenea: *Diplostomum* sp., (LaRue et al. 1926)
Larval/Immature Cestoda: *Ligula* sp., (Cooper 1919)

***Notropis rubellus* (Rosyface Shiner)**
Adult Digenea: *Plagioporus sinitsini*, (Dobrovolny 1939b)
Larval/Immature Digenea: *Microphallus opacus*, (Muzzall 1982)
Larval/Immature Cestoda: *Proteocephalus* sp., (Muzzall 1982)
Larval/Immature Nematoda: *Rhabdochona* sp., (Muzzall 1982)
Immature Acanthocephala: *Pomphorhynchus bulbocolli*, (Muzzall 1982)

***Notropis stramineus* (Sand Shiner)**
Adult Digenea: *Plagioporus sinitsini*, (Muzzall 1982)
Larval/Immature Digenea: *Crassiphiala bulboglossa*, (Van Haitsma 1925); *Tylodelphys* sp., (Van Haitsma 1925); *Neascus* of *Ornithodiplostomum ptychocheilus*, (Hughes and Piszczek 1928; Van Haitsma 1930a)
Larval/Immature Cestoda: *Proteocephalus* sp., (Muzzall 1982)
Larval/Immature Nematoda: *Rhabdochona* sp., (Muzzall 1982)
Larval/Immature Acanthocephala: *Pomphorhynchus bulbocolli*, (Muzzall 1982)

***Notropis volucellus* (Mimic Shiner)**
Adult Digenea: *Plagioporus sinitsini* (Dobrovolny 1939b)

***Pimephales notatus* (Bluntnose Minnow)**
Adult Digenea: *Plagioporus sinitsini* (Dobrovolny 1939b)
Larval/Immature Digenea: *Podocotyle* sp., (Muzzall 1982)
Larval/Immature Cestoda: *Proteocephalus* sp., (Muzzall 1982)
Larval/Immature Nematoda: *Rhabdochona* sp., (Muzzall 1982)
Immature Acanthocephala: *Pomphorhynchus bulbocolli*, (Muzzall 1982); *Neoechinorhynchus cylindratus*, (Muzzall 1982)

***Rhinichthys cataractae* (Longnose Dace)**
Ciliophora: *Epistylis* sp., (Muzzall et al. 1992 UP); *Trichodina* sp., (Muzzall et al. 1992 UP)
Myxozoa: *Myxobolus* sp., (Muzzall et al. 1992 UP)
Larval/Immature Digenea: *Neascus* sp., (Muzzall et. al. 1992 UP); *Posthodiplostomum m. minimum*, (Muzzall et al. 1992 UP)
Monogenea: *Gyrodactylus* sp., (Muzzall et al. 1992 UP)
Larval/Immature Cestoda: *Ligula intestinalis*, (Muzzall et al. 1992 UP); *Proteocephalus* sp., (Muzzall et al. 1992 UP)
Adult Nematoda: *Rhabdochona canadensis*, (Muzzall et al. 1992 UP)

TABLE 6. (continued)

Larval/Immature Nematoda: *Sterliadochona ephemeridarum*, (Muzzall et al. 1992 UP); *Haplonema hamulatum*, (Muzzall et al. 1992 UP); *Raphidascaris acus*, (Muzzall et al. 1992 UP)
Adult Acanthocephala: *Neoechinorhynchus saginatus*, (Muzzall et al. 1992 UP)

***Rhinichthys obtusus* (Western Blacknose Dace)**
Larval/Immature Nematoda: *Rhabdochona* sp., (Muzzall 1982)

***Semotilus atromaculatus* (Creek Chub)**
Adult Digenea: *Allocreadium lobatum*, (Spence and Peters 1971 UP; Muzzall 1982); *Plagioporus sinitsini*, (Muzzall 1982)
Monogenea: *Dactylogyrus semotilus*, (Wood and Mizelle 1957)
Adult Cestoda: *Proteocephalus buplanensis*, (Muzzall 1982)
Larval/Immature Nematoda: *Camallanus oxycephalus*, (Muzzall 1982)
Adult Acanthocephala: *Neoechinorhynchus saginatus*, (Muzzall 1982); *Paulisentis missouriensis*, (Muzzall 1982)
Immature Acanthocephala: *Pomphorhynchus bulbocolli*, (Muzzall 1982)

**CATOSTOMIDAE**

***Catostomus commersonii* (White Sucker)**
Adult Digenea: *Phyllodistomum lysteri*, (Fischthal 1952)
Larval/Immature Digenea: *Diplostomum flexicaudum*, (LaRue et al. 1926; Van Haitsma 1931); *Diplostomum spathaceum*, (Hughes and Berkhout 1929); *Diplostomum* sp., (Butler 1920; LaRue et al. 1926); *Ichthyocotylurus platycephalus*; (Hughes 1928c; Van Haitsma 1930b); *Ichthyocotylurus* sp., (Butler 1920)
Monogenea: *Acolpenteron catostomi*, (Fischthal and Allison 1942)
Adult Cestoda: *Glaridacris catostomi*, (Cooper 1920; Hunter 1927; Muzzall 1982); *Glaridacris laruei*, (Hunter 1927); *Isoglaridacris* sp., (Muzzall 1982)
Larval/Immature Cestoda: *Ligula* sp., (Cooper 1919)
Adult Nematoda: *Philometroides nodulosa*, (Thomas 1929)
Adult Acanthocephala: *Neoechinorhynchus crassus*, (Van Cleave 1919); *Neoechinorhynchus cristatus*, (Muzzall 1982); *Octospinifer macilentus*, (Van Cleave 1919); *Pomphorhynchus bulbocolli*, (Van Cleave 1919; Muzzall 1982); *Leptorhynchoides thecatus*, (Van Cleave 1919)
Hirudinea: *Actinobdella inequiannulata*, (Klemm 1971); *Piscicola milneri*, (Klemm 1971)

***Erimyzon sucetta* (Lake Chubsucker)**
Adult Digenea: *Lissorchis mutabile*, (Wallace 1941)

***Hypentelium nigricans* (Northern Hog Sucker)**
Adult Digenea: *Lissorchis hypentelii*, (Fischthal 1942a); *Plagioporus sinitsini*, (Dobrovolny 1939b)
Monogenea: *Acolpenteron catostomi*, (Fischthal and Allison 1942)

TABLE 6. (continued)

Adult Cestoda: *Isoglaridacris folius*, (Muzzall 1982)
Adult Acanthocephala: *Pomphorhynchus bulbocolli*, (Muzzall 1982)

***Moxostoma anisurum* (Silver Redhorse)**
Adult Nematoda: *Rhabdochona* sp., (Muzzall 1982)
Larval/Immature Nematoda: *Rhabdochona* sp., (Muzzall 1982)
Adult Acanthocephala: *Pomphorhynchus bulbocolli*, (Muzzall 1982)

***Moxostoma* sp. (Redhorse)**
Immature Acanthocephala: *Neoechinorhynchus limi*, (Muzzall 1984a)

**ICTALURIDAE**

***Ameiurus melas* (Black Bullhead)**
Larval/immature Digenea: *Clinostomum* sp., (Taylor 1964 UP)
Adult Cestoda: *Corallobothrium fimbriatum*, (Taylor 1964 UP); *Corallobothrium giganteum*, (Muzzall 1982)
Immature Acanthocephala: *Pomphorhynchus bulbocolli*, (Muzzall 1982)
Larval/immature nematode: unidentified nematode larva, (Taylor 1964 UP)

***Ameiurus natalis* (Yellow Bullhead)**
Adult Digenea: *Megalogonia ictaluri*, (Muzzall 1982)
Adult Cestoda: *Corallobothrium fimbriatum*, (Muzzall 1982)
Larval/Immature Cestoda: *Proteocephalus* sp., (Muzzall 1982)
Immature Acanthocephala: *Pomphorhynchus bulbocolli*, (Muzzall 1982)

***Ameiurus nebulosus* (Brown Bullhead)**
Adult Digenea: *Microphallus opacus*, (Muzzall 1982)
Larval/Immature Digenea: *Diplostomum* sp., (LaRue et al. 1926); *Tylodelphys scheuringi*, (Butler 1920); *Microphallus opacus*, (Muzzall 1982)
Adult Cestoda: *Corallobothrium parvum*, (Larsh 1941); *Corallobothrium fimbriatum*, (Muzzall 1982)
Larval/Immature Nematoda: *Spiroxys* sp., (Hedrick 1935)
Immature Acanthocephala: *Pomphorhynchus bulbocolli*, (Van Cleave 1919)

***Ameiurus* sp. (Bullhead)**
Larval/Immature Digenea: *Diplostomum* sp., (Butler 1920); *Ribeiroia ondatrae*, (Beaver 1939); *Ichthyocotylurus* sp., (Butler 1920)
Larval/Immature Nematoda: *Spiroxys* sp., (Hedrick 1935)

***Noturus gyrinus* (Tadpole Madtom)**
Ciliophora: *Trichodina* sp., (Muzzall and Pracheil 2007)
Adult Digenea: *Acetodextra amiuri*, (Muzzall and Pracheil 2007); *Alloglossidium corti*, (Carney and Brooks 1991; Muzzall and Pracheil 2007)

TABLE 6. (continued)

Larval/Immature Digenea: *Azygia* sp., (Muzzall and Pracheil 2007); *Macroderoides* sp., (Muzzall and Pracheil 2007); *Maritreminoides* sp., (Muzzall and Pracheil 2007)
Monogenea: *Ligictaluridus* sp., (Muzzall and Pracheil 2007)
Larval/Immature Cestoda: *Proteocephalus* sp., (Muzzall and Pracheil 2007)
Larval/Immature Nematoda: *Spiroxys* sp., (Muzzall and Pracheil 2007)
Immature Acanthocephala: *Neoechinorhynchus* sp. (Muzzall and Pracheil 2007)

**ESOCIDAE**

***Esox americanus* (Redfin Pickerel)**
Adult Cestoda: *Proteocephalus pinguis*, (Muzzall 1982)

***Esox lucius* (Northern Pike)**
Adult Digenea: *Prosorhyhnchoides pusilla*, (Woodhead 1929)
Adult Cestoda: *Proteocephalus pinguis*, (Pynnonen 1960 UP)
Larval/Immature Cestoda: *Diphyllobothrium latum*, (Warthin 1912 UP; Vergeer 1928 UP)
Immature Acanthocephala: *Leptorhynchoides thecatus*, (Van Cleave 1919)

**UMBRIDAE**

***Umbra limi* (Central Mudminnow)**
Adult Digenea: *Phyllodistomum brevicecum*, (Spence and Peters 1971 UP)
Larval/Immature Digenea: *Tylodelphys scheuringi*, (Muzzall and Kilroy 2007)
Larval/Immature Nematoda: *Spiroxys* sp., (Hedrick 1935)
Adult Acanthocephala: *Fessisentis tichiganensis*, (Muzzall 1984a); *Neoechinorhynchus limi*, (Muzzall and Buckner 1982; Muzzall 1984a)
Immature Acanthocephala: *Pomphorhynchus bulbocolli*, (Muzzall 1982)

**SALMONIDAE**

***Coregonus artedi* (Lake Herring)**
Larval/Immature Cestoda: *Triaenophorus* sp., (Cooper 1919)

***Oncorhynchus gorbuscha* (Pink Salmon)**
Parasites believed to be of river origin.
Larval/Immature Digenea: *Crepidostomum farionis*, (Muzzall and Peebles 1986 UP)
Adult Cestoda: *Eubothrium salvelini*, (Muzzall and Peebles 1986 UP)
Adult Nematoda: *Sterliadochona ephemeridarum*, (Muzzall and Peebles 1986 UP); *Spinitectus gracilis*, (Muzzall and Peebles 1986 UP); *Rhabdochona canadensis*, (Muzzall and Peebles 1986 UP)
Parasites believed to be of Great Lake origin.
Adult Cestoda: *Cyathocephalus truncatus*, (Muzzall and Peebles 1986 UP); *Eubothrium salvelini* (see text for explanation); *Proteocephalus parallacticus*, (Muzzall and Peebles 1986 UP)
Larval/Immature Cestoda: *Diphyllobothium* sp., (Muzzall and Peebles 1986 UP)

TABLE 6. (continued)

Adult Nematoda: *Capillaria salvelini*, (Muzzall and Peebles 1986 UP); *Cystidicola farionis*, (Muzzall and Peebles 1986 UP)
Adult Acanthocephala: *Echinorhynchus* sp. (Muzzall and Peebles 1986), *Echinorhynchus salmonis*, (Muzzall and Peebles 1986 UP)
Immature Acanthocephala: *Neoechinorhynchus tumidus*, (Muzzall and Peebles 1986 UP)
Remarks: All *Oncorhynchus gorbuscha* examined by Muzzall and Peebles (1986) were adults.

***Oncorhynchus kisutch* (Coho Salmon)**
Parasites believed to be of river origin.
Adult Cestoda: *Eubothrium salvelin*i, (Muzzall 1993a; Muzzall and Peebles 1986 UP)
Adult Nematoda: *Sterliadochona ephemeridarum*, (Muzzall and Peebles 1986 UP) *Spinitectus gracilis*, (Muzzall and Peebles 1986 UP); *Rhabdochona canadensis*, (Muzzall and Peebles 1986 UP)
Parasites believed to be of Great Lake origin.
Adult Cestoda: *Eubothrium salvelini* (see text for explanation); *Proteocephalus parallacticus*, (Muzzall and Peebles 1986 UP)
Larval/Immature Cestoda: *Diphyllobothrium* sp., (Muzzall 1993a; Muzzall and Peebles 1986 UP)
Adult Nematoda: *Capillaria salvelini*, (Muzzall and Peebles 1986 UP); *Cystidicola farionis*, (Muzzall and Peebles 1986 UP)
Adult Acanthocephala: *Echinorhynchus salmonis*, (Muzzall 1993a; Muzzall and Peebles 1986 UP)
Immature Acanthocephala: *Echinorhynchus* sp., (Muzzall and Peebles 1986), *Neoechinorhynchus tumidus*, (Muzzall and Peebles 1986 UP)
Origin of parasites could not be determined.
Larval/Immature Cestoda: *Proteocephalus* sp., (Muzzall 1993a)
Larval/Immature Nematoda: *Haplonema* sp., (Muzzall and Peebles 1986 UP)
Remarks: All *Oncorhynchus kisutch* examined by Muzzall (1993a) were adults from Lake Michigan.

***Oncorhynchus mykiss* (Rainbow Trout or Steelhead)**
Parasites believed to be of river origin.
Ciliophora: *Epistylis* sp., (Muzzall 1993a); *Trichodina* sp., (Muzzall 1993a)
Myxozoa: *Myxosoma cerebralis*, (Yoder 1972)
Adult Digenea: *Crepidostomum cooperi*, (Muzzall 1993a)
Monogenea: *Gyrodactylus* sp., (Muzzall 1993a)
Adult Cestoda: *Eubothrium salvelini*, (Muzzall 1993a)
Larval/Immature Nematoda: *Truttaedacnitis* sp., (Muzzall 1986)
Adult Acanthocephala: *Acanthocephalus dirus*, (Muzzall 1984b; 1993a); *Pomphorhynchus bulbocolli*, (Muzzall 1984b)
Parasites believed to be of Great Lake origin.
Adult Cestoda: *Eubothrium salvelini* (see text for explanation).
Larval/Immature Cestoda: *Diphyllobothrium* sp., (Muzzall 1993a)
Adult Nematoda: *Cystidicola farionis*, (Muzzall 1993a)

TABLE 6. (continued)

Adult Acanthocephala: *Echinorhynchus salmonis*, (Muzzall 1993a)
Origin of parasites could not be determined.
Larval/Immature Cestoda: *Diphyllobothrium* sp., (Pynnonen 1960 UP); *Proteocephalus* sp., (Muzzall 1993a)
Remarks: Parr of *Oncorhynchus mykiss* examined by Muzzall (1993a) were infected with *Epistylis* sp., *Trichodina* sp., *Gyrodactylus* sp., and *Acanthocephalus dirus* in the Pere Marquette River. It is believed that some adults of infected *Oncorhynchus mykiss* were from Lake Michigan and other adults were residents of the river.

***Oncorhynchus tshawytscha* (Chinook Salmon)**
Parasites believed to be of river origin.
Ciliophora: *Epistylis* sp., (Muzzall 1993a); *Trichodina* sp., (Muzzall 1993a)
Adult Cestoda: *Eubothrium salvelini*, (Muzzall 1993a; Muzzall and Peebles 1986 UP)
Adult Nematoda: *Spinitectus gracilis*, (Muzzall 1993a; Muzzall and Peebles 1986 UP)
Adult Acanthocephala: *Acanthocephalus dirus*, (Muzzall 1993a)
Parasite believed to be of Great Lake origin.
Adult Cestoda: *Cyathocephalus truncatus*, (Muzzall 1993a); *Eubothrium salvelini* (see text for explanation); *Proteocephalus parallacticus*, (Muzzall and Peebles 1986 UP)
Larval/Immature Cestoda: *Diphyllobothrium* sp., (Muzzall 1993a; Muzzall and Peebles 1986 UP)
Adult Nematoda: *Capillaria salvelini*, (Muzzall 1993a; Muzzall and Peebles 1986 UP); *Cystidicola farionis*, (Muzzall and Peebles 1986 UP)
Adult Acanthocephala: *Echinorhynchus salmonis*, (Muzzall 1993a; Muzzall and Peebles 1986 UP)
Immature Acanthocephala: *Echinorhynchus* sp., (Muzzall and Peebles 1986), *Neoechinorhynchus tumidus*, (Muzzall and Peebles 1986 UP)
Origin of parasites could not be determined.
Larval/Immature Cestoda: *Proteocephalus* sp., (Muzzall 1993a)
Larval/Immature Nematoda: *Haplonema hamulatum*, (Muzzall 1993a); *Haplonema* sp., (Muzzall and Peebles 1986 UP)
Remarks: Parr of *Oncorhynchus tshawytscha* examined by Muzzall (1993a) were infected with *Epistylis* sp., *Trichodina* sp., *Spinitectus gracilis*, and *Acanthocephalus dirus* in the Pere Marquette River. Adult *Oncorhynchus tshawytscha* from Lake Michigan were infected with the other parasite species listed by Muzzall (1993a).

***Salmo trutta* (Brown Trout)**
Ciliophora: *Trichodina* sp., (Muzzall 1986)
Myxozoa: *Myxobolus cerebralis*, (Yoder 1972; Collins et al. 1999; Hnath 1970)
Adult Digenea: *Crepidostomum cooperi*, (Muzzall 1986) *Crepidostomum cornutum*, (Muzzall 1984b)
Larval/Immature Digenea: *Neascus* sp., (Muzzall 1986)
Adult Cestoda: *Proteocephalus* sp., (Muzzall 1984b)
Larval/Immature Cestoda: *Proteocephalus* sp., (Muzzall 1984b; 1986)

TABLE 6. (continued)

Adult Nematoda: *Sterliadochona ephemeridarum*, (Muzzall 1986); *Spinitectus gracilis*, (Muzzall 1986); *Rhabdochona canadensis*, (Muzzall 1986)
Larval/Immature Nematoda: *Truttaedacnitis* sp., (Muzzall 1986)
Adult Acanthocephala: *Acanthocephalus dirus*, (Muzzall 1984b); *Pomphorhynchus bulbocolli*, (Muzzall 1984b)
Immature Acanthocephala: *Neoechinorhynchus cristatus*, (Muzzall 1984b)

***Salvelinus fontinalis* (Brook Trout)**
Ciliophora: *Epistylis* sp., (Muzzall 1986); *Trichodina* sp., (Muzzall 1986)
Myxozoa: *Myxobolus cerebralis*, (Yoder 1972; Collins et al. 1999; Hnath 1970)
Adult Digenea: *Crepidostomum cooperi*, (Muzzall 1984b; 1986; 2007); *Crepidostomum cornutum*, (Muzzall 1984b); *Crepidostomum* sp. (Muzzall, 1984, personal observation UP)
Larval/Immature Digenea: *Apophallus imperator*, (Pynnonen 1960 UP); *Neascus* sp., (Muzzall 1986)
Adult Cestoda: *Eubothrium crassum*, (Cooper 1919); *Eubothrium salvelini*, (Pynnonen 1960 UP, Muzzall 1993b; Hernandez and Muzzall 1998)
Larval/Immature Cestoda: *Eubothrium* sp., (Muzzall 1984b; 1986); *Schistocephalus solidus*, (Pynnonen 1960 UP), *Proteocephalus* sp., (Muzzall 1984b; 1986)
Adult Nematoda: *Sterliadochona ephemeridarum*, (Muzzall 1984, personal observation UP; 1986; 2007); *Spinitectus gracilis*, (Muzzall 1986); *Rhabdochona canadensis*, (Muzzall 1986)
Larval/Immature Nematoda: *Truttaedacnitis* sp., (Muzzall 1984b); *Rhabdochona* sp., (Muzzall 1984b)
Adult Acanthocephala: *Acanthocephalus dirus*, (Muzzall 2007)
Immature Acanthocephala: *Neoechinorhynchus saginatus*, (Muzzall 1984b)
Hirudinea: *Piscicola punctata*, (Meyer 1946)
Copepoda: *Salmincola edwardsii*, (Allison and Latta 1969; Muzzall 1984b; 1986; 2007)

***Thymallus arcticus* (Arctic Grayling)**
Ciliophora: *Capriniana* sp., (Muzzall 1990 UP)
Adult Digenea: *Crepidostomum* sp., (Muzzall 1990 UP)
Larval/Immature Digenea: *Diplostomum* sp., (Muzzall 1990 UP); *Ornithodiplostomum* sp., (Muzzall 1990 UP)
Larval/Immature Cestoda: *Proteocephalus* sp., (Muzzall 1990 UP)
Larval/Immature Nematoda: *Sterliadochona ephemeridarum*, (Muzzall 1990); *Spiroxys* sp., (Muzzall 1990 UP)
Adult Acanthocephala: *Pomphorhynchus bulbocolli*, (Muzzall 1990)

TABLE 6. (continued)

## PERCOPSIDAE

***Percopsis omiscomaycus* (Trout-Perch)**
Larval/Immature Digenea: *Diplostomum huronense*, (Hughes and Hall 1929); *Tylodelphys scheuringi*, (Hughes 1929); *Diplostomum* sp., (Butler 1920; LaRue et al.1926); *Ichthyocotylurus pileatus*, (Hughes 1928c); *Ichthyocotylurus platycephalus*, (Hughes 1928c; LaRue 1932); *Ichthyocotylurus* sp., (Butler 1920)

## GADIDAE

***Lota lota* (Burbot)**
Ciliophora: *Epistylis* sp., (Muzzall et al. 1987 UP); *Trichodina* sp., (Muzzall et al. 1987 UP)
Myxozoa: *Myxobolus* sp., (Muzzall et al.1987 UP)
Adult Digenea: *Crepidostomum farionis*, (Muzzall et al. 1987 UP); *Proterometra autraini*, (LaBeau and Peters 1995 UP)

Larval/Immature Digenea: *Azygia* sp., (Muzzall et al. 1987 UP); *Diplostomum* sp., (LaRue et al. 1926); *Posthodiplostomum* sp., (Muzzall et al. 1987 UP)
Larval/Immature Cestoda: *Diphyllobothrium latum*, (Warthin 1912 UP)
Adult Nematoda: *Haplonema hamulatum*, (Muzzall et al. 1987 UP); *Raphidascaris acus*, (Muzzall et al. 1987 UP)
Larval/Immature Nematoda: *Sterliadachona ephemeridarum*, (Muzzall et al. 1987 UP)
Adult Acanthocephala: *Neoechinorhynchus pungitius*, (Muzzall et al. 1987 UP)
Immature Acanthocephala: *Neoechinorhynchus saginatus*, (Muzzall et al. 1987 UP)
Hirudinea: *Myzobdella lugubris*, (Muzzall et al. 1987 UP)
Mollusca: *Elliptio* sp., (Muzzall et al. 1987 UP)

## GASTEROSTEIDAE

***Culaea inconstans* (Brook Stickleback)**
Immature Acanthocephala: *Neoechinorhynchus limi*, (Muzzall and Buckner 1982; Muzzall 1984a)

## COTTIDAE

***Cottus bairdii* (Mottled Sculpin)**
Ciliophora: *Epistylis* sp., (Muzzall and Sweet 1986); *Trichodina* sp., (Muzzall and Sweet 1986)
Myxozoa: unidentified myxozoan, (Muzzall and Sweet 1986)
Microspora: *Glugea* sp., (Homola et al. 2011; 2012a; 2012b; 2014; Ryan and Kohler 2011a; 2011b)
Adult Digenea: *Phyllodistomum undulans*, (Fallon and Wallace 1977); *Crepidostomum cooperi*, (Muzzall and Sweet 1986); *Proterometra autraini*, (LaBeau and Peters 1995 UP)
Larval/Immature Digenea: *Diplostomum spathaceum*, (Muzzall and Sweet 1986); *Diplostomum* sp., (Muzzall and Sweet 1986); *Neascus* sp., (Muzzall and Sweet 1986); *Ichthyocotylurus* sp., (Muzzall and Sweet 1986)

TABLE 6. (continued)

Monogenea: *Gyrodactylus bairdi*, (Muzzall and Sweet 1986)
Larval/Immature Cestoda: *Proteocephalus* sp., (Muzzall and Sweet 1986)
Adult Nematoda: *Rhabdochona cotti*, (Muzzall and Sweet 1986; Muzzall and Whelan 1995 UP); *Spinitectus gracilis*, (Muzzall and Sweet 1986)
Larval/Immature Nematoda: *Sterliadochona ephemeridarum*, (Muzzall and Sweet 1986)

***Cottus cognatus* (Slimy Sculpin)**
Larval/Immature Cestoda: *Eubothrium salvelini*, (Muzzall 1993b; Hernandez and Muzzall 1998)

**CENTRARCHIDAE**

***Ambloplites rupestris* (Rock Bass)**
Adult Digenea: *Bucephalus elegans*, (Woodhead 1930); *Crepidostomum cornutum*, (Esch 1971; Muzzall 1982); *Cryptogonimus chyli*, (Muzzall 1982); unknown cryptogonimid, (Esch 1971); unidentified microphallid, (Esch 1971); *Prosorhynchoides pussila*, (Woodhead 1930); *Proterometra autraini*, (LaBeau and Peters 1995 UP)

Larval/Immature Digenea: *Diplostomum* sp., (Butler 1920; La Rue et al. 1926); *Uvulifer ambloplitis*, (Hughes 1927; 1928b); *Posthodiplostomum minimum*, (Hughes 1928b); *Ichthyocotylurus* sp., (Butler 1920); external metacercariae, (Esch 1971); visceral metacercariae, (Esch 1971)
Adult Cestoda: *Proteocephalus pearsei*, (LaRue 1919)
Larval/Immature Cestoda: *Ligula* sp., (Cooper 1919); *Proteocephalus* spp., (Esch 1971; Muzzall 1982)
Adult Nematoda: *Contracaecum brachyurum*, (Muzzall 1982); *Spinitectus carolini*, (Muzzall 1982); *Spinitectus* sp., (Esch 1971)
Adult Acanthocephala: *Leptorhynchoides thecatus*, (Van Cleave 1919; Muzzall 1982); *Leptorhynchoides* sp., (Esch 1971); *Pomphorhynchus bulbocolli*, (Van Cleave 1919; Muzzall 1982); *Pomphorhynchus* sp., (Esch 1971)
Hirudinea: *Myzobdella lugubris*, (Klemm 1971)
Copepoda: *Ergasilus centrarchidarum*, (Muzzall et al. 1995); *Ergasilus megaceros*, (Muzzall et al. 1995); *Lernaea cruciata*, (Muzzall 1982; Muzzall 1984, personal observations); *Achtheres pimelodi*, (Kellicott 1882; Muzzall et al. 1995)

***Lepomis cyanellus* (Green Sunfish)**
Adult Digenea: *Allocredium lobatum*, (Muzzall 1982)
Larval/Immature Cestoda: *Proteocephalus* sp., (Muzzall 1982)
Adult Nematoda: *Spinitectus micracanthus*, (Muzzall 1982)
Adult Acanthocephala: *Leptorhynchoides thecatus*, (Muzzall 1982)
Hirudinea: *Piscicolaria reducta*, (Klemm 1971)
Copepoda: *Lernaea cruciata*, (Muzzall 1982); *Lernaea cyprinacea* (Muzzall 1982)

***Lepomis gibbosus* (Pumpkinseed)**
Larval/Immature Digenea: *Diplostomum* sp., (Butler 1920; LaRue et al. 1926); *Posthodiplostomum minimum*, (Hughes 1928b); *Ichthyocotylurus* sp., (Butler 1920)

TABLE 6. (continued)

Adult Nematoda: *Camallanus* sp., (Esch 1971); *Spinitectus* sp., (Esch 1971)
Hirudinea: *Piscicola geometra*, (Klemm 1971)

***Lepomis gulosus* (Warmouth)**
Adult Nematoda: *Spinitectus micracanthus*, (Muzzall 1982)
Adult Acanthocephala: *Leptorhynchoides thecatus*, (Muzzall 1982)
Immature Acanthocephala: *Pomphorhynchus bulbocolli*, (Muzzall 1982)

***Lepomis macrochirus* (Bluegill)**
Ciliophora: *Trichodina* sp., (Muzzall and Peebles 1998; Pracheil and Muzzall 2009; 2010)
Myxozoa: *Myxobolus* sp., (Wilson et al. 1996; Muzzall and Peebles 1998; Pracheil and Muzzall 2009; 2010)
Adult Digenea: *Crepidostomum cornutum*, (Esch 1971; Muzzall and Peebles 1998; Pracheil and Muzzall 2009; 2010); *Azygia* sp., (Pracheil and Muzzall 2009; 2010)
Larval/Immature Digenea: *Azygia* sp., (LaBeau and Peters 1995 UP); *Clinostomum* sp., (Wilson et al. 1996; Muzzall and Peebles 1998; Pracheil and Muzzall 2009; 2010); *Cryptogonimus* sp., (Pracheil and Muzzall 2009; 2010); *Diplostomum* sp., (Wilson et al. 1996; Muzzall and Peebles 1998; Pracheil and Muzzall 2009; 2010); *Neascus* sp., (Wilson et al. 1996; Muzzall and Peebles 1998; Pracheil and Muzzall 2009; 2010); *Posthodiplostomum minimum*, (Hughes 1928b; Wilson et al. 1996); *Posthodiplostomum* sp., (John Hnath 1997, personal communication; Muzzall and Peebles 1998); unidentified strigeids (Tompkins 1947 UP); visceral metacercariae, (Esch 1971); external metacercariae, (Esch 1971)
Monogenea: *Actinocleidus* sp., (Pracheil and Muzzall 2009; 2010); *Anchoradiscus* sp., (Pracheil and Muzzall 2009; 2010); *Dactylogyrus* sp., (Wilson et al. 1996)
Adult Cestoda: *Bothriocephalus* sp., (Tompkins 1947 UP)
Larval/Immature Cestoda: *Haplobothrium globuliforme*, (Pracheil and Muzzall 2009; 2010); *Proteocephalus ambloplitis*, (Wilson et al. 1996; Pracheil and Muzzall 2009; 2010); *Proteocephalus* sp., (Esch 1971; John Hnath 1971, personal communication; Muzzall and Peebles 1998)
Adult Nematoda: *Camallanus oxycephalus*, (Wilson et al. 1996); *Spinitectus gracilis*, (Pracheil and Muzzall 2009; 2010); *Spinitectus micracanthus*, (Muzzall 1982; Muzzall and Peebles 1998); *Spinitectus* sp., (Esch 1971)
Larval/Immature Nematoda: *Contracaecum* sp., (Muzzall and Peebles 1998); *Camallanus* sp., (Pracheil and Muzzall 2009; 2010); *Spinitectus* sp., (Wilson et al. 1996); *Spiroxys* sp., (Wilson et al. 1996; Muzzall and Peebles 1998; Pracheil and Muzzall 2009; 2010); *Capillaria* sp., (Wilson et al. 1996)
Adult Acanthocephala: *Pomphorhynchus bulbocolli*, (Esch et al. 1976; Pracheil and Muzzall 2009; 2010); *Pomphorhynchus* sp., (Esch 1971); *Leptorhynchoides thecatus*, (Esch et al. 1976; Muzzall and Peebles 1998); *Leptorhynchoides* sp., (Esch 1971); *Pomphorhynchus bulbocolli* (John Hnath 1997, personal communication)
Immature Acanthocephala: *Neoechinorhynchus cylindratus*, (Wilson et al. 1996); Pracheil and Muzzall 2009; 2010); *Neoechinorhynchus limi*, (Muzzall 1984a); *Leptorhynchoides thecatus*, (Pracheil and Muzzall 2009; 2010)

TABLE 6. (continued)

Copepoda: *Ergasilus caeruleus*, (Muzzall and Peebles 1998); *Lernaea cruciata* (Muzzall 1982)

***Lepomis microlophus* (Redear Sunfish)**
Larval/Immature Cestoda: *Proteocephalus* sp., (John Hnath 1997, personal communication)

***Lepomis peltastes* (Northern Longear Sunfish)**
Adult Digenea: *Plagioporus sinitsini*, (Dobrovolny 1938; 1939a)
Larval/Immature Digenea: *Posthodiplostomum minimum*, (Hughes 1928b)

***Lepomis* sp. hybrid**
Adult Digenea: *Crepidostomum cornutum*, (Esch 1971)
Larval/Immature Digenea: external metacercariae, (Esch 1971); visceral metacercercariae, (Esch 1971)
Adult Nematoda: *Camallanus* sp., (Esch 1971); *Spinitectus* sp., (Esch 1971)

***Micropterus dolomieu* (Smallmouth Bass)**
Adult Digenea: *Microphallus opacus*, (Strandine 1943); *Crepidostomum cooperi*, (Muzzall 1982); *Crepidostomum cornutum*, (Esch 1971; Muzzall 1982), *Cryptogonimus chili* (Esch and Huffines 1973); *Microphallus opacus*, (Muzzall 1982); *Prosorhynchoides pusilla*, (Woodhead 1929); *Proterometra autraini*, (LaBeau and Peters 1995 UP); *Caecincola parvulus*, (Esch and Huffines 1973); unknown cryptogonimid, (Esch 1971); *Sanguinicola huronis*, (Fischthal 1949); *Sanguinicola* sp., (Esch and Huffines 1973)
Larval/Immature Digenea: *Uvulifer amblopiltes*, (Pynnonen 1960 UP), *Neascus ambloplitis*, (Hughes 1927; 1928b); visceral metacercariae, (Esch 1971); external metacercariae, (Esch 1971)
Monogenea: *Acolpenteron ureteroectes*, (Fischthal and Allison 1940; 1941)
Adult Cestoda: *Proteocephalus ambloplitis*, (Pynnonen 1960 UP), Esch 1971; Esch et al. 1975; Gillilland and Muzzall 2004); *Proteocephalus fluviatilis*, (Esch et al. 1975)
Larval/Immature Cestoda: *Proteocephalus* sp., (Esch 1971; Muzzall 1982)
Adult Nematoda: *Spinitectus micracanthus*, (Muzzall 1982); *Spinitectus* sp., (Esch 1971)
Adult Acanthocephala: *Neoechinorhynchus cylindratus*, (Esch et al. 1975; Muzzall and Gillilland III 2004); *Neoechinorhynchus* sp., (Esch 1971) *Leptorhynchoides thecatus*, (Van Cleave 1919; Esch et al. 1975; Esch and Huffines 1973; Muzzall 1982; Muzzall and Gillilland III 2004; Steinauer 2004; Steinauer et al. 2006; 2007); *Leptorhynchoides* sp., (Esch 1971); *Pomphorhynchus bulbocolli*, (Van Cleave 1919)
Immature Acanthocephala: *Pomphorhynchus bulbocolli*, (Muzzall 1982; Muzzall and Gillilland III 2004)
Copepoda: *Ergasilus centrarchidarum*, (Muzzall et al. 1995); *Achtheres pimelodi*, (Muzzall et al. 1995)

***Micropterus salmoides* (Largemouth Bass)**
Adult Digenea: *Azygia* sp., (Esch 1971); *Caecincola parvulus*, (Lundahl 1941); *Crepidostomum cornutum*, (Esch 1971); *Prosorhynchoides pusilla*, (Woodhead 1929); unknown cryptogonimid, (Esch 1971); *Sanguinicola huronis*, (Fischthal 1949)

TABLE 6. (continued)

Larval/Immature Digenea: external metacercariae, (Esch 1971); visceral metacercariae, (Esch 1971)
Monogenea: *Acolpenteron ureteroecetes*, (Fischthal and Allison 1940; 1941)
Adult Cestoda: *Bothriocephalus claviceps*, (Esch 1971); *Proteocephalus ambloplitis*, (Esch 1971; Gillilland and Muzzall 2004); *Proteocephalus* sp. (Tompkins 1946 UP)
Larval/Immature Cestoda: *Proteocephalus ambloplitis*, (Esch and Huffiness 1973; Gillilland and Muzzall 2004; Elsayed and Faisal 2008); *Proteocephalus* sp., (Esch 1971; Muzzall 1982)
Adult Nematoda: *Camallanus* sp., (Esch 1971); *Spinitectus carolini*, (Muzzall 1982); *Spinitectus micracanthus*, (Muzzall 1982); *Spinitectus* sp., (Esch 1971)
Adult Acanthocephala: *Neoechinorhynchus cylindratus*, (Muzzall 1982; Muzzall and Gillilland III 2004); *Neoechinorhynchus* sp., (Esch 1971; Elsayed and Faisal 2008); *Leptorhynchoides thecatus*, (Van Cleave 1919; Muzzall and Gillilland III 2004); *Leptorhynchoides* sp., (Esch 1971; Elsayed and Faisal 2008)
Immature Acanthocephala: *Leptorhynchoides* sp., (Elsayed and Faisal 2008); *Pomphorhynchus bulbocolli*, (Muzzall and Gillilland III 2004)

Hirudinea: *Myzobdella lugubris*, (Faisal et al. 2011)
Copepoda: *Ergasilus centrarchidarum*, (Muzzall et al. 1995); *Ergasilus megaceros*, (Muzzall et al. 1995); *Achtheres pimelodi*, (Muzzall et al. 1995)

***Micropterus* sp. (Bass)**
Larval/Immature Cestoda: *Proteocephalus* sp., (John Hnath, 1997, personal communication)

***Pomoxis nigromaculatus* (Black Crappie)**
Larval/Immature Cestoda: *Proteocephalus* sp., (Muzzall 1982)
Nematoda: *Camallanus oxycephalus*, (Muzzall 1982)

**Unidentified Centrarchids**
Adult Digenea: *Plagioporus sinitsini*, (Dobrovolny 1938; 1939a)

**Unknown Sunfish Species**
Larval/Immature Digenea: *Rebeiroia ondatrae*, (Beaver 1939)

## PERCIDAE

***Etheostoma blennioides* (Greenside Darter)**
Adult Digenea: *Phyllodistomum etheostomae*, (Fischthal 1942b; 1943)

***Etheostoma nigrum* (Johnny Darter)**
Adult Digenea: *Crepidostomum isostomum*, (Muzzall 1982); *Podocotyle* sp., (Muzzall 1982)
Adult Cestoda: *Bothriocephalus formosus*, (Muzzall 1982)
Immature Acanthocephala: *Leptorhynchoides thecatus*, (Muzzall 1982); *Pomphorhynchus bulbocolli*, (Muzzall 1982)

*TABLE 6. (continued)*

***Perca flavescens* (Yellow Perch)**

Adult Digenea: *Azygia angusticauda*, (Spence and Peters 1971 UP); *Bunodera luciopercae*, (Peters and LaBonte 1965 UP); *Bunodera sacculata*, (Muzzall 2002; Peters and LaBonte 1965 UP); *Proterometra autraini*, (LaBeau and Peters 199 5UP); *Sanguinicola occidentalis*, (Muzzall 2000b)

Larval/Immature Digenea: *Diplostomum huronense*, (Hughes and Hall 1929); *Clinostomum marginatum* (Pynnonen 1960 UP), *Crassiphiala bulboglossa*, (Pynnonen 1960 UP, Hughes 1928a); *Diplostomum* sp., (Butler 1920; LaRue et al. 1926); *Tylodelphys scheuringi*, (Hughes 1929); *Ichthyocotylurus pileatus*, (Hughes 1928c); *Ichthyocotylurus* sp., (Butler 1920); unidentified strigeids, (Tompkins 1946 UP)

Adult Cestoda: *Bothriocephalus* sp., (Tompkins 1946 UP); *Proteocephalus pearsei*, (LaRue 1919); *Proteocephalus* sp., (Tompkins 1946 UP, Muzzall 1982)

Larval/Immature Cestoda: *Ligula* sp., (Cooper 1919); *Proteocephalus* sp., (Tompkins 1946 UP, Muzzall 1982)

Adult Acanthocephala: *Leptorhynchoides thecatus*, (Pynnonen 1960 UP)

Immature Acanthocephala: *Leptorhynchoides thecatus*, (Van Cleave 1919)

Hirudinea: *Myzobdella lugubris*, (Kopenski 1969 UP), *Piscicola punctata* (Klemm 1971), *Piscicola* sp. (Tompkins 1946 UP)

***Percina caprodes semifasciata* (Logperch)**

Adult Digenea: *Phyllodistomum etheostomae*, (Fischthal 1942b; 1943)

Larval/Immature Cestoda: *Bothriocephalus cuspidatus*, (Cooper 1919)

Adult Acanthocephala: *Pomphorhynchus bulbocolli*, (Van Cleave 1919)

Immature Acanthocephala: *Leptorhynchoides thecatus*, (Van Cleave 1919)

***Percina maculata* (Blackside Darter)**

Adult Digenea: *Phyllodistomum etheostomae*, (Fischthal 1942b; 1943); *Podocotyle* sp., (Muzzall 1982)

Immature Acanthocephala: *Pomphorhynchus bulbocolli*, (Muzzall 1982)

***Sander vitreus* (Walleye)**

Adult Digenea: *Prosorhynchoides pusilla*, (Woodhead 1930)

Adult Cestoda: *Bothriocephalus cuspidatus*, (Pynnonen 1960 UP); *Bothriocephalus* sp., (Tompkins 1946 UP), *Proteocephalus* sp., (Tompkins 1946 UP)

Larval/immature Cestoda: unidentified plerocercoid, (Tompkins 1946 UP)

***Sander* spp.**

Larval/immature Cestoda: *Diphyllobothrium latum*, (Vergeer 1928 UP)

TABLE 6. (continued)

**Unknown Family**

**"Fish"**
Myxozoa: *Myxobolus cerebralis*, (Hnath 1970)

**Unknown fish species**
Copepoda: *Lernaea cruciata* (Allison et al. 1977)

**"Several different species of fish"**
Larval/Immature Digenea: *Cercaria flexicauda*, (Cort and Brooks 1928); *Cercaria laruei*, (Cort and Brooks 1928); *Cercaria modicella*, (Cort and Brooks 1928)

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