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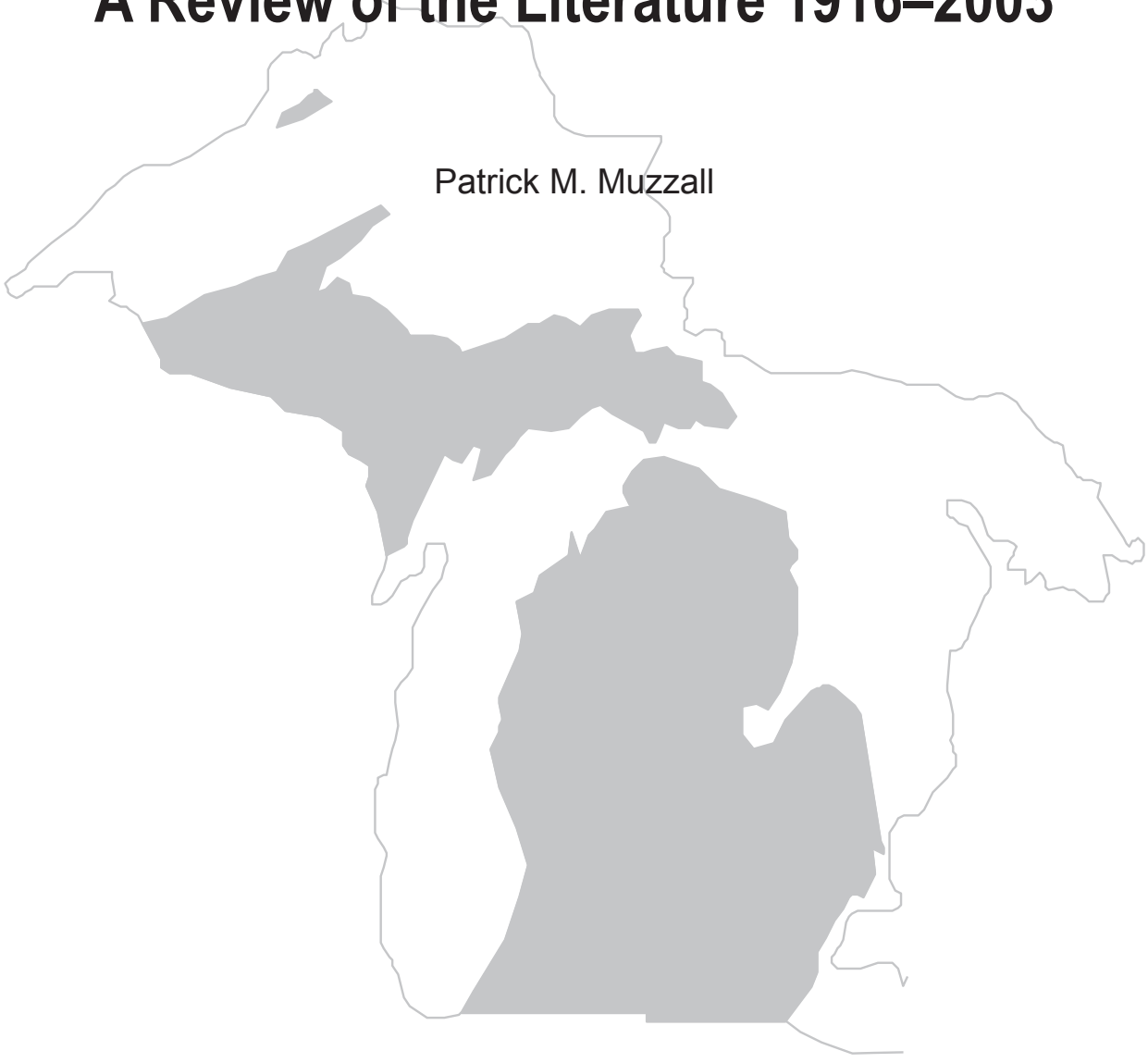

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Parasites of Amphibians and Reptiles from Michigan: A Review of the Literature 1916–2003

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Abstract.–A summary of the literature on the parasites (protozoans, digenetic trematodes, monogeneans, cestodes, and nematodes) of amphibians and reptiles (herps) in Michigan is presented. It is divided into three sections: 1.) a list of the parasite species by taxonomic group and family followed by their herp hosts and studies, 2.) a list of the herp species in Michigan by order and family and their parasites, and 3.) a list of body sites occupied by parasites in herps by order. At least 84 studies (abstracts and articles) have been published on the parasites of herps in Michigan from 1916 through 2003. These studies include: 49 on frogs, 5 on toads, 19 on salamanders, 15 on snakes, and 16 on turtles. The more widespread or common herp species have more parasite species reported from them compared to the less common species. At least 17 protozoan species, 39 adult digenetic trematode species, 12 larval digenetic trematode species, 2 adult monogenean species, 5 adult cestode species, 2 larval cestode species, 15 adult nematode species, and 3 larval nematode species have been reported from herps in Michigan. Acanthocephalans have not been reported in Michigan herps. Only two studies have been published on the parasites of herps in the Upper Peninsula of Michigan. Nineteen (36%) of the 53 herp species in Michigan have not had articles published on their parasites. This study is the first one to summarize the parasites of herps in a state or province in North America.

The literature on the parasites of herps (defined here as amphibians, snakes, turtles, and lizards) in the central United States is extensive, diverse, and scattered. Historically, studies have focused on two major areas, parasite life histories and taxonomy. Parasite fauna surveys have also received considerable attention. However, many of these surveys are limited in that only one parasite species or parasite group was studied, only one herp species was studied, or the number of herps examined was small. More studies have been performed on the parasites of amphibians than reptiles. Dyer (1991) listed many of the helminth parasites of amphibians from Illinois and adjacent midwestern states. Andrews et al. (1992) provided a checklist of helminths in bullfrogs *Rana catesbeiana* in North America. Prudhoe and Bray (1982) discussed the helminth parasites of amphibians. Ernst and Ernst (1977) listed the helminths infecting native turtles of the United States. Baker (1987) provided a synopsis of the nematodes parasitic in herps of the world. Kuzmin et al. (2003) reviewed and summarized the literature on the nematode genus *Rhabdias* from herps of the Neartic. Aho (1990) presented and explored mechanisms influencing the patterns and processes of helminth community organization in herps.

Based on discussions with parasitologists and herpetologists as well as reviewing articles on the parasites of herps, it became apparent that

many investigators were unaware of the existence of published information on the parasites of Michigan herps. This might be because titles of some articles do not indicate that parasites of Michigan herps were studied. Furthermore, the information in some older articles is difficult to interpret, often not indicating specifically what species of herps were examined, where in Michigan the study was performed, and if the study was actually done in Michigan. The objective of the present study was to summarize information on the parasites of herps in Michigan in an accessible form, as the literature on this subject is widely scattered in several journals. For investigators interested in these parasites and herp groups, this review will provide a basis for a better understanding of this subject and for future study.

Infectious diseases, such as chytridiomycosis, ranavirus, saprolegniosis, and trematode (*Ribeiroia* sp.) infection have been discussed as causes of mortality leading to amphibian population declines (Daszak et al. 2003). Another objective of this study, therefore, was to determine if relationships between helminths and amphibian mortalities and malformations have ever been reported in Michigan. Furthermore, it is important to document parasites of herps in Michigan so that changes brought about by environmental variation and the introduction of exotic organisms can be understood.

Methods

Ten species of salamanders, 13 species of frogs and toads, 18 species of snakes, 10 species of turtles, and 2 species of lizards occur in Michigan (Harding and Holman 1990; Harding and Holman 1992; Holman et al. 1989; Harding 1997). Information on the parasites of herps in Michigan was obtained from studies published since 1916, when the first study was published. Some studies report experimental infections of herps with parasites. Several studies occurred in the Douglas Lake and Ann Arbor areas, and have been designated to occur in Cheboygan County and Washtenaw County, respectively. In most situations, no attempt has been made to demonstrate the past complexities of parasite synonyms or to review the validity of published results. Studies on viruses, bacteria, fungi, and leech parasitism of herps from Michigan were not included.

Results

The parasites found in herps of Michigan, by taxonomic group and family, are listed in Table 1. The numbers of parasite species counted, presented, and reported in the text only involve those identified to species, unless only one genus or common name was reported in the original article. A total of 17 protozoan species (1 ameba, 10 flagellates, 2 ciliates, 4 apicomplexans) in 9 families have been reported in herps. Six studies involved some aspect of *Cepedietta michiganensis* infecting the four-toed salamander *Hemidactylium scutatum*. Only *Entamoeba invadens*, *Trichomonas* sp., coccidians, and a haemogregarine-like form have been reported from snakes. Only one protozoan *Haemoproteus metchinikovi* has been reported from a turtle. Flagellates were found in ranid frogs and the Eastern American toad *Bufo a. americanus*, based on one study. The rest of the protozoan species, such as *Nyctotherus cordiformis*, were reported from ranid frogs, while the coccidian species *Eimeria longaspora* and *Eimeria megaresidua* were reported from the eastern newt *Notophthalmus viridescens*.

Thirty-nine species of adult digenetic trematodes from 13 families have been reported in Michigan herps (Table 1). A total of 19 digenetic trematode species have been found in amphibians (18 in frogs, 2 in toads, 5 in salamanders), 8 species in snakes, 15 species in turtles, and 1 species has been found in both a frog and a turtle. Regarding trematode families, members of the Brachycoelidae and Cephalogonimidae infect amphibians; Gorgoderidae, Haematoloechidae, Hemiuridae, and Lecithodendriidae primarily infect ranid frogs; Macroderoididae and Paramphistomidae (except for *Allassostomoides parvum*) primarily infect hylid and ranid frogs; Plagiorchiidae infect snakes and turtles; Pronocephalidae infect turtles and a frog; Heronimidae and Spirorchiidae infect turtles; and Telorchiidae primarily infect turtles. The families Haematoloechidae and Plagiorchiidae are

represented by six and seven species, respectively, and the Spirorchiidae and Telorchiidae each have five species.

At least 12 different species of larval digenetic trematodes representing 7 families have been reported from herps in Michigan (Table 1). Most species infect amphibians (11 in frogs, 1 in toads, 4 species in salamanders). Only larval *Alaria intermedia*, *Alaria marcianae*, and mesocercaria (=*Alaria*) have been reported from snakes. Only one larval trematode (*Cercaria welleri*) has been reported from turtles.

Adult cestodes in three families have been reported from amphibians in Michigan with *Bothriocephalus rarus* infecting *Notophthalmus viridescens*, *Cylindrotaenia americana* and *Cylindrotaenia quadrijugosa* infecting the northern leopard frog *Rana pipiens*, and *Proteocephalus saphena* infecting green frogs *Rana clamitans melanota* (Table 1). The one report of *Proteocephalus* sp. infecting the tiger salamander *Ambystoma t. tigrinum* and ranid frogs involves non-gravid worms. Only one cestode species (*Proteocephalus perspicua*) has been reported from snakes. Larvae of two genera of cestodes (*Mesocestoides* and *Proteocephalus*) infect ranid frogs. Cestodes have not been reported from turtles.

Adults of at least 15 nematode species in 10 families have been reported from herps in Michigan (Table 1). Eleven species infect amphibians with most of them in ranid frogs and three species occur in salamanders. *Thelandros magnavulvaris* only infects salamanders. Adult *Camallanus microcephalus*, *Spiroxys amydae*, and *Spiroxys contortus* have been reported from turtles. *Dracunculus ophidensis*, *Rhabdias fuscovenosa*, unidentified adults, and microfilariae (larvae) have been found in snakes. Encysted larval *Spiroxys* sp. are common nematodes of amphibians.

The parasites found in amphibians and reptiles in Michigan by herp order are listed in Table 2. Six species of salamanders in three families have parasites reported from them. Seven parasite species from three studies have been reported from the blue-spotted salamander *Ambystoma laterale*. The spotted salamander *Ambystoma maculatum* and eastern tiger salamander *Ambystoma t. tigrinum* each have only had one study on their parasites.

Eight studies have been performed on the parasites of *Notophthalmus viridescens* from Michigan. Five of the 11 species infecting newts are digenetic trematodes. Only one study was done on the parasites of the red-backed salamander *Plethodon cinereus*. Seven studies have been performed on the protozoan species *Cepedietta michiganensis* infecting the four-toed salamander *Hemidactylium scutatum*.

Five studies have been performed on the parasites of toads with most studies involving *Bufo a. americanus*. Six parasite species (four protozoans, two digeneans) have been reported from this toad species. The digenetic trematode *Cephalogonimus americanus* is the only species reported from the Fowler's toad *Bufo fowleri* in one study.

Twelve parasite species from eight studies have been reported from four hylid frog species. Ten species of parasites have been reported from the northern spring peeper *Pseudacris c. crucifer* and four species from the striped chorus frog *Pseudacris triseriata*. Only one parasite species has been reported from Blanchard's cricket frog *Acris crepitans blanchardi* and one from the eastern gray treefrog *Hyla versicolor*.

Eighteen species of parasites from nine studies have been reported from *Rana catesbeiana*. Twenty-eight studies have been performed on green frog parasites with 43 parasite species listed. Twenty-three species are digenetic trematodes with 15 of these being adults and 8 species are larvae. Three cestode species and 10 nematode species are reported from green frogs. Thirty studies have been performed on the parasites of the northern leopard frog *Rana pipiens* with at least 31 parasite species listed. At least nine of these species are represented as larval trematodes and six species are adult trematodes.

Only one study has been published on the parasites of each of the pickerel frog *Rana palustris* and of the mink frog *Rana septentrionalis*, and this last one only involved the blood. Eight studies listing 14 parasite species have been done on wood frogs; 7 of these species are digenetic trematodes.

Tadpoles of the following anuran species have been found infected with parasites (in parentheses): *Bufo a. americanus* (*Cephalogonimus americanus*), *Bufo fowleri* (*C. americanus*), *Bufo* sp. (*C. americanus*),

Rana catesbeiana (*Halipegus eccentricus*), *Rana c. melanota* (*Alaria marcianae*, *Alaria mustelae*, *Caudorchis eurinus*, *C. americanus*, *Diplostomum micradenum*, *Echinoparyphium flexum*, *H. eccentricus*, *Lechriorchis primus*, *Megalodiscus temperatus*, trematode cysts, *Proteocephalus perspicua*, *Proteocephalus saphena*, *Spiroxys contortus*, *Spiroxys* sp.); *Rana pipiens* (*A. marcianae*, *Alaria intermedia*, *A. mustelae*, *Apharyngostrigea pipientis*, *C. eurinus*, *D. micradenum*, *E. flexum*, *H. eccentricus*, *L. primus*, gorgoderids); *Rana sylvatica* (*E. flexum*); *Pseudacris c. crucifer* (*E. flexum*); *Pseudacris triseriata* (*E. flexum*); *Hyla versicolor* (*A. pipientis*); species not given (*Ribeiroa ondatrae*, *D. micradenum*, *Cercorchis medius*, *Telorchis medius*). Parasites found in the following larval caudates are: *Notophthalmus viridescens* (*Bothriocephalus rarus*); *Ambystoma maculatum* (*C. americanus*); *Ambystoma t. tigrinum* (*Telorchis corti*, *Diplostomum* sp., *Proteocephalus* sp.). All these helminth species occurring in tadpoles and larval caudates were larval or immature stages except for *T. corti* that was represented by some gravid stages.

Eight species of snakes in one family from Michigan have parasites reported from them. At least 10 parasite species occur in the northern water snake *Nerodia s. sipedon* based on 8 studies. The northern ribbon snake *Thamnophis sauritus septentrionalis* and the common garter snake *Thamnophis sirtalis* have five and eight species reported from them, respectively. The other snake species (brown snake *Storeria dekayi*, northern red-bellied snake *Storeria o. occipitomaculata*, northern ring-necked snake *Diadophis punctatus edwardsi*, eastern milk snake *Lampropeltis t. triangulum*, eastern smooth green snake *Opheodrys vernalis*) had one to three species reported from them involving three studies or less. All snake species infected with *Entamoeba invadens* involved experimental infections in the laboratory. These snakes were caught in the Douglas Lake area of Michigan. Wild snakes in Michigan have not been found infected with *E. invadens*.

Eight species of turtles in four families have parasites reported from them in Michigan. *Spiroxys contortus* infected all these species. The painted turtle *Chrysemys picta* had 18 parasite species (13 of which are digenetic trematodes) reported from it involving 14 studies. Three studies on the parasites of the eastern spiny softshell turtle *Apalone s. spinifera* reported five parasite species. Digenetic trematodes have been found in four turtle species. Of the turtle species, the painted turtle is the only one infected with a larval trematode. Of all the herp species examined from Michigan, the painted turtle is the only one infected with monogeneans.

The sites occupied by parasites in Michigan amphibians and reptiles by host order are in Table 3. At least 11 species of parasites occur in the digestive tract of salamanders from Michigan with 8 of these species reported from the intestine. The gall bladder, lung, blood, and lens of the eye each harbored one parasite species. Five species of larval parasites occurred elsewhere in the body.

At least 23 species of parasites have been reported from the digestive tract of anurans in Michigan. Eight species infect the lungs and at least four species have been found in the urinary bladder and kidneys. Six *Trypanosoma* spp. have been found in the blood. Larval and immature parasites of all the parasite groups except the monogeneans occur unencysted or encysted in the body cavity, extra intestinal visceral organs, and muscles.

Most parasites reported from Michigan snakes are from the digestive tract and lungs. Five parasite species are reported from the blood of turtles, four species from the digestive tract, and one species from the lungs. The sites of several species infecting turtles were not given in the original articles.

Published studies on the parasites of herps have been performed in 13 counties of Michigan. At least 45 studies occurred in Cheboygan County from 1916 through 1968, due to the investigations of parasitologists at the University of Michigan Biological Station at Douglas Lake. Washtenaw County has had at least 17 studies. Specific locations of six studies in Michigan were not reported. Only two articles have been published on the parasites of herps in the Upper Peninsula. One of these involved the occurrence of *Cephalogonimus americanus* in *Rana c. melanota* and the other listed blood flagellates found in six species of anurans. The number of studies (in parentheses) published on the parasites of herps in Michigan

in 20-year intervals were: 1910–1929 (11), 1930–1949 (43), 1950–1969 (19), 1970–1989 (2), and after 1990 (9). Most studies (35) were published from 1930 through 1939.

Discussion

A survey of the literature on the parasites of herps in Michigan reveals that most articles deal with parasite life histories and taxonomy, and parasite surveys of one or more herp species. These studies were not warranted by some pressing or continuous issue involving parasite or herp biology or pathology, but represent the interests of specific investigators. At least 84 studies have been published on some aspect of parasites infecting Michigan herps. Of these studies, 49 involve frogs, 5 involve toads, 19 involve salamanders, 15 involve snakes, and 16 involve turtles. These numbers are inflated because some abstracts and articles by a few authors involve the same parasites and hosts. Many articles present data on the prevalence (percentage of a herp species infected with a parasite species), mean intensity (mean number of parasites per infected herp), and mean abundance (mean number of parasites per examined herp). A few articles include information on the diversity of the helminth fauna of a herp species. More parasite species have been found in amphibians, primarily anurans, than in reptiles because more studies have examined their parasites, and more amphibian species and greater numbers of them have been examined. None of the parasites species reported from Michigan herps are exotic species.

A few species of helminths (e.g., *Clinostomum* sp., *Diplostomum* sp., *Ribeiroia ondatrae*, *Proteocephalus* sp., *Camallanus* sp., *Spinitectus gracilis*, and *Spiroxys* sp.) found in Michigan amphibians also infect fish. Gravid *S. gracilis* have been found in both ranid frogs and centrarchid fish. Larval *R. ondatrae* occur in both tadpoles and fish. Larval *Clinostomum* sp., *Diplostomum* sp., *Proteocephalus* sp., *Camallanus* sp., and *Spiroxys* sp. infect amphibians and fish in Michigan but it is not known if infections in these animals involve the same helminth species.

The total numbers of parasite species found in each herp group in parentheses are: salamanders (19), toads (7), hylid frogs (12), ranid frogs (at least 50), snakes (15), and turtles (22). Overall, both toads and hylid frogs were infected with two parasite groups: toads (protozoans 57%; trematodes, 43%) and hylid frogs (trematodes 67%; nematodes, 33%). The percentages (in parentheses) of each parasite group (protozoans, trematodes, monogeneans, cestodes, and nematodes, respectively) for the remaining herp groups are: salamanders (21%, 47%, 0%, 11%, 21%), ranid frogs (13%, 57%, 0%, 11%, 19%), snakes (27%, 53%, 0%, 7%, 13%), and turtles (5%, 71%, 10%, 0%, 14%). Excluding toads, trematodes are the most common parasites found in the herp groups. Monogeneans have only been reported from turtles. Cestodes have not been found in toads, hylid frogs, and turtles. As more studies are performed on herp species (groups) in Michigan, more parasite species will be found.

Earlier it was mentioned that no attempt was made to demonstrate the past complexities of parasite synonyms. However, it should be pointed out that a few helminth species in some families such as Haematoloechidae, Spirorchiidae, Telorchiidae, and Molineidae have undergone name revisions and synonymizations. Therefore, the taxonomic status of some species listed in the tables in this review article may be uncertain.

Several investigators have suggested there is a positive correlation between type of habitat occupied by the herp species and number of helminth species found, with those species associated with aquatic environments having more parasite species than terrestrial ones. Most parasite species reported from herps in Michigan are digenetic trematodes that utilize molluscs as intermediate hosts. The presence of more parasite species in frogs compared to other herp groups in Michigan is likely due to their association with aquatic habitats. Frogs eat many aquatic organisms that serve as intermediate hosts for digenetic trematodes and other parasite groups, and live in the water where larval parasites (primarily trematodes) can directly penetrate and infect them. Other explanations may be that snakes and turtles in Michigan have not been surveyed for their parasites as commonly as frogs, or parasites may

not be that common in Michigan snakes and turtles.

Herps may be infected with either the larval or adult stage of the parasite species and can serve as either the intermediate or definitive host or both at the same time. In many cases, the predator-prey relationships of herps help explain the transmission of the parasites that infect them. Frogs are infected with many species of larval parasites indicating they serve as intermediate hosts for several parasites and are eaten by several species of predators. Not enough studies in Michigan have been performed on toads, salamanders, snakes, and turtles to determine if they have many larval parasites. Many herp species in Michigan serve as definitive hosts for several parasite species that they acquire by eating intermediate hosts.

Where the parasitological data comparing herp developmental stages are known, more parasite species have been found in adult frogs compared to tadpoles or juveniles. An increase in the number of parasite species and their numbers in adults can be a function of time, with older (larger) individuals having a longer time to acquire parasites, or reflect ontogenetic shifts in diet, habitat, or behavior.

Studies on the parasites of herps sometimes offer some interesting insights on how they affect their hosts. Two examples in Michigan will suffice. Brackett (1938) reported that gravid females of the nematode *Dracunculus ophidensis* are found primarily on the dorsal surface of the snake *Thamnophis sirtalis*, producing dermal elevations characteristic of infection. Brackett (1938) stated "The remains of a female worm which has given off its larvae are in some way disposed of by the snake's tissue, for all traces of the infection disappear by fall or early winter." In a letter from Bruce Lang regarding *D. ophidensis* infecting *T. sirtalis*, it was stated "The snake's tail is damaged to the point where portions drop off when an infection forms in the area around the blister where the larvae exit the snake." And furthermore "This then could explain the high percentage of *T. sirtalis* with portions of their tail missing" in the Cheboygan area of Michigan. Cort and Brackett (1938) reported that the unencysted larval diplostomula stages of the trematode, *Cercaria ranae*, occurred in the body cavity and are widely distributed in the tissues of tadpoles. They reported that heavy infections in the tadpoles caused severe symptoms, producing a condition that they called "bloat disease," due to the characteristic distension of the abdomen.

Studies have not been published on the parasites of mudpuppies *Necturus maculosus maculosus*, western lesser sirens *Siren intermedia nettingi*, marbled salamanders *Ambystoma opacum*, small-mouthed salamanders *Ambystoma texanum*, Cope's gray treefrog *Hyla chrysoscelis*, Kirtland's snake *Clonophis kirtlandii*, northern copper-bellied water snake *Nerodia erythrogaster neglecta*, queen snake *Regina septemvittata*, Butler's garter snake *Thamnophis butleri*, eastern hognose snake *Heterodon platyrhinos*, racer *Coluber constrictor foxi*, black rat snake *Elaphe obsoleta obsoleta*, eastern fox snake *Elaphe gloydi*, western fox snake *Elaphe vulpina*, eastern massasauga rattlesnake *Sistrurus catenatus catenatus*, wood turtle *Glyptemys insculpta*, red-eared slider *Trachemys scripta elegans*, five-lined skink *Eumeces fasciatus*, and six-lined racerunner *Cnemidophorus sexlineatus*, in Michigan. Fowler's toad, Blanchard's cricket frog, eastern gray treefrog, pickerel frog, mink frog, spotted salamander, eastern tiger salamander, red-backed salamander, brown snake, northern red-bellied snake, northern ring-necked snake, common musk turtle, spotted turtle, eastern box turtle, and Blanding's turtle each have had only one study published on their parasites. Furthermore, before the anecdotal report of Muzzall et al. (2001) of *Pneumatophilus foliaformis* infecting *Nerodia s. sipedon*, the last publication on the parasites of snakes in Michigan was Yongue (1964). Also, the last report of a parasite infecting a turtle in Michigan was the brief mention by Esch and Kocan (1966). The lack of parasitological studies on these herp species and the infrequency of studies on other species in Michigan are not surprising and are due to several reasons. These include: the distributions of some herp species in Michigan are restricted; some species occur in low numbers; some species are threatened or endangered; lack of interest by investigators; and lack of financial support for studies like this.

Parasites can be found in all the organs of a herp. If only the digestive tract of the herp is examined, some parasite species (and their

numbers), as indicated by this review, would be missed and not counted. There may be hundreds of larval parasites in the herp. Many of the larval digenetic trematodes, cestodes, and nematodes infecting herps (especially amphibians) in Michigan are difficult to work with because removing larvae from their cysts may be difficult. If successfully removed, they should be examined alive to find characteristics, if developed enough, that will be useful for identification. Larval parasites may also be identified to species if feeding experiments of the larvae are performed and adult worms are found in the animals that were fed the larvae.

There are a few terms that describe various larval stages of trematodes and cestodes that occur in herps, primarily amphibians, that deserve mention for clarification purposes. Several species of cercariae have been described and illustrated in the older literature, being given the generic name *Cercaria* for these species. Therefore, the scientific name of these digenetic trematodes may not be known. Thus, the term cercaria has been used as a generic name, and more appropriately as a common name for certain larval stages of digenetic trematodes. Bosma (1934) used the terms, immature metacercaria and agamodistomum to define the larval trematode stage that forms from the cercaria that penetrates into and occurs in tadpoles and frogs of the trematode genus *Alaria*. She demonstrated by experiments that the so-called agamodistomum of *Alaria mustelae* is an essential step in the development of the next larval stage called the metacercaria. She suggested that the name mesocercaria should be used instead of immature metacercaria or agamodistomum. In support of this, Olivier and Odlaug (1938) employed mesocercaria (sometimes referred to as the genus *Mesocercaria* (=*Agamodistomum*) in the earlier literature) as the name for these stages of trematodes with four-host life cycles. The latter authors found mesocercaria of *Alaria intermedia* (=*Mesocercaria intermedia*) in the muscles and pericardial region of tadpoles and adult *Rana pipiens* and in the fatty tissue of the tail of *Thamnophis sirtalis*. Therefore, unencysted mesocercaria can be found in both amphibians and reptiles. Schell (1985) reported that the mesocercaria stage can also be produced by digenetic trematodes in the genera *Procyotrema*, *Pharyngostomoides*, and *Strigea*.

In general, larval cestodes can be recognized by the presence of calcareous corpuscles. Larval cestodes generally referred to as tetrathyridia may be found and are considered to be of the genus *Mesocestoides*. These stages have a deeply invaginated and inverted unarmed scolex with four suckers. Schmidt (1970) defined a tetrathyridium as the cysticercoid of *Mesocestoides* that has a solid body and a scolex not surrounded by special membranes. A juvenile cestode in its host can also be called a metacestode.

Johnson et al. (2002) reviewed information on larval trematodes producing deformities in amphibians in North America. They reported that the larval trematode *Ribeiroia ondatrae* was associated with, and functionally related to, higher frequencies of amphibian limb malformations than found in uninfected populations. Gillilland and Muzzall (2002) reported on the larval helminth parasites infecting amphibians from southern Michigan and discussed the lack of deformities in them from this area. The earliest article on the larval trematodes of amphibians in Michigan was Cort (1918). Although all the animal species (snails, amphibians and fish, herons, and hawks) necessary for the completion of the life cycle of *R. ondatrae* occur in Michigan, limb malformations of amphibians and the relationship between larval trematodes and amphibian malformations were never mentioned in articles on the larval trematodes of Michigan amphibians. If *R. ondatrae* can produce limb malformations in amphibians, might it also be possible that larval cestodes and nematodes can cause deformities. In Michigan and elsewhere, unencysted and encysted larval cestodes and nematodes are common parasites of amphibians but so far, a relationship between these larval helminths and deformities has not been reported.

Beaver (1939) reported on the occurrence of metacercariae of *Ribeiroia* (= *Psilostomum*) *ondatrae* in the lateral line canal and under the scales of freshwater fish (experimental and field infections) from Douglas Lake, Michigan and the surrounding region. He stated that metacercariae "also develop in the nostrils of tadpoles and fish, and occasionally may be found in the cloaca and associated ducts after

prolonged exposure to heavy suspensions of cercariae" and that "Never more than a dozen or so would encyst in any one of these small hosts, however." He also mentioned that adult *R. ondatrae* were found in Cooper's Hawks and that laboratory infections were obtained in other birds. Since the study by Beaver (1939), *R. ondatrae* has not been reported from Michigan herps. Dyer (1991) did not list *Ribeiroia* occurring in amphibians from Illinois and adjacent states.

Several articles and reports have mentioned that some species of herps in the world have declined and other species showed no decline in their numbers. Apparently there is no single factor or set of factors that can be presented to explain these declines. However, habitat destruction, general environmental degradation, and exploitation of herps serving as food items were implicated in many instances. It is important to point out that if herp species are declining, and if one or more of their parasite species are host specific, then parasites are also declining.

The parasites of herps should not be overlooked and their influence on herps should not be underestimated. Johnson et al. (2002) and Daszak et al. (2003) demonstrated their importance in causing amphibian deformities and reducing their population numbers at some locations. I recommend that if individuals are removed from a herp population to be studied for various purposes, they should also be examined for parasites. A multidisciplinary approach to studying herp populations is essential to understand all aspects of the biology of the herp species being examined.

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Table 1.–List of parasites reported in amphibians and reptiles from Michigan. The classification of parasites is partly based on that of Baker (1987) and Yamaguti (1959, 1971). References in parentheses following hosts refer to references for host records.

Sarcodina (Ameba):

Entamoebidae Chatton, 1925

Entamoeba invadens Rodhain, 1934

Host: *Diadophis punctatus edwardsii*, *Lampropeltis t. triangulum*, *Nerodia s. sipedon*, *Opheodrys vernalis*, *Storeria dekayi*, *Storeria o. occiptomaculata Thamnophis sauritus septentrionalis*, *Thamnophis sirtalis*, (Barrow and Stockton 1960).

Mastigophora (Flagellates):

Hexamitidae Kent

Octomitus intestinalis Dujardin

Host: *Rana clamitans melanota*, *Rana pipiens*, (Fortner 1923).

Opalinidae Claus, 1874

Opalina obtrigonoidea Metcalf

Host: *Rana c. melanota*, *Rana pipiens*, *Rana sylvatica*, (Fortner 1923).

Trichomonadidae Chalmus and Pekkola, 1918

Trichomonas sp. Donne, 1836

Host: *Nerodia s. sipedon*, (Barrow and Stockton 1960).

Trypanosomatidae Doflein, 1901

Trypanosoma bufophlebotomi Ayala, 1970

Host: *Bufo a. americanus*, (Werner and Walewski 1976).

Trypanosoma diemictyli Tobey, 1906

Host: *Notophthalmus viridescens*, (Werner and Walewski 1976).

Trypanosoma pipientis Diamond, 1950

Host: *Rana c. melanota*, *Rana pipiens*, (Werner and Walewski 1976).

Trypanosoma pseudopodium Werner and Walewski, 1976

Host: *Bufo a. americanus*, (Werner and Walewski 1976).

Trypanosoma ranarum (Lankester, 1871) Danilewsky 1885

Host: *Rana catesbeiana*, *Rana c. melanota*, *Rana pipiens*, *Rana septentrionalis*, *Rana sylvatica*, (Werner and Walewski 1976).

Trypanosoma rotatorium (Mayer, 1843) Laveran and Mesnil 1901

Host: *Rana catesbeiana*, *Rana c. melanota*, *Rana pipiens*, *Rana septentrionalis*, (Werner and Walewski 1976).

Trypanosoma schmidti-like species Diamond, 1965

Host: *Bufo a. americanus*, (Werner and Walewski 1976).

Ciliophora (Ciliates):

Haptophyridae Cepede, 1910

Cepedietta michiganenesis Woodhead, 1928

Host: *Ambystoma laterale*, (McIntosh 1935; Woodhead 1928); *Plethodon cinereus*, (Muzzall 1990); *Hemidactylium scutatum*, (Blanchard 1923; Bush 1934; MacLennan 1944; McIntosh 1935; Rankin 1938; Woodhead 1928; Woodhead and Kruidenier 1936); *Bufo a. americanus*, (McIntosh 1935); *Rana c. melanota*, (Muzzall et al. 2001).

Nyctotheridae Amaro, 1972

Nyctotherus cordiformis Ehrenberg

Host: *Rana c. melanota*, *Rana pipiens*, (Fortner 1923).

Table 1–Continued.

Apicomplexa (Apicomplexans):

Eimeriidae Minchin, 1903
Eimeria longaspora Barrow and Hoy, 1960
Host: *Notophthalmus viridescens*, (Barrow and Hoy 1960).
Eimeria megaresidua Barrow and Hoy, 1960
Host: *Notophthalmus viridescens*, (Barrow and Hoy 1960).
Coccidians
Host: *Thamnophis sauritus septentrionalis,* (Barrow and Stockton 1960).

Plasmodiidae Mesnil, 1903
Haemoproteus metchinikovi (Simond, 1901)
Host: *Chrysemys picta*, (DeGiusti and Batten 1951).
Haemogregarine-like form
Host: *Nerodia s. sipedon*, (Yongue 1964).

Unidentified protozoans
Host: *Rana sylvatica*, (Woodhams et al. 2000).

Adult Digenea (Digenetic Trematodes):

Brachycoeliidae Johnston, 1912
Brachycoelium salamandrae (Froelich, 1789)
Host: *Ambystoma laterale*, (Muzzall and Schinderle 1992); *Plethodon cinereus*, (Muzzall 1990); *Acris crepitans blanchardi*, (Najarian 1955); *Rana sylvatica*, (Najarian 1955).
Brachycoelium sp. Stiles and Hassall, 1898
Host: *Hemidactylium scutatum*, (Rankin 1938).

Cephalogonimidae Nicoll, 1915
Cephalogonimus americanus Stafford, 1902
Host: *Ambystoma maculatum*, (Lang 1968); *Bufo fowleri*, (Lang 1968); *Bufo* sp., (Lang 1968); *Rana c. melanota*, (Fortner 1923; Lang 1968; Najarian 1955; Spence and Peters 1971); *Rana pipiens*, (Fortner 1923; Najarian 1955).
Cephalogonimus vesicaudus Nickerson, 1912
Host: *Rana c. melanota*, (Najarian 1955).

Gorgoderidae Looss, 1901
Gorgodera amplicava Looss, 1899
Host: *Rana c. melanota*, (Muzzall 1991b; Muzzall et al. 2001; Najarian 1955).
Gorgoderina attenuata (Stafford, 1902) Stafford, 1905
Host: *Rana catesbeiana*, (Muzzall 1991b); *Rana c. melanota*, (Fortner 1923; Muzzall 1991b; Muzzall et al. 2001); *Rana pipiens*, (Fortner 1923).
Gorgoderina simplex (Looss, 1899) Looss, 1902
Host: *Rana catesbeiana*, *Rana c. melanota*, (Najarian 1955).
Juvenile gorgoderids
Host: *Rana pipiens*, (Goodchild 1950).

Haematoloechidae Odening, 1964
Haematoloechus breviplexus Stafford, 1902
Host: *Rana c. melanota*, (Najarian 1955).
Haematoloechus longiplexus Stafford, 1902
Host: *Rana catesbeiana*, (Krull 1932; Muzzall 1991b; Najarian 1955); *Rana c. melanota*, (Muzzall 1991b).
Haematoloechus medioplexus Stafford, 1902
Host *Bufo a. americanus*, (Krull 1931); *Rana c. melanota*, (Fortner 1923); *Rana pipiens*, (Fortner 1923; Krull 1930; Krull 1931).

Table 1–Continued.

Haematoloechus parviplexus (Irwin, 1929)
Host: *Rana catesbeiana*, (Muzzall 1991b); *Rana c. melanota*, (Krull 1930; Krull 1931; Muzzall 1991b; Najarian 1955); *Rana sylvatica*, (Muzzall and Peebles 1991).
Haematoloechus similiplexus Stafford, 1902
Host: *Rana c. melanota*, *Rana pipiens*, (Fortner 1923).
Haematoloechus varioplexus Stafford, 1902
Host: *Rana c. melanota*, (Muzzall et al. 2001); *Rana sylvatica*, (Najarian 1955).

Hemiuridae Luhe, 1901
Halipegus eccentricus Thomas, 1939
Host: *Rana catesbeiana*, *Rana pipiens*, (Thomas 1939); *Rana c. melanota*, (Ameel et al. 1949; Muzzall et al. 2001; Thomas 1939).
Halipegus sp. Looss, 1899
Host: *Notophthalmus viridescens*, (Muzzall 1991a); *Rana catesbeiana*, (Muzzall 1991b); *Rana c. melanota*, (Krull 1935; Muzzall 1991b).

Heronimidae Ward, 1917
Heronimus chelydrae MacCallum, 1902
Host: *Chrysemys picta*, (Ward 1917; Esch and Gibbons 1967).

Lecithodendriidae Odhner, 1910
Loxogenes arcanum (Nickerson, 1900) Stafford, 1905
Host: *Rana catesbeiana*, (Muzzall 1991b); *Rana c. melanota*, (Muzzall 1991b; Spence and Peters 1971).

Macroderoididae McMullen, 1937
Glypthelmins pennsylvaniensis Cheng, 1961
Host: *Pseudacris c. crucifer*, (Muzzall and Peebles 1991); *Pseudacris triseriata*, (Muzzall and Peebles 1991).
Glypthelmins quieta (Stafford, 1900) Stafford, 1905
Host: *Pseudacris c. crucifer*, (Najarian 1955); *Rana catesbeiana*, (Muzzall 1991b; Najarian 1955); *Rana c. melanota*, (Muzzall 1991b; Muzzall et al. 2001; Najarian 1955); *Rana sylvatica*, (Muzzall and Peebles 1991).

Paramphistomidae Fischoeder, 1901
Allassostomoides parvum (Stunkard, 1916) Travassos, 1934
Host: *Chrysemys picta*, (Esch and Gibbons 1967).
Megalodiscus temperatus (Stafford, 1905) Harwood, 1932
Host: *Notophthalmus viridescens*, (Muzzall 1991a; Muzzall et al. 2003); *Pseudacris c. crucifer*, (Herber 1939; Najarian 1955); *Rana catesbeiana*, (Krull and Price 1932; Muzzall 1991b; Najarian 1955); *Rana c. melanota*, (Fortner 1923; Krull and Price 1932; Muzzall 1991b; Muzzall et al. 2001; Najarian 1955); *Rana pipiens*, (Fortner 1923; Krull and Price 1932; Van der Woude 1954); *Rana sylvatica*, (Krull and Price 1932; Van der Woude 1954).

Plagiorchiidae Ward, 1917
Eustomos chelydrae MacCallum, 1921
Host: *Chelydra s. serpentina*, (McMullen 1935); *Chrysemys picta*, (Esch and Gibbons 1967; McMullen 1935).
Lechriorchis primus Stafford, 1905
Host: *Thamnophis s. septentrionalis*, (Cort et al. 1952); *Thamnophis sirtalis*, (Cort et al. 1952).
Natriodera verlata (Talbot, 1934)
Host: *Nerodia s. sipedon*, (Talbot 1934).
Pneumatophilus foliaformis Talbot, 1934
Host: *Nerodia s. sipedon*, (Muzzall et al 2001; Talbot 1934).

Table 1.–Continued.

Renifer orula (Talbot, 1934)
Host: *Nerodia s. sipedon*, (Talbot 1934).
Zeugorchis eurinus (Talbot, 1933)
Host: *Thamnophis s. septentrionalis*, *Thamnophis sirtalis*, (Talbot 1933).
Zeugorchis megametricum (Talbot, 1934)
Host: *Thamnophis sirtalis*, (Talbot 1934).

Pronocephalidae Looss, 1902
Macravestibulum eversum Hsu, 1937
Host: *Graptemys geographica*, (Hsu 1937).
Teloporia aspidonectes (MacCallum, 1917) Fukui, 1933
Host: *Rana catesbeiana*, *Apalone s. spinifera*, (Esch and Kocan 1966).

Spirorchiidae Stunkard, 1921
Spirorchis artericola (Ward, 1921)
Host: *Chrysemys picta*, (Esch and Gibbons 1967).
Spirorchis elephantis (Cort, 1917)
Host: *Chrysemys picta*, (Wall 1941b).
Spirorchis parvus (Stunkard, 1923)
Host: *Chrysemys picta*, (Wall 1940; Wall 1941a).
Spirorchis sp. MacCallum, 1919
Host: *Chrysemys picta*, (Cort et al. 1954; Wall 1939).
Vasotrema amydae (Stunkard, 1926)
Host: *Apalone s. spinifera*, (Wall 1951).
Vasotrema robustum Stunkard, 1928
Host: *Apalone s. spinifera*, (Wall 1951).

Telorchiidae Stunkard, 1924
Protenes angustus (Stafford, 1900) Ward, 1918
Host: *Chrysemys picta*, (Esch and Gibbons 1967).
Telorchis attenuatus Goldberger, 1911
Host: *Chrysemys picta*, (Esch and Gibbons 1967).
Telorchis corti Stunkard, 1915
Host: *Notophthalmus viridescens*, (Muzzall 1991a); *Ambystoma t. tigrinum*, (Muzzall and Schinderle 1992); *Chrysemys picta*, (Esch and Gibbons 1967).
Telorchis diminutis Stunkard, 1915
Host: *Chrysemys picta*, (Esch and Gibbons 1967).
Telorchis medius Stunkard, 1915
Host: tadpoles, *Chrysemys picta*, *Thamnophis* spp., (McMullen 1934).

Larval Digenea (Digenetic Trematodes):

Clinostomidae Luhe, 1901
Clinostomum attenuatum Cort, 1913
Host: *Rana c. melanota*, (Fortner 1923; Najarian 1955); *Rana pipiens*, (Fortner 1923).
Clinostomum sp. Leidy, 1856
Host: *Notophthalmus viridescens*, (Muzzall 1991a); *Rana catesbeiana*, (Muzzall 1991b); *Rana c. melanota*, (Muzzall et al. 2001); *Rana pipiens*, (Gillilland and Muzzall 1999).

Diplostomidae Poirier, 1886
Diplostomum micradenum Olivier, 1940
Host: *Bufo a. americanus, Pseudacris c. crucifer, Rana c. melanota, Rana pipiens*, (Olivier 1938; Olivier 1940); *Rana pipiens*, (Olivier 1942).

Table 1.–Continued.

Diplostomum sp. Nordmann, 1832
Host: *Ambystoma t. tigrinum*, (Muzzall and Schinderle 1992).
Fibricola sp. Dubois, 1932
Host: *Rana c. melanota*, (Muzzall et al. 2001); Rana pipiens, (Gillilland and Muzzall 1999).

Echinostomatidae Poche, 1926
Echinoparyphium flexum (Linton, 1892) Dietz, 1910
Host: *Pseudacris c. crucifer, Pseudacris triseriata, Rana c. melanota, Rana pipiens, Rana sylvatica*, (Najarian 1952; Najarian 1953a; Najarian 1954); *Rana pipiens*, (Najarian 1953b).

Echinostome metacercariae
Host: *Ambystoma laterale*, (Muzzall and Schinderle 1992); *Pseudacris c. crucifer*, (Najarian 1955); *Rana c. melanota*, (Muzzall et al. 2001; Najarian 1955); *Rana sylvatica*, (Najarian 1955).

Gorgoderidae Looss, 1901

Gorgoderid metacercariae
Host: *Pseudacris c. crucifer*, (Najarian 1955); *Rana c. melanota*, (Muzzall et al. 2001; Najarian 1955); *Rana sylvatica*, (Najarian 1955).

Plagiorchiidae Ward, 1917
Lechriorchis primus Stafford, 1905
Host: *Rana c. melanota*, *Rana pipiens*, (Talbot 1933).
Renifer metacercariae
Host: *Rana pipiens*, (Najarian 1955).
Immature plagiorchids
Host: *Rana pipiens*, (Gillilland and Muzzall 1999).

Psilostomatidae Odhner, 1913
Ribeiroia ondatrae (Price, 1931)
Host: unspecified tadpoles, (Beaver 1939).

Strigeidae Railliet, 1919
Alaria intermedia Olivier and Odlaug, 1938
Host: *Rana pipiens*, *Thamnophis sirtalis*, (Olivier and Odlaug 1938).
Alaria marcianae (La Rue 1917)
Host: *Rana c. melanota*, *Rana pipiens*, (Cort 1918); *Thamnophis sirtalis*, (Cort 1918; Cort and Brooks 1928); *Nerodia s. sipedon*, (Cort and Brooks 1928).
Alaria mustelae Bosma 1925
Host: *Rana catesbeiana*, *Rana c. melanota*, *Rana palustris*, *Rana pipiens*, (Bosma 1934); unidentified frogs, (Bosma 1925).
Apharyngostrigea pipientis (Faust, 1918)
Host: *Hyla versicolor*, *Rana pipiens*, (Hughes 1928; Olivier 1939).

Strigeid metacercariae
Host: *Rana pipiens*, (Gillilland and Muzzall 1999).

Mesocercaria
Host: *Nerodia s. sipedon*, (Yongue 1964).

Cercaria ranae
Host: *Rana pipiens*, (Cort and Brackett 1937; Cort and Brackett 1938).

Cercaria welleri McMullen, 1938
Hosts: *Chelydra* sp., *Chrysemys* sp., *Nerodia* sp., (McMullen 1938).

Metacercariae A
Host: *Notophthalmus viridescens*, (Muzzall et al. 2003); *Rana c. melanota*, (Muzzall et al. 2001).

Table 1.–Continued.

Unidentified metacercariae
Host: *Ambystoma laterale*, (Muzzall and Schinderle 1992); *Rana pipiens*, (Gillilland and Muzzall 1999); *Rana sylvatica*, (Muzzall and Peebles 1991; Woodhams et al. 2000).

Adult Monogenea (Monogeneans):

Polystomatidae Gamble, 1896
Neopolystoma orbiculare (Stunkard, 1916) Price, 1939
Host: *Chrysemys picta*, (Esch and Gibbons 1967).
Polystomoides coronatum (Leidy, 1888) Ozaki, 1935
Host: *Chrysemys picta*, (Bychowsky 1961; Esch and Gibbons 1967).

Adult Cestoda (Cestodes):

Bothriocephalidae Blanchard, 1849
Bothriocephalus rarus Thomas, 1937
Host: *Notophthalmus viridescens*, (Muzzall 1991a; Thomas 1927; Thomas 1934; Thomas 1937a; Thomas 1937b).

Nematotaeniidae Luhe, 1910
Cylindrotaenia americana Jewell, 1916
Host: *Rana pipiens*, (Jewell 1916).
Cylindrotaenia quadrijugosa Lawler, 1939
Host: *Rana pipiens*, (Lawler 1939).

Proteocephalidae La Rue, 1911
Proteocephalus perspicua La Rue, 1911
Host: *Nerodia s. sipedon*, (Thomas 1941).
Proteocephalus saphena Osler, 1931
Host: *Rana c. melanota*, (Muzzall et al. 2001; Osler 1931; Thomas 1931).
Proteocephalus sp. Weinland, 1858
Host: *Ambystoma t. tigrinum*, (Muzzall and Schinderle 1992); *Rana c. melanota*, (Muzzall 1991b).
Proteocephalidae La Rue, 1911
Host: *Rana c. melanota*, *Rana pipiens*, (Fortner 1923).

Larval Cestoda (Cestodes):

Mesocestoididae Perrier, 1897
Mesocestoides sp. Vaillant, 1863
Host: *Rana c. melanota*, (Muzzall et al 2001); *Rana pipiens*, (Gillilland and Muzzall 1999); *Rana sylvatica*, (Woodhams et al. 2000).

Proteocephalidae La Rue, 1911
Proteocephalus perspicua La Rue, 1911
Host: *Rana c. melanota*, (Thomas 1941).
Proteocephalus sp. Weiland 1858
Host: *Rana c. melanota*, (Muzzall et al. 2001).

Adult Nematoda (Nematodes):

Camallanidae Railliet and Henry, 1915
Camallanus microcephalus (Dujardin, 1845) (Railliet and Henry, 1915)
Host: *Chrysemys picta*, (Esch and Gibbons 1967).
Camallanus sp. Railliet and Henry, 1915
Host: *Rana c. melanota*, (Muzzall et al. 2001).
Serpinema sp. Yeh, 1960
Host: *Rana c. melanota*, (Muzzall 1991b).

Table 1.–Continued.

Cosmocercidae (Railliet, 1916) Travassos, 1925
Cosmocercoides dukae (Holl, 1928) Travassos, 1931
Host: *Pseudacris triseriata*, (Muzzall and Peebles 1991); *Rana pipiens*, (Gillilland and Muzzall 1999); *Rana sylvatica*, (Muzzall and Peebles 1991).
Cosmocercoides sp. Wilkie, 1930
Host: *Pseudacris c. crucifer*, (Muzzall and Peebles 1991).
Raillietnema sp. Travassos, 1927
Host: *Rana c. melanota*, (Muzzall et al. 2001); *Rana pipiens*, (Gillilland and Muzzall 1999).
Aplectana/*Cosmocercoides* sp.
Host: *Rana catesbeiana*, (Muzzall 1991b); *Rana c. melanota*, (Muzzall 1991b).

Cystidicolidae Skrjabin, 1946
Spinitectus gracilis Ward and Magath, 1917
Host: *Rana catesbeiana*, (Muzzall 1991b); *Rana c. melanota*, (Muzzall et al. 2001).

Dracunculidae (Stiles, 1907) Leiper, 1912
Dracunculus ophidensis Brackett, 1938
Host: *Nerodia s. sipedon*, *Thamnophis sirtalis*, (Brackett 1938).

Gnathostomatidae Railliet, 1915
Spiroxys amydae Cobb, 1929
Host: *Apalone s. spinifera*, (Hedrick 1935).
Spiroxys contortus (Rudolphi, 1819) Schneider, 1866
Host: *Apalone s. spinifera*, *Chelydra s. serpentina*, *Chrysemys picta*, *Clemmys guttata*, *Emydoidea blandingi*, *Graptemys geographica*, *Sternotherus odoratus*, *Terrapene c. carolini*, (Hedrick 1935); *Chrysemys picta*, (Esch and Gibbons 1967).

Kathlaniidae York and Maplestone, 1926
Falcaustra catesbeianae Walton, 1929
Host: *Notophthalmus viridescens*, (Muzzall 1991a); *Rana catesbeiana*, (Muzzall 1991b); *Rana c. melanota*, (Muzzall 1991b).
Falcaustra sp. Lane, 1915
Host: *Notophthalmus viridescens*, (Muzzall et al. 2003); *Rana c. melanota*, (Muzzall et al. 2001).

Molineidae (Skrjabin and Schulz, 1937) Durette-Desset and Chabaud, 1977
Oswaldocruzia pipiens Walton, 1929
Host: *Rana sylvatica*, (Muzzall and Peebles 1991).
Oswaldocruzia priceae Slimane and Durette – Desset 1997
Host: *Rana c. melanota*, (Muzzall et al. 2001); *Rana pipiens*, (Gillilland and Muzzall 1999).
Oswaldocruzia sp. Travassos, 1917
Host: *Rana catesbeiana*, *Rana c. melanota*, *Rana pipiens*, (Ridgeway 1964).

Onchocercidae (Leiper, 1911)
Waltonella sp. Schacher, 1974
Host: *Rana c. melanota*, (Muzzall et al. 2001).

Pharyngodonidae Travassos, 1919
Thelandros magnavulvaris (Rankin, 1937)
Host: *Ambystoma laterale*, (Muzzall and Schinderle 1992); *Plethodon cinereus*, (Muzzall 1990).

Rhabdiasidae Railliet, 1915
Rhabdias fuscovenosa (Railliet, 1899) Goodey, 1924
Host: *Lampropeltis t. triangulum*, *Nerodia s. sipedon*, *Opheodrys vernalis*, *Thamnophis s. septentrionalis*, *Thamnophis sirtalis*, (Chu 1936a); *Nerodia s. sipedon*, *Thamnophis sirtalis*, (Chu 1936b).

Table 1.–Continued.

Rhabdias ranae Walton, 1929
Host: *Ambystoma laterale*, (Muzzall and Schinderle 1992); *Pseudacris c. crucifer*, (Muzzall and Peebles 1991); *Rana c. melanota*, (Muzzall et al. 2001); *Rana pipiens*, (Gillilland and Muzzall 1999; Walton 1929); *Rana sylvatica*, (Muzzall and Peebles 1991; Woodhams et al. 2000).

Unidentified adults
Host: *Rana sylvatica*, (Fortner 1923); *Thamnophis sirtalis*, (Barrow and Stockton 1960).

Unidentified juvenile
Host: *Rana c. melanota*, (Muzzall et al. 2001).

Larval Nematoda (Nematodes):

Dracunculidae (Stiles, 1907) Leiper, 1912
Dracunculus ophidensis Brackett, 1938
Host: unidentified tadpoles, (Brackett 1938).

Gnathostomatidae Railliet, 1915
Spiroxys contortus (Rudolphi, 1819) Schneider, 1866
Host: *Notophthalmus viridescens*, *Rana c. melanota*, (Hedrick 1935).
Spiroxys sp. Schneider, 1866
Host: *Notophthalmus viridescens*, (Muzzall 1991a; Muzzall et al. 2003); *Ambystoma laterale*, (Muzzall and Schinderle 1992); *Pseudacris c. crucifer*, (Muzzall and Peebles 1991); *Rana catesbeiana*, (Muzzall 1991b); *Rana c. melanota*, (Muzzall 1991b; Muzzall et al. 2001); *Rana pipiens*, (Gillilland and Muzzall 1999); *Rana sylvatica*, (Muzzall and Peebles 1991).

Onchocercidae (Leiper, 1911)

Microfilaria
Host: *Nerodia s. sipedon*, (Yongue 1964).

Unidentified larva
Host: *Rana c. melanota*, (Muzzall et al. 2001); *Rana pipiens*, (Gillilland and Muzzall 1999).

Table 2.–List of Michigan amphibians and reptiles from which parasites have been reported. The material on which the list is based is derived from the material in Table 1. The classification of hosts is based on Harding and Holman (1990, Harding and Holman (1992), Holman et al. (1989), and Harding (1997). References in parentheses following hosts refer to references for host records.

Order: Caudata (Salamanders).

Ambystomatidae (Mole Salamanders)

Blue-spotted salamander *Ambystoma laterale*
- Ciliophora: *Cepedietta michiganensis*, (McIntosh 1935; Woodhead 1928).
- Adult Digenea: *Brachycoelium salamandrae*, (Muzzall and Schinderle 1992).
- Larval Digenea: echinostome metacercaria, unidentified metacercaria, (Muzzall and Schinderle 1992).
- Adult Nematoda: *Rhabdias ranae*, (Muzzall and Schinderle 1992); *Thelandros magnavulvaris*, (Muzzall and Schinderle 1992).
- Larval Nematoda: *Spiroxys* sp., (Muzzall and Schinderle 1992).

Spotted salamander *Ambystoma maculatum*
- Adult Digenea: *Cephalogonimus americanus*, (Lang 1968).

Eastern tiger salamander *Ambystoma tigrinum tigrinum*
- Adult Digenea: *Telorchis corti*, (Muzzall and Schinderle 1992).
- Larval Digenea: *Diplostomum* sp., (Muzzall and Schinderle 1992).
- Adult Cestoda: *Proteocephalus* sp., (Muzzall and Schinderle 1992).

Salamandridae (Newts)

Eastern newt *Notophthalmus viridescens*
- Apicomplexa: *Eimeria longaspora*, *Eimeria megaresidua*, (Barrow and Hoy 1960).
- Mastigophora: *Trypanosoma diemictyli*, (Werner and Walewski 1976).
- Adult Digenea: *Halipegus* sp., (Muzzall 1991a); *Megalodiscus temperatus*, (Muzzall 1991a; Muzzall et al. 2003); *Telorchis corti*, (Muzzall 1991a).
- Larval Digenea: *Clinostomum* sp., (Muzzall 1991a); metacercaria A, (Muzzall et al. 2003).
- Adult Cestoda: *Bothriocephalus rarus*, (Thomas 1927; Thomas 1937a; Thomas 1937b; Muzzall 1991a).
- Adult Nematoda: *Falcaustra catesbeianae*, *(*Muzzall 1991a); *Falcaustra* sp., (Muzzall et al. 2003).
- Larval Nematoda: *Spiroxys contortus*, (Hedrick 1935); *Spiroxys* sp., (Muzzall 1991a; Muzzall et al. 2003).

Plethodontidae (Lungless Salamanders)

Red-backed salamander *Plethodon cinereus*
- Ciliophora: *Cepedietta michiganensis*, (Muzzall 1990).
- Adult Digenea: *Brachycoelium salamandrae*, (Muzzall 1990).
- Adult Nematoda: *Thelandros magnavulvaris*, (Muzzall 1990).

Four-toed salamander *Hemidactylium scutatum*
- Ciliophora: *Cepedietta michiganensis*, (Blanchard 1923; Bush 1934; MacLennan 1944; McIntosh 1935; Rankin 1938; Woodhead 1928; Woodhead and Kruidenier 1936).

Order: Anura (Toads and Frogs).

Bufonidae (True Toads)

Eastern American toad *Bufo americanus americanus*
- Ciliophora: *Cepedietta michiganensis*, (McIntosh 1935).
- Mastigophora: *Trypanosoma bufophlebotomi*, *Trypanosoma schmidti* – like species, *Trypanosoma pseudopodium*, (Werner and Walewski 1976).
- Adult Digenea: *Haematoloechus medioplexus*, (Krull 1931).
- Larval Digenea: *Diplostomum micradenum*, (Olivier 1940).

Table 2.–Continued.

Fowler's toad *Bufo fowleri*
Adult Digenea: *Cephalogonimus americanus*, (Lang 1968).

Toad *Bufo* sp.
Adult Digenea: *Cephalogonimus americanus*, (Lang 1968).

Hylidae (True Treefrogs)

Blanchard's cricket frog *Acris crepitans blanchardi*
Adult Digenea: *Brachycoelium salamandrae*, (Najarian 1955).

Eastern gray treefrog *Hyla versicolor*
Larval Digenea: *Apharyngostrigea pipientis*, (Olivier 1939, Olivier 1940).

Northern spring peeper *Pseudacris crucifer crucifer*
Adult Digenea: *Glypthelmins pennsylvaniensis,* (Muzzall and Peebles 1991); *Glypthelmins quieta*, (Najarian 1955); *Megalodiscus temperatus*, (Herber 1939, Najarian 1955).
Larval Digenea: *Diplostomum micradenum*, (Olivier 1940); *Echinoparyphium flexum*, (Najarian 1952; Najarian 1953a; Najarian 1954; Najarian 1955); gorgoderid metacercariae, (Najarian 1955).
Adult Nematoda: *Cosmocercoides* sp., (Muzzall and Peebles 1991); *Oswaldocruzia pipiens*, (Muzzall and Peebles 1991); *Rhabdias ranae*, (Muzzall and Peebles 1991).
Larval Nematoda: *Spiroxys* sp., (Muzzall and Peebles 1991).

Striped chorus frog *Pseudacris triseriata*
Adult Digenea: *Glypthelmins pennsylvaniensis*, (Muzzall and Peebles 1991).
Larval Digenea: *Echinoparyphium flexum*, (Najarian 1952; Najarian 1953a; Najarian 1954; Najarian 1955); gorgoderid metacercariae, (Najarian 1955).
Adult Nematoda: *Cosmocercoides dukae*, (Muzzall and Peebles 1991).

Ranidae (True Frogs)

Bullfrog *Rana catesbeiana*
Mastigophora: *Trypanosoma ranarum*, *Trypanosoma rotatorium*, (Werner and Walewski 1976).
Adult Digenea: *Glypthelmins quieta*, (Muzzall 1991b; Najarian 1955); *Gorgoderina attenuata*, (Muzzall 1991b); *Gorgoderina simplex*, (Najarian 1955); *Haematoloechus longiplexus*, *(*Krull 1932; Muzzall 1991b; Najarian 1955), *Haematoloechus parviplexus*, (Muzzall 1991b; Najarian 1955); *Halipegus eccentricus*, (Thomas 1939), *Halipegus* sp., (Muzzall 1991b); *Loxogenes arcanum*, (Muzzall 1991b); *Megalodiscus temperatus*, (Krull and Price 1932; Muzzall 1991b; Najarian 1955); *Teloporia aspidonectes*, (Esch and Kocan 1966).
Larval Digenea: *Alaria mustelae,* (Bosma 1934); *Clinostomum* sp., (Muzzall 1991b).
Adult Nematoda: *Aplectana*/*Cosmocercoides*, (Muzzall 1991b); *Falcaustra catesbeianae*, (Muzzall 1991b); *Oswaldocruzia* sp., (Ridgeway 1964); *Spinitectus gracilis*, (Muzzall 1991b).
Larval Nematoda: *Spiroxys* sp., (Muzzall 1991b).

Green frog *Rana clamitans melanota*
Ciliophora: *Nyctotherus cordiformis*, (Fortner 1923).
Mastigophora: *Octomitus intestinalis*, *Opalina obtrigonoidea*, (Fortner 1923); *Trypanosoma ranarum*, *Trypanosoma rotatorium*, *Trypanosoma pipientis*, (Werner and Walewski 1976).

Table 2.–Continued.

Adult Digenea: *Cephalogonimus americanus*, (Fortner 1923; Lang 1968; Muzzall et al. 2001; Najarian 1955; Spence and Peters 1971); *Cephalogonimus vesicaudus*, (Najarian 1955); *Glypthelmins quieta*, (Najarian 1955; Muzzall 1991b; Muzzall et al. 2001); *Gorgodera amplicava*, (Muzzall 1991b; Muzzall et al. 2001; Najarian 1955); *Gorgoderina attenuata*, (Muzzall 1991b; Muzzall et al. 2001); *Gorgoderina simplex*, (Najarian 1955); *Gorgoderina* sp., (Fortner 1923); *Haematoloechus breviplexus*, (Najarian 1955); *Haematoloechus longiplexus*, (Muzzall 1991b); *Haematoloechus medioplexus*, (Fortner 1923); *Haematoloechus parviplexus*, (Krull 1930; Krull 1931; Muzzall 1991b; Najarian 1955); *Haematoloechus similiplexus*, (Fortner 1923); *Haematoloechus varioplexus*, (Muzzall et al. 2001; Fortner 1923); *Halipegus eccentricus*, (Thomas 1939; Ameel et al. 1949; Muzzall et al. 2001); *Halipegus* sp., (Krull 1935; Muzzall 1991b); *Loxogenes arcanum*, (Muzzall 1991b; Spence and Peters 1971); *Megalodiscus temperatus*, (Fortner 1923; Herber 1939; Krull and Price 1932; Muzzall 1991b; Muzzall et al. 2001; Najarian 1955; Van der Woude 1954).

Larval Digenea: *Alaria marcianae*, (Cort 1918); *Alaria mustelae*, (Bosma 1934);*Clinostomum attenuatum*, (Fortner 1923; Najarian 1955); *Clinostomum* sp., (Muzzall et al. 2001); *Diplostomum micradenum*, (Olivier 1940); *Echinoparyphium flexum*, (Najarian 1952; Najarian 1953a; Najarian 1954; Najarian 1955); *Fibricola* sp., (Muzzall et al. 2001); *Lechriorchi*s *primus*, Talbot 1933); echinostomid-like metacercariae, (Muzzall et al. 2001): gorgoderid metacercariae, (Muzzall et al. 2001; Najarian 1955); metacercaria A, (Muzzall et al. 2001).

Adult Cestoda: *Proteocephalus perspicua*, (Thomas 1941); *Proteocephalus saphena*, (Osler 1931; Muzzall et al. 2001); *Proteocephalus* sp., (Muzzall 1991b; Thomas 1931; Thomas 1934); Proteocephalidae, (Fortner 1923).

Larval Cestoda: *Mesocestoides* sp., (Muzzall et al. 2001); *Proteocephalus perspicua*, (Thomas 1941); *Proteocephalus* sp., (Muzzall et al. 2001).

Adult Nematoda: *Aplectana*/*Cosmocercoides*, (Muzzall 1991b); *Camallanus* sp. (Muzzall et al. 2001); *Falcaustra catesbeianae*, (Muzzall 1991b); *Falcaustra* sp., (Muzzall et al. 2001); *Oswaldocruzia priceae*, (Muzzall et al. 2001); *Oswaldocruzia* sp., (Ridgeway 1964); *Raillietnema* sp., (Muzzall et al. 2001); *Rhabdias ranae*, (Muzzall et al. 2001); *Spinitectus gracilis*, (Muzzall et al. 2001); *Waltonella* sp., (Muzzall et al. 2001); unidentified juvenile, (Muzzall et al. 2001).

Larval Nematoda: *Serpinema* sp., (Muzzall 1991b); *Spiroxys contortus*, (Hedrick 1935); *Spiroxys* sp., (Muzzall 1991b; Muzzall et al. 2001); unidentified larva, (Muzzall et al. 2001).

Northern leopard frog *Rana pipiens*

Ciliophora: *Nyctotherus cordiformis*, (Fortner 1923).

Mastigophora: *Octomitus intestinalis*, *Opalina obtrigonoidea*, (Fortner 1923); *Trypanosoma pipientis*, *Trypanosoma ranarum*, *Trypanosoma rotatorium*, (Werner and Walewski 1976).

Adult Digenea: *Cephalogonimus americanus*, (Najarian 1955); *Gorgoderina attenuata*, (Fortner 1923); *Haematoloechus medioplexus*, (Fortner 1923; Krull 1930; Krull 1931); *Haematoloechus similiplexus*, (Fortner 1923); *Halipegus eccentricus*, (Thomas 1939; Fortner 1923); immature plagiorchid, (Gillilland and Muzzall 1999); *Megalodiscus temperatus*, (Fortner 1923; Herber 1939; Krull and Price 1932; Van der Woude 1954); juvenile gorgoderids, (Goodchild 1950).

Table 2.–Continued.

Larval Digenea: *Apharyngostrigea pipientis*, (Hughes 1928; Olivier 1939; Olivier 1940); *Alaria intermedia*, (Olivier and Odlaug 1938); *Alaria marcianae*, (Cort 1918); *Alaria mustelae*, (Bosma 1934); diplostomulum type metacercariae, (Cort and Brackett 1937, these diplostomulum type metacercariae named *Cercaria ranae* in Cort and Brackett 1938); *Cercaria ranae*, (Cort and Brackett 1938); *Clinostomum attenuatum*, (Fortner 1923); *Clinostomum* sp., (Gillilland and Muzzall 1999); *Diplostomum micradenum*, (Olivier 1938; Olivier 1940; Olivier 1942); *Echinoparyphium flexum*, (Najarian 1952; Najarian 1953a; Najarian 1953b; Najarian 1954); *Fibricola* sp., (Gillilland and Muzzall 1999); *Lechriorchis primus*, (Talbot 1933); renifer metacercariae, (Najarian 1955); strigeid metacercariae, (Gillilland and Muzzall 1999); unidentified metacercariae (Gillilland and Muzzall 1999).

Adult Cestoda: *Cylindrotaenia americana*, (Jewell 1916); *Cylindrotaenia quadrijugosa*, (Lawler 1939); Proteocephalidae, (Fortner 1923).

Larval Cestoda: *Mesocestoides* sp., (Gillilland and Muzzall 1999).

Adult Nematoda: *Cosmocercoides dukae*, (Gillilland and Muzzall 1999); *Oswaldocruzia priceae*, (Gillilland and Muzzall 1999); *Oswaldocruzia* sp., (Ridgeway 1964); *Raillientnema* sp., (Gillilland and Muzzall 1999); *Rhabdias ranae*, (Walton 1929; Gillilland and Muzzall 1999).

Larval Nematoda: *Spiroxys* sp., (Gillilland and Muzzall 1999); immature larva, (Gillilland and Muzzall 1999). .

Pickerel frog *Rana palustris*

Larval Digenea: *Alaria mustelae*, (Bosma 1934).

Mink frog *Rana septentrionalis*

Mastigophora: *Trypanosoma ranarum*, *Trypanosoma rotatorium*, (Werner and Walewski 1976)

Wood frog *Rana sylvatica*

Mastigophora: *Trypanosoma ranarum*, (Werner and Walewski 1976).

Unidentified protozoans, (Woodhams et al. 2000).

Adult Digenea: *Brachycoelium salamandrae*, (Najarian 1955); *Glypthelmins quieta* (Muzzall and Peebles 1991); *Haematoloechus parviplexus* (Muzzall and Peebles 1991); *Haematoloechus varioplexus*, (Najarian 1955); *Megalodiscus temperatus*, (Krull and Price 1932).

Larval Digenea: *Echinoparyphium flexum*, (Najarian 1952; Najarian 1953a; Najarian 1954; Najarian 1955); gorgoderid metacercariae, (Najarian 1955); unidentified metacercaria, (Muzzall and Peebles 1991; Woodhams et al. 2000).

Larval Cestoda: *Mesocestoides* sp., (Woodhams et al. 2000).

Adult Nematoda: *Cosmocercoides dukae*, (Muzzall and Peebles 1991); *Oswaldocruzia pipiens*, (Muzzall and Peebles 1991); *Oswaldocruzia* sp., (Woodhams et al. 2000); *Rhabdias ranae*, (Muzzall and Peebles 1991, Woodhams et al. 2000).

Larval Nematoda: *Spiroxys* sp., (Muzzall and Peebles 1991).

Unspecified tadpoles and frogs

Larval Digenea: *Alaria mustelae*, (Bosma 1925).

Unspecified Tadpoles

Larval Digenea: *Ribeiroia ondatrae*, (Beaver 1939); *Cercorchis medius*, (McMullen 1934).

Larval Nematoda: *Dracunculus ophidensis*, (Brackett 1938).

Order: Squamata (Snakes).

Colubridae (Snakes)

Northern water snake *Nerodia sipedon sipedon*

Sarcodina: *Entamoeba invadens*, (Barrow and Stockton 1960).

Mastigophora: *Trichomonas* sp., (Barrow and Stockton 1960).

Apicomplexa: haemogregarine-like form, (Yongue 1964).

Table 2.–Continued.

Adult Digenea: *Alaria marcianae*, (Cort and Brooks 1928); *Pneumatophilus foliaformis*, (Talbot 1934; Muzzall et al. 2001); *Natriodera verlata*, (Talbot 1934); *Renifer orula*, (Talbot 1934).
Larval Digenea: mesocercaria, (Yongue 1964).
Adult Nematoda: *Dracunculus ophidensis*, (Brackett 1938); *Rhabdias fuscovenosa*, (Chu 1936a; Chu 1936b).
Larval Nematoda: microfilaria, (Yongue 1964).

Brown snake *Storeria dekayi*
Sarcodina: *Entamoeba invadens*, (Barrow and Stockton 1960).

Northern red-bellied snake *Storeria occipitomaculata occipitomaculata*
Sarcodina: *Entamoeba invadens*, (Barrow and Stockton 1960).

Northern ribbon snake *Thamnophis sauritus septentrionalis*
Sarcodina: *Entamoeba invadens*, (Barrow and Stockton 1960).
Apicomplexa: coccidians, (Barrow and Stockton 1960).
Adult Digenea: *Zeugorchis eurinus*, (Talbot 1933); *Lechriorchis primus*, (Cort et al. 1952).
Adult Nematoda: *Rhabdias fuscovenosa*, (Chu 1936a).

Common garter snake *Thamnophis sirtalis*
Sarcodina: *Entamoeba invadens*, (Barrow and Stockton 1960).
Adult Digenea: *Zeugorchis eurinus* (Talbot 1933); *Lechriorchis primus*, (Cort et al. 1952); *Zeugorchis megametricus*, (Talbot 1934).
Larval Digenea: *Alaria intermedia*, (Olivier and Odlaug 1938); *Alaria marcianae*, (Cort 1918; Cort and Brooks 1928).
Adult Nematoda: *Dracunculus ophidensis*, (Brackett 1938); *Rhabdias fuscovenosa*, (Chu 1936a; Chu 1936b); unidentified nematodes, (Barrow and Stockton 1960).

Thamnophis spp.
Adult Digenea: *Cercorchis medius*, (McMullen 1934).

Northern ring-necked snake *Diadophis punctatus edwardsii*
Sarcodina: *Entamoeba invadens*, (Barrow and Stockton 1960).

Eastern milk snake *Lampropeltis triangulum triangulum*
Sarcodina: *Entamoeba invadens*, (Barrow and Stockton 1960).
Adult Nematoda: *Rhabdias fuscovenosa*, (Chu 1936a).

Eastern smooth green snake *Opheodrys vernalis*
Sarcodina: *Entamoeba invadens*, (Barrow and Stockton 1960).
Adult Nematoda: *Rhabdias fuscovenosa*, (Chu 1936a).

Order: Testudines (Turtles and Tortoises).

Chelydridae
Snapping turtle *Chelydra serpentina serpentina*
Adult Digenea: *Eustomos chelydrae*, (McMullen 1935).
Adult Nematoda: *Spiroxys contortus*, (Hedrick 1935).

Kinosternidae
Common musk turtle *Sternotherus odoratus*
Adult Nematoda: *Spiroxys contortus*, (Hedrick 1935).

Emydidae
Spotted turtle *Clemmys guttata*
Adult Nematoda: *Spiroxys contortus*, (Hedrick 1935).

Eastern box turtle *Terrrapene carolina carolina*
Adult Nematoda: *Spiroxys contortus*, (Hedrick 1935)

Table 2.–Continued.

Blanding's turtle *Emydoidea blandingii*
Adult Nematoda: *Spiroxys contortus*, (Hedrick 1935).

Common map turtle *Graptemys geographica*
Adult Digenea: *Macravestibulum eversum*, (Hsu 1937).
Adult Nematoda: *Spiroxys contortus*, (Hedrick 1935).

Painted turtle *Chrysemys picta*
Apicomplexa: *Haemoproteus metchinikovi*, (De Giusti and Batten 1951).
Adult Digenea: *Allassostomoides parvum*, (Esch and Gibbons 1967); *Cercorchis medius*, (McMullen 1934); *Eustomos chelydrae*, (McMullen 1935; Esch and Gibbons 1967); *Heronimus chelydrae,* (Ward 1917; Esch and Gibbons 1967); *Protenes angustus*, (Esch and Gibbons 1967); *Spirorchis artericola*, (Esch and Gibbons 1967); *Spirorchis elephantis*, (Wall 1941b); *Spirorchis parvus* Wall 1940; Wall 1941a); *Spirorchis* sp., (Cort et al. 1954; Wall 1939); *Telorchis attenuatus*, (Esch and Gibbons 1967); *Telorchis corti*, (Esch and Gibbons 1967); *Telorchis diminutis*, (Esch and Gibbons 1967); *Vasotrema robustum*, (Wall 1951).
Larval Digenea: *Cercaria welleri*, (McMullen 1938).
Adult Monogenea: *Neopolystoma orbiculare*, (Esch and Gibbons 1967); *Polystomoides coronatum*, (Bychowsky 1961; Esch and Gibbons 1967).
Adult Nematoda: *Camallanus microcephalus*, (Esch and Gibbons 1967); *Spiroxys contortus*, (Hedrick 1935; Esch and Gibbons 1967).

Trionychidae

Eastern spiny softshell turtle *Apalone spinifera spinifera*
Adult Digenea: *Teloporia aspidonectes*, (Esch and Kocan 1966); *Vasotrema amydae*, (Wall 1951); *Vasotrema robustum*, (Wall 1951).
Adult Nematoda: *Spiroxys amydae*, (Hedrick 1935); *Spiroxys contortus*, (Hedrick 1935).

Table 3.–Sites occupied by parasites in Michigan amphibians and reptiles by host order. *Encysted.

Order: Caudata (Salamanders).

Stomach: *Halipegus* sp.
Intestine: *Cepedietta michiganensis*, *Eimeria longaspora*, *Eimeria megaresidua*, *Brachycoelium salamandrae*, *Telorchis corti*, *Bothriocephalus rarus*, *Proteocephalus* sp., *Falcaustra* sp.
Rectum: *Megalodiscus temperatus*, *Falcaustra catesbeianae*, *Thelandros magnavulvaris.*
Gall bladder: *Cepedietta michiganensis*.
Lung: *Rhabdias ranae*.
Blood: *Trypanosoma diemictyli*.
Unencysted in lens of eye: *Diplostomum* sp.
* In stomach wall: *Spiroxys contortus*, *Spiroxys* sp.
* On outer surface of lungs: unidentified metacercariae.
* In mesentery: echinostome metacercariae, Metacercaria A.
* In muscle: *Clinostomum* sp., *Spiroxys contortus*, *Spiroxys* sp.

Order: Anura (Frogs and Toads).

Mouth, esophagus, and eustachian tubes: *Halipegus eccentricus*, *Halipegus* sp.
Stomach: *Halipegus eccentricus*, *Halipegus* sp., *Oswaldocruzia* sp.
*At junction of stomach and small intestine: *Loxogenes arcanum*.
Intestine: *Cepedietta michiganensis*, unidentified protozoans, *Brachycoelium salamandrae*, *Cephalogonimus americanus*, *Cephalogonimus vesicaudus*, *Glypthelmins pennsylvaniensis*, *Glypthelmins quieta*, *Cylindrotaenia americana*, *Cylindrotaenia quadrijugosa*, *Proteocephalus* sp., Proteocephalidae, *Aplectana*/*Cosmocercoides*, *Camallanus* sp., *Falcaustra catesbeianae*, *Oswaldocruzia pipiens*, *Oswaldocruzia priceae*, *Oswaldocruzia* sp., *Raillietnema* sp., *Serpinema* sp., *Spinitectus gracilis*, unidentified nematode.
Rectum: *Octomitus intestinalis*, *Opalina obtrigonoidea*, *Nyctotherus cordiformis*, *Megalodiscus temperatus*, immature plagiorchid, *Aplectana*/*Cosmocercoides*, *Cosmocercoides dukae*, *Cosmocercoides* sp., *Falcaustra catesbeianae*, *Falcaustra* sp., *Oswaldocruzia pipiens*.
Lung: *Haematoloechus breviplexus*, *Haematoloechus longiplexus*, *Haematoloechus medioplexus*, *Haematoloechus parviplexus*, *Haematoloechus similiplexus*, *Haematoloechus varioplexus*, *Teloporia aspidonectes*, *Rhabdias ranae*.
Urinary bladder: *Gorgodera amplicava*, *Gorgoderina attenuata*, *Gorgoderina simplex*, juvenile gorgoderids.
Kidneys: *Echinoparyphium flexum*, juvenile gorgoderids, echinostome-like metacercariae, unidentified metacercariae.
Blood: *Trypanosoma bufophlebotomi*, *Trypanosoma pipientis*, *Trypanosoma pseudopodium*, *Trypanosoma ranarum*, *Trypanosoma rotatorium*, *Trypanosoma schmidti*-like species.
Body cavity: *Rhabdias ranae*, *Mesocestoides* sp., *Proteocephalus perspicua*, *Waltonella* sp., unidentified nematode larvae.
*And unencysted in lymph spaces, muscles and tissues: *Alaria marcianae*, *Alaria mustelae* (and in wall of digestive tract).
Unencysted in brain, spinal cord, and under the meninges: *Diplostomum micradenum*.
*In muscle: *Clinostomum* sp., *Fibricola* sp., *Lechriorchis primus*.
*In peritoneum, mesentery, urinary bladder, pericardial cavity: *Apharyngostrigea pipientis*.
*In urinary bladder, kidney, mesentery, and stomach: gorgoderid metacercariae.
*In/on mesentery, muscle, stomach wall and small intestine: *Spiroxys* sp.
*In muscles, mesentery, body cavity, and tongue: *Clinostomum attenuatum*, *Clinostomum* sp.
*In body, muscles, mesentery and tissues: *Cercaria ranae*, metacercaria A.

Table 3.–Continued.

*In leg muscle, external surface of heart, under skin, external surface of small intestine, mesentery, liver, body cavity: strigeid metacercariae.
*In body musculature: *Lechriorchis primus*.
*In mesentery and free in body cavity: *Proteocephalus perspicua*.
*And free in muscle and pericardial region: *Alaria intermedia*.
*In mesentery: renifer metacercariae.
*In mesentery, outer surface of stomach and small intestine, liver, and body cavity: *Mesocestoides* sp.
*In underlying tissues: *Cercorchis medius*.
*In leg muscle: immature nematode (?) larva.
*On the heart or the mesentery: *Apharyngostrigea pipientis*.
*Nostrils and cloaca: *Ribeiroia ondatrae*.

Order: Squamata (Snakes).
Mouth: *Renifer orula*.
Esophagus: *Zeugorchis megametricus*.
Intestine: *Trichomonas* sp., coccidians, *Proteocephalus perspicua*, unidentified nematodes.
Small intestine, colon, rectum, liver: *Entamoeba invadens*.
Lung: *Zeugorchis eurinus*, *Lechriorchis primus*, *Natriodera verlata*, *Pneumatophilus foliaformis*, *Rhabdias fuscovenosa*.
Blood: haemogregarine-like form, mesocercaria , microfilaria.
* And free in digestive tract, body cavity, fatty tissue, and in tail: *Alaria marcianae*.
*In mesentery, pericardial membrane, and subcutaneous tissue: *Dracunculus ophidensis*.
Not given: *Cercorchis medius*, *Cercaria welleri*.

Order: Testudines (Turtles and Tortoises).
Stomach: *Spiroxys amydae*, *Spiroxys contortus*.
Intestine: *Eustomos chelydrae*, *Macravestibulum eversum*.
Lungs: *Heronimus chelydrae*.
Blood: *Haemoproteus metchinikovi*, *Spirorchis elephantis*, *Spirorchis parvus*, *Spirorchis* sp., *Vasotrema amydae*, *Vasotrema robustum*.
Not given: *Allassostomoides parvum*, *Cercorchis medius*, *Protenes angustus*, *Spirorchis artericola*, *Cercaria welleri*, *Neopolystoma orbiculare*, *Polystomoides coronatum*, *Camallanus microcephalus*.

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