

Parasites and Disease-causing Organisms Reported from Wisconsin Amphibians and Reptiles



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Summary: This report compiles and summarizes published information on parasites and disease-causing organisms reported from Wisconsin amphibians and reptiles in an accessible general reference for use by wildlife health and conservation practitioners. The catalog consists of two primary tables that summarize the available literature. The first lists parasite species by taxonomic group and provides a host list for each parasite. The second provides a checklist of Wisconsin amphibians and reptiles along with their reported parasites. A short "Discussion" section presents observations and summary conclusions derived from a cursory analysis of the records contained in these tables. Investigators have looked at a wide range of parasites affecting Wisconsin amphibians and reptiles: at least six bacteria, three fungi, 15 protoctists, 46 trematodes, five monogeneans, four cestodes, 22 nematodes, two acanthocephalans, three leeches, one mollusk, and 11 flies. The parasites of amphibians have been treated more frequently than those of reptiles. No papers address the parasites of 21 Wisconsin species, demonstrating that there is much yet to be learned in our area. The effects of most parasite species on the health and reproduction of their hosts remain largely uninvestigated. This report provides a foundation for documenting the composition of the regional parasite fauna and can help biologists understand changes brought on by environmental variation and the introduction and spread of invasive species. Useful references are identified as starting points for future efforts.

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**Parasites and Disease-causing Organisms
Reported from Wisconsin Amphibians and Reptiles**

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“They are, people will assure you, the hangnail on life’s little toe – insignificant uglies and annoying to boot.”

“Yet such organisms are parts of that great and ponderous machine we call life.”

- Robert Michael Pyle (1989)

Introduction

Parasites and disease-causing organisms are a growing concern among conservationists and wildlife health professionals. In particular, the potentially deleterious impacts of widespread infectious diseases on amphibian and reptile populations have garnered increasing attention (Green et al. 2002, Carey et al. 2003, Origgi 2006, Lee 2013, Duffus et al. 2014, Martel et al. 2014, Price et al. 2014). A report of the “largest mass die-off of amphibians ever recorded in the academic literature” and linked to ranavirus recently appeared in print (Wheelright et al. 2014), capturing the interest of both the scientific community and general public (Earl and Gray 2014, Whittle 2014). Further, Brenes et al. (2014) have shown that this pathogen can be transmitted between fish, amphibians, and reptiles, thus contributing to ranavirus’ persistence in the environment, potential spread, and broader impact. Chinchar and Waltzek (2014) have identified this organism as an emerging threat to aquaculture. The impact of chytridiomycosis on frog populations has also been reported widely (Skerratt et al. 2007, James et al. 2009, Vredenburg et al. 2010), and Martel et al. (2014) recently described *Batrachochytrium salamandrivorans*’ effect on salamander populations. Similarly, the U.S. Geological Survey’s National Wildlife Health Center has confirmed snake fungal disease in snakes in several eastern and Midwestern states, including Wisconsin, raising concerns that it could pose a threat to snakes similar to what white-nose syndrome does in bats (Miller 2013, Sleeman 2013).

Many host-parasite relationships appear to be relatively innocuous, with some individual hosts harboring large numbers of microorganisms and worms of several different species.¹ In some cases, however, parasites may present disease threats to the animals they infect or could infect, a particular concern for endangered species and small, isolated populations. For example, trematode parasites (*Ribeiroia* sp.) have been implicated as a cause of deformities and mortality, and possibly declines, in some frog populations (Johnson et al. 2002, Johnson and Sutherland 2003, Johnson et al. 2004). The nematode *Serpinema microcephalus* has been associated with pancreatitis in red-eared sliders (*Trachemys scripta elegans*) (Wieczorowski 1939, Hidalgo-Vila et al. 2011), raising concerns about the spread of this potentially invasive host species into new habitats. Pentastomes have been found to infect some rare and endangered species, with infections sometimes leading to death (Riley 1986). Myiasis (infestations by fly larvae that grow inside the host while feeding on its tissue) leading to death is believed to be more widespread in frogs than previously reported (Bolek and Janovy 2004, Wolff et al. 2013). In addition, the presence of some parasites may predispose their host to other ailments either by a reduction in general vitality resulting in increased susceptibility or through the introduction of other disease-causing organisms.

Parasites and zoonotic diseases may also pose human health concerns. For example, Harris et al. (2009) have referred to reptile-associated *Salmonella* infections in humans as a significant public health problem. Furthermore, Eckner et al. (2011) have shown that lizards may serve as reservoirs of *Borrelia burgdorferi*, the causative agent of Lyme disease. Other potential pathogens carried by reptiles include the bacteria *Aeromonas*, *Campylobacter*, and *Mycobacterium*, and various zygomycetes and protozoans.

The effects of parasites may interact in complex ways with environmental conditions and other stressors (e.g., see Johnson and Chase 2004, Johnson et al. 2007, Kerby and Storfer 2009, Hartson et al. 2011, and Kerby et al. 2011). The observed relationships between environmental contaminants and parasites have led to the occasional use of parasitological data in environmental monitoring (Overstreet 1997, Marcogliese and Giamberini 2013).

¹ It is important to acknowledge that very few individual animals of any species are completely free of parasitic organisms.

Our ability to manage proactively for concerns such as these has been somewhat limited due to a lack of basic information on the parasites and disease-causing organisms affecting our state's fauna. Knowledge of epidemiology and control techniques appears to be of growing importance, but the literature regarding the parasites of amphibians and reptiles remains widely scattered throughout a variety of sources, often crossing disciplines. Titles of many articles do not indicate that the parasites of Wisconsin species were studied (e.g., Goodchild and Dennis 1967); occasionally, the titles may even suggest otherwise (e.g., Bolek et al. 2009b). Sometimes, particularly in older references, authors have failed to indicate the source of their study organisms or the location where their work was performed. As a result, attempts to find information specific to Wisconsin species can pose significant challenges. Even with the availability of modern electronic indexing and abstracting services, presenting a basic host-parasite species list for the state has proven to be a difficult task.

The objective of this report, therefore, is to compile and summarize the published information on parasites and disease-causing organisms of Wisconsin amphibians and reptiles in an accessible general reference for use by wildlife health and conservation practitioners. Similar comprehensive catalogs have been prepared for only one other state in our region: Michigan (Muzzall 2005). Together these "snapshots" provide a starting point for characterizing and quantifying the regional richness and diversity of parasite communities across the host species' geographic ranges.

Methods

Parasite records were gleaned from a variety of sources including bibliographies focused on Wisconsin herpetology (Dlutkowski et al. 1987, Watermolen 1991, Watermolen 2013). I searched for Wisconsin records in standard references addressing the various parasite taxa (Bychowsky 1957, Petrochenko 1971, Yamaguti 1971, Schell 1985, Riley 1986, Levine 1988, Barta 1991, Anderson 1992, Walters et al. 2011), as well as references specific to those species parasitic in amphibians and reptiles (Reiber et al. 1940; Hughs, Baker and Dawson 1941a, 1941b, and 1942; Hughes, Higginbotham, and Clary 1941, 1942a, and 1942b; Nigrelli 1945; Bardsley and Harmsen 1973; Ernst and Ernst 1977, 1979, and 2006; Prudhoe and Bray 1982; Baker 1987; Dyer 1991; Telford 1995; McAlpine 1996; Kuzman et al. 2003; Duszynski et al. 2007; and Fajfer 2012). I also searched various electronic databases (*Biological Abstracts*, *Zoological Record*, *Web of Science*, etc.) and *Google Scholar* for the names of Wisconsin biologists and various combinations of taxonomic and subject terms to identify titles that might cover Wisconsin or involve Wisconsin specimens. I then reviewed the works cited in each source found for additional likely references.

Search terms covered a wide range of parasite taxa. No attempt, however, was made to identify studies addressing viruses, and although several bacteria, fungi, and protozoists are included in the catalog, only limited efforts were made to investigate these groups. Greater focus was placed on helminths and leeches, taxa with which I am more familiar. No effort was made to investigate the freshwater mollusk (*Simpsoniias ambigua*) larvae that parasitize mudpuppies (and possibly other salamanders), although a record is included as a result of other work. Records of arthropod ectoparasites were noted when they were encountered, but as with mollusks were not a focus of the effort.

I made no efforts to sift through the "gray" literature, but included agency reports when I stumbled upon them in the course of my other searching. Several academic theses are included, but I did not tabulate the records contained in these documents as those records

were generally published in other papers that are cited herein. I applied a similar approach to the abstracts that appear in the annual reports of the UW-Milwaukee Field Station.

The result of these efforts is an extensive catalog of parasite records from the state published through the end of 2014, including several missed during previous compilations and reviews. In spite of best efforts, however, I have undoubtedly missed some references with Wisconsin information and will appreciate learning about additional records. Every attempt has been made to ensure the accuracy of the catalog entries and literature citations, but it is nonetheless conceivable that errors may have crept into the work. For these, I take responsibility. Future workers should check the original sources to avoid perpetuating any such errors.

Structure of the Catalog

The catalog consists of two tables that summarize the available literature. **Table 1** (pages 5-24) lists parasite species by taxonomic group and provides a host list for each parasite. Parasites are listed to the lowest taxonomic unit possible and nomenclature appears here as it did in the original work, with only minimal attempts to address the past complexities of parasite taxonomy and the resulting synonyms. In cases where I was able to update parasite nomenclature, the species name as reported in the original source(s) usually follows the updated name in parentheses. It should be recognized, however, that review of the validity of the published names was well beyond the scope of current efforts. Parasite species are listed alphabetically by family and genera. The bewildering diversity of protocists has led to continuous debate about organismal names and classification schemes. I have generally followed the classification presented by Margulis et al. (1990), with a few minor revisions based on information contained in the online *Encyclopedia of Life* resource ². Parasite location within/on the host (anatomical habitat) is indicated in parentheses when this information has been included in the sources. Each entry includes a citation to the relevant literature source(s).

Entries in Table 1 are presented in the following format:

Parasite Species (Name in Original Source, if Updated by Me)
Host Species (Anatomical Habitat) – Literature Citation(s)

Since this is not a taxonomic work and for the sake of simplicity, I omitted the author and year of description associated with genus-species names for both parasites and hosts. These are generally available in the cited references.

Table 2 (pages 25-36) provides a checklist of Wisconsin amphibians and reptiles along with their reported parasites. Amphibian and reptile nomenclature follows Casper and Anton (2013), with species names listed alphabetically by order. Although included in Table 1, nonnative host species reported from captive settings in the state are omitted from this table. County of occurrence is provided when this information has been included in the reference. As in Table 1, each entry is followed by a citation to the relevant literature source(s).

² <http://eol.org/>

Entries in Table 2 are presented in the following format:

Host Species (Host Common Name)
Taxa Group: *Parasite Species* (Geographic Location) – Literature Citation(s)

In sum, Table 1 lists parasites and their hosts and Table 2 lists hosts and their parasites.

A short "Discussion" section follows these tables and presents observations and summary conclusions derived from a cursory analysis of the records contained in the tables. **Table 3** in this section (page 38) lists host species for which I was unable to find any published parasite records from Wisconsin. All references cited in the tables are listed together in the "Literature Cited" section that follows the discussion. Finally, Appendix A concludes the catalog by providing a list of references that specifically address parasites of Wisconsin amphibians and reptiles.

Notes

Catalog of the Parasites and Disease-causing Organisms

Table 1. Parasites and disease-causing organisms reported from amphibians and reptiles in Wisconsin. Host records are listed alphabetically and then chronologically. The location of the parasite infestation within/on the host is indicated in parentheses following the host name. Author and year citations refer to the literature source(s) of records.

Bacteria

Aeromonadaceae

Aeromonas hydrophila ("red-leg" disease)

Lithobates pipiens (unspecified) – Dent and Schuellein 1950

Lithobates pipiens (unspecified) – Hine et al. 1975, Hine et al. 1981

Aeromonas spp.

Lithobates pipiens (unspecified) – Hine et al. 1975, Hine et al. 1981

Clostridiaceae

Clostridium manganotii

Crotalus horridus (fecal matter) – McLaughlin et al. 2014

Enterobacteriaceae

Salmonella enterica diarizonae

Python molurus bivittatus (unspecified) – Fermaglich et al. 2012

Salmonella serotype Marina

Iguana (unspecified) – CDC 1999

Salmonella serotype Pomona

"small turtles" (unspecified) – CDC 2005

Salmonella serotype Typhimurium

African dwarf frog, presumably *Hymenochirus boettgeri* (unspecified) – CDC 2010a

"small turtles" (unspecified) – CDC 2010b

Salmonella serotype IV 44:z₄z₂₃: -

Iguana (unspecified) – CDC 2003

Flavobacteriaceae

Flavobacterium sp. (as *Flavobacter*)

Lithobates pipiens (unspecified) – Hine et al. 1975, Hine et al. 1981

Mycobacteriaceae

Mycobacterium marinum (tuberculosis)

- Lithobates catesbeianus* (unspecified) – Maslow et al. 2002
- Coluber constrictor* (unspecified) – Maslow et al. 2002
- Crotalus horridus* (unspecified) – Maslow et al. 2002
- Heterodon platirhinos* (unspecified) – Maslow et al. 2002
- Lampropeltis triangulum* (unspecified) – Maslow et al. 2002
- Nerodia sipedon* (unspecified) – Maslow et al. 2002
- Pantherophis spiloides* (unspecified) – Maslow et al. 2002
- Pantherophis vulpinus* (unspecified) – Maslow et al. 2002
- Pituophis catenifer* (unspecified) – Maslow et al. 2002
- Sistrurus catenatus* (unspecified) – Maslow et al. 2002
- Thamnophis sirtalis* (unspecified) – Maslow et al. 2002

Pseudomonadaceae

Pseudomonas sp.

- Lithobates pipiens* (unspecified) – Hine et al. 1975, Hine et al. 1981

Fungi: Ascomycota

Blastocystaceae

Blastocystis sp.

- Lithobates pipiens* (large intestine) – Hine et al. 1975, Hine et al. 1981

Onygenaceae

Chrysosporium ophidiicola

- Snakes of several species (skin) – Sleeman 2013

Fungi: Chytridiomycota

Batrachochytrium dendrobatidis

- Anaxyrus americanus* (skin) – Ortiz-Santaliestra et al. 2013
- Lithobates clamitans* (skin) – Klemish et al 2012
- Lithobates clamitans* (skin) – Sadinski and Roth 2009, Sadinski et al. 2010
- Lithobates pipiens* (skin) – Sadinski and Roth 2009, Sadinski et al. 2010
- Lithobates pipiens* (skin) – Ortiz-Santaliestra et al. 2013
- Lithobates septentrionalis* (skin) – Sadinski and Roth 2009, Sadinski et al. 2010
- Lithobates sylvaticus* (skin) – Sadinski and Roth 2009, Sadinski et al. 2010
- Lithobates sylvaticus* (skin) – Ortiz-Santaliestra et al. 2013

Fungi: Unidentified

White growths of fish mold

- Necturus maculosus* (skin) – Pearse 1921

Protoctista: Apicomplexa (Sporozoa)

Dactylosomatidae

Babesiosoma stableri

Lithobates pipiens (blood) – Schmittner and McGhee 1961

Eimeriidae

Hyaloklossia lieberkühni (as *Isopora lieberkühni*)

Lithobates pipiens (kidney) – Levine and Nye 1977³

Haemogregarinidae

Haemogregarina magna

Lithobates pipiens (kidney) – Levine and Nye 1977

Haemogregarina sp.

Lithobates pipiens (blood) – Heller 1973

Lankesterellidae

Lankesterella minima

Lithobates pipiens (erythrocyte) – Levine and Nye 1977

Lankesterella sp.

Lithobates pipiens (unspecified) – Heller 1974

Plasmodiidae

Haemoproteus metchnikovi

Chrysemys picta (unspecified) – De Giusti and Batten 1951

Graptemys geographica (unspecified) – De Giusti and Batten 1951

Protoctista: Ciliophora

Nyctotheridae

Nyctotherus cordiformis

Hyla chrysoscelis (small intestine, large intestine) – Bolek and Coggins 1998a

Pseudacris triseriata (small intestine, large intestine) – Bolek and Coggins 1998a

Nyctotherus sp.

Lithobates pipiens (large intestine) – Hine et al. 1975, Hine et al. 1981

³ The authors based this report solely on merozoites seen in the frog's kidney tubules. Duszynski et al. (2007) felt that there was no justification for identifying *Hyaloklossia lieberkühni* solely on this basis and believed the report may actually represent an undescribed apicomplexan.

Protoctista: Myxozoa (Cnidospora)

Ceratomyxidae

Leptotheca ohlmacheri

Lithobates pipiens (kidney) – Kudo 1922

Lithobates pipiens (kidney) – Levine and Nye 1977

Protoctista: Euglenozoa (Sarcomastigophora: Kinetoplastida)

Bodonidae

Bodo sp.

Lithobates pipiens (large intestine) – Hine et al. 1975, Hine et al. 1981

Trypanosomatidae

Trypanosoma pipientis

Lithobates pipiens (blood) – Levine and Nye 1977⁴

Lithobates pipiens (blood) – Woo 1983

Trypanosoma ranarum

Lithobates pipiens (blood) – Woo 1983

Trypanosoma rotatorium

Lithobates pipiens (blood) – Woo 1983

Protoctista: Sarcomastigophora: Opalinata

Opalinidae

Opalina sp.

Hyla chrysoscelis (small intestine, large intestine) – Bolek and Coggins 1998a

Unidentified opalinids

Lithobates pipiens (large intestine) – Hine et al. 1975, Hine et al. 1981

Protoctista: Sarcomastigophora: Proteromonadida

Proteromonadidae

Proteromonas sp.

Lithobates pipiens (large intestine) – Hine et al. 1975, Hine et al. 1981

⁴ The authors note that although purchased from a Wisconsin vendor, the host specimen may have originated in Mexico.

Protoctista: Sarcomastigophora: Parabasalia

Hexamastigidae (incertae sedis)

Hexamastix sp. (incertae sedis)

Lithobates pipiens (large intestine) – Hine et al. 1975, Hine et al. 1981

Trichomonadidae

Trichomonas sp.

Lithobates pipiens (large intestine) – Hine et al. 1975, Hine et al. 1981

Digenetic Trematoda (Flukes)

Auridistomidae

Auridistomum chelydrae (as *Heronimus chelydrae* by Guilford 1955)

Lithobates clamitans (gastrocnemius, foot, tail resorption site, around orbits of eyes)
– Sutherland 2005

Chelydra serpentina (lungs) – Guilford 1955

Chelydra serpentina (unspecified, likely lungs) – Guilford 1959

Brachycoeliidae

Brachycoelium salamandrae

Lithobates palustris (unspecified) – Coggins and Sajdak 1982

Ambystoma maculatum (small intestine, large intestine) – Bolek and Coggins 1998b

Ambystoma maculatum (unspecified) – Coggins and Sajdak 1982

Plethodon cinereus (unspecified) – Coggins and Sajdak 1982

Plethodon cinereus (small intestine, large intestine) – Bolek and Coggins 1998b

Cephalogonimidae

Cephalogonimus salamandrus

Lithobates clamitans (unspecified) – Coggins and Sajdak 1982

Ambystoma tigrinum (unspecified) – Coggins and Sajdak 1982

Cephalogonimus sp.

Lithobates pipiens (unspecified) – Williams and Taft 1980

Clinostomidae

Clinostomum sp.

Lithobates clamitans (body cavity) – Yoder et al. 2000, Yoder et al. 2001



Derogenidae⁵

Halipegus occidualis (as *Halipegus eccentricus*)

Lithobates clamitans (eustachian tubes) – Guilford 1961

Lithobates clamitans (unspecified) – Williams and Taft 1980

Lithobates clamitans (eustachian tubes) – Bolek and Coggins 2001

Lithobates clamitans (eustachian tubes) – Yoder et al. 2001

Lithobates pipiens (unspecified) – Williams and Taft 1980

Halipegus projecta

Lithobates clamitans (under tongue, esophagus) – Guilford 1961

Halipegus sp.

Lithobates clamitans (eustachian tubes, pharynx, stomach) – Sutherland 2005

Diplostomatidae

Alaria arisaemoides

Lithobates pipiens (between thigh muscles, under sternum) – Hofer and Johnson 1970

Alaria marciana

Lithobates pipiens (between thigh muscles, under sternum) – Hofer and Johnson 1970

Lithobates pipiens (small intestine, parenchyma, liver⁶) – Schaefer and Etges 1969

Alaria mustelae

Lithobates pipiens (between thigh muscles, under sternum) – Hofer and Johnson 1970

Lithobates sylvaticus (body cavity, rectal area) – Yoder and Coggins 1996

Pseudacris crucifer (body cavity, rectal area) – Yoder and Coggins 1996

Pseudacris crucifer (leg musculature) – Yoder and Coggins 2007

Alaria sp.

Lithobates clamitans (unspecified) – Hartson et al. 2011

Lithobates pipiens (unspecified) – Hartson et al. 2011

Lithobates pipiens (intramuscular fascia) – Sutherland 2005

Fibricola texensis

Anaxyrus americanus (leg musculature) – Yoder and Coggins 2007

Lithobates sylvaticus (musculature, body cavity) – Yoder and Coggins 1996

Lithobates sylvaticus (leg musculature) – Yoder and Coggins 2007

Pseudacris crucifer (musculature, body cavity) – Yoder and Coggins 1996

Pseudacris crucifer (leg musculature) – Yoder and Coggins 2007

⁵ Assignment of previously published records to species names within this family is based on the evidence presented by McAlpine and Burt (1998).

⁶ This report included cases of hyperparasitism with this species being found within *Ophiotaenia* sp. and *Haematoloecus* sp. in the host's liver and lungs, respectively.

Fibricola sp.

Anaxyrus americanus (leg muscles, body cavity) – Bolek and Coggins 2003

Lithobates clamitans (unspecified) – Hartson et al. 2011

Lithobates pipiens (unspecified) – Hartson et al. 2011

Lithobates pipiens (leg muscles, body cavity) – Bolek and Coggins 2003

Unidentified diplostomid metacercariae

Lithobates clamitans (leg muscles) – Bolek and Coggins 2001

Echinostomatidae

Echinoparaphyium spp.

Lithobates clamitans (unspecified) – Hartson et al. 2011

Echinostoma spp.

Lithobates clamitans (unspecified) – Hartson et al. 2011

Lithobates pipiens (unspecified) – Hartson et al. 2011

Unidentified echinostomatid metacercariae

Anaxyrus americanus (body cavity, kidneys) – Bolek and Coggins 2000, Bolek and Coggins 2003

Lithobates pipiens (body cavity, kidneys) – Bolek and Coggins 2003

Ambystoma laterale (body cavity, kidneys) – Bolek and Coggins 2003

Gorgoderidae

Gorgoderina amplicava

Lithobates catesbeianus (bladder) – Bolek et al. 2009b

Gorgoderina attenuata

Lithobates clamitans (unspecified) – Williams and Taft 1980

Lithobates clamitans (urinary bladder) – Coggins and Sajdak 1982

Lithobates clamitans (urinary bladder) – Bolek et al. 2009a

Lithobates pipiens (urinary bladder) – Goodchild 1954

Lithobates pipiens (unspecified) – Williams and Taft 1980

Lithobates pipiens (urinary bladder) – Bolek and Coggins 2003

Lithobates pipiens (urinary bladder) – Bolek et al. 2009a

Gorgoderina bilobata

Anaxyrus americanus (urinary bladder) – Coggins and Sajdak 1982

Anaxyrus americanus (bladder) – Tiekotter and Coggins 1982

Anaxyrus americanus (urinary bladder) – Yoder and Coggins 2007

Lithobates clamitans (urinary bladder) – Yoder et al. 2001

Hemidactylium scutatum (urinary bladder) – Coggins and Sajdak 1982

Gorgoderina simplex

Lithobates clamitans (unspecified) – Williams and Taft 1980

Lithobates clamitans (bladder) – Bolek et al. 2009b

Gorgoderina sp.

- Anaxyrus americanus* (bladder) – Bolek and Coggins 2000
- Lithobates pipiens* (bladder) – Burton 1966

Phyllodistomum americanum

- Ambystoma laterale* (urinary bladder) – Yoder and Coggins 2007
- Ambystoma tigrinum* (bladder) – Coggins and Sajdak 1982
- Ambystoma tigrinum* (urinary bladder) – Tiekotter and Coggins 1982

Phyllodistomum coatneyi

- Ambystoma maculatum* (bladder) – Meserve 1941, 1943

Haematoloechidae ⁷

Haematoloechus complexus

- Lithobates clamitans* (unspecified, most likely lungs) – Bolek and Janovy 2007b

Haematoloechus longiplexus

- Lithobates clamitans* (unspecified, most likely lungs) – Williams and Taft 1980

Haematoloechus medioplexus

- Lithobates pipiens* (lungs) – Burton 1967
- Lithobates pipiens* (lungs) – Kennedy 1981
- Lithobates pipiens* (lungs) – Leon-Regagnon and Brooks 2003
- Lithobates sylvaticus* (unspecified) – Williams and Taft 1980

Haematoloechus parviplexus

- Lithobates clamitans* (unspecified, most likely lungs) – Schell 1965
- Lithobates clamitans* (unspecified, most likely lungs) – Williams and Taft 1980
- Lithobates clamitans* (unspecified, most likely lungs) – Bolek and Janovy 2007a

Haematoloechus varioplexus (as *Pneumonoeces similiplexus* by Cort 1915a and Cort 1915b)

- Anaxyrus americanus* (lungs) – Bolek and Coggins 2003
- Lithobates clamitans* (unspecified, most likely lungs) – Williams and Taft 1980
- Lithobates clamitans* (lungs) – Bolek and Coggins 2001
- Lithobates clamitans* (lung) – Yoder et al. 2001
- Lithobates pipiens* (lungs) – Cort 1915a, Cort 1915b
- Lithobates pipiens* (unspecified, most likely lungs) – Williams and Taft 1980
- Lithobates pipiens* (lungs) – Bolek and Coggins 2003
- Lithobates pipiens* (lungs) – Leon-Regagnon and Brooks 2003
- Lithobates sylvaticus* (lungs) – Yoder and Coggins 1996
- Lithobates sylvaticus* (lungs) – Bolek and Janovy 2007a
- Lithobates sylvaticus* (lungs) – Yoder and Coggins 2007
- Pseudacris crucifer* (lungs) – Yoder and Coggins 2007

Haematoloechus spp.

- Lithobates clamitans* (unspecified) – Williams and Taft 1980
- Lithobates clamitans* (unspecified) – Hartson et al. 2011
- Lithobates pipiens* (lung) – Dent and Schuellein 1950

⁷ Assignment of previously published records to species names within this family is based on the evidence provided by Kennedy (1981) and Bolek and Janovy (2007a, 2007b).

Lithobates pipiens (lung) – Schaefer and Etges 1969
Lithobates pipiens (lung) – Sutherland 2005

Lecithodendriidae

Langeronia provitellaria
Lithobates pipiens (intestine) – Christian 1970

Loxogenes arcanum
Lithobates clamitans (unspecified) – Williams and Taft 1980

Macroderoididae

Glyphelmims pennsylvaniensis
Hyla chrysoscelis (small intestine) – Bolek and Coggins 1998a
Pseudacris crucifer (unspecified) – Coggins and Sajdak 1982
Pseudacris crucifer (small intestine) – Yoder and Coggins 1996
Pseudacris crucifer (small intestine) – Yoder and Coggins 2007
Pseudacris triseriata (small intestine) – Bolek and Coggins 1998a

Glyphelmims quieta
Lithobates catesbeianus (intestine) – Schell 1962
Lithobates clamitans (unspecified) – Williams and Taft 1980
Lithobates clamitans (small intestine) – Bolek and Coggins 2001
Lithobates clamitans (small intestine) – Yoder et al. 2001
Lithobates pipiens (unspecified) – Williams and Taft 1980

Microscaphidiidae

Dictyangium chelydrae
Glyptemys insculpta (cloaca) – Guilford 1959

Ochetosomatidae

Lechriorchis sp.
Thamnophis sirtalis (lungs) – Sutherland 2005

Ochetosoma sp.
Thamnophis sirtalis (mouth, anterior reaches of esophagus) – Sutherland 2005

Paralechriorchis sp.
Thamnophis sirtalis (mouth, anterior reaches of esophagus) – Sutherland 2005

Paramphistomidae

Allassostomoides chelydrae
Chrysemys picta (urinary bladder) – Platt 2000

Allassostomoides parvum

Chrysemys picta (unspecified) – Guilford 1959

Megalodiscus temperatus

Lithobates clamitans (unspecified) – Williams and Taft 1980

Lithobates clamitans (colon) – Yoder et al. 2001

Lithobates pipiens (unspecified) – Williams and Taft 1980

Megalodiscus sp.

Lithobates pipiens (large intestine) – Hine et al. 1981

Plagiorchiidae

Eustomos chelydrae

Chelydra serpentina (unspecified) – Guilford 1959

Chrysemys picta (stomach, small intestine) – Platt 2000

Unidentified plagiorchid

Lithobates clamitans (unspecified) – Hartson et al. 2011

Lithobates pipiens (unspecified) – Hartson et al. 2011

Psilostomidae

Ribeiroia ondatrae

Anaxyrus americanus (unspecified) – Johnson and Chase 2004

Lithobates catesbeianus (unspecified) – Johnson and Chase 2004, Johnson et al. 2007

Lithobates clamitans (unspecified) – Johnson and Chase 2004

Lithobates clamitans (unspecified) – Hartson et al. 2011

Lithobates palustris (unspecified) – Johnson et al. 2004

Lithobates pipiens (limb buds) – Schotthoefer et al. 2003

Lithobates pipiens (unspecified) – Johnson and Chase 2004, Johnson et al. 2004

Lithobates pipiens (unspecified) – Hartson et al. 2011

Lithobates septentrionalis (unspecified) – Johnson and Chase 2004, Johnson et al. 2004

Lithobates septentrionalis (metacercariae: unspecified) – Wilson et al. 2005

Lithobates sylvaticus (unspecified) – Johnson and Chase 2004

Ribeiroia-like metacercaria

Lithobates catesbeianus (unspecified) – Sadinski and Roth 2009

Lithobates clamitans (unspecified) – Sadinski and Roth 2009

Lithobates pipiens (unspecified) – Sadinski and Roth 2009

Lithobates septentrionalis (unspecified) – Sadinski and Roth 2009

Spirorchiidae

Hapalorhynchus gracilis

Chelydra serpentina (unspecified) – Guilford 1959

Heronimus chelydrae

Chrysemys picta (lungs) – Guilford 1958

Chrysemys picta (unspecified) – Guilford 1959

Spirorchis elegans

Chrysemys picta (unspecified) – Guilford 1959

Spirorchis haematobium

Chelydra serpentina (unspecified) – Guilford 1959

Spirorchis kirki

Chrysemys picta (brain and cranial circulation) – Platt 2000

Spirorchis parvus

Chrysemys picta (cranial cavity) – Platt 2000

Spirorchis sp.

Chrysemys picta (unspecified) – Guilford 1959

Chrysemys picta (eggs: numerous organs; adult: heart) – Goodchild and Dennis 1967

Strigeidae

Apharyngostrigea pipientis

Lithobates clamitans (unspecified) – Hartson et al. 2011

Unidentified strigeid

Lithobates clamitans (unspecified) – Hartson et al. 2011

Telorchiiidae

Protenes angustus

Chrysemys picta (unspecified) – Guilford 1959

Telorchis attenuatus

Chrysemys picta (unspecified) – Guilford 1959

Telorchis corti

Chelydra serpentina (unspecified) – Guilford 1959

Emydoidea blandingii (unspecified) – Guilford 1959

Glyptemys insculpta (unspecified) – Guilford 1959

Telorchis sp.

Chelydra serpentina (unspecified) – Guilford 1959

Chrysemys picta (unspecified) – Wieczoroski 1939

Trachemys scripta (unspecified) – Wieczoroski 1939



Uncertain Identification

Cloacal flukes

Lithobates septentrionalis (cloaca) – Sadinski and Roth 2009

Unidentified diplostomulum

Lithobates pipiens (subdermal in middle toes of hind feet) – Sutherland 2005

Unidentified mesocercariae

Pseudacris crucifer (leg muscles) – Yoder and Coggins 1996

Unidentified metacercariae

Anaxyrus americanus (kidney, organ mesentery, leg musculature) – Yoder and Coggins 2007

Hyla chrysoscelis (leg muscle, body cavity) – Bolek and Coggins 1998a

Lithobates clamitans (body cavity, kidneys) – Bolek and Coggins 2001

Lithobates clamitans (mesentery) – Yoder et al. 2001

Lithobates sylvaticus (liver, leg muscle) – Yoder and Coggins 1996

Lithobates sylvaticus (kidney, organ mesentery, leg musculature) – Yoder and Coggins 2007

Pseudacris crucifer (liver, leg muscle) – Yoder and Coggins 1996

Pseudacris crucifer (kidney, organ mesentery, leg muscle) – Yoder and Coggins 2007

Pseudacris triseriata (leg muscle, body cavity) – Bolek and Coggins 1998a

Ambystoma tigrinum (liver parenchyma) – Coggins and Sajdak 1982

Hemidactylium scutatum (liver parenchyma) – Coggins and Sajdak 1982

Notophthalmus viridescens (kidney, organ mesentery, leg musculature) – Yoder and Coggins 2007

Unidentified immature trematode

Hyla chrysoscelis (small intestine) – Bolek and Coggins 1998a

Pseudacris crucifer (lung) – Yoder and Coggins 1996

Monogenea

Polystomatidae

Neopolystoma elizabethae

Chrysemys picta (conjunctival sac) – Platt 2000

Neopolystoma orbiculare

Chrysemys picta (unspecified) – Guilford 1959

Neopolystoma sp.

Chrysemys picta (nostrils) – Guilford 1959

Trachemys scripta (urinary bladder) – Henke et al. 1990

Polystoma nearcticum

Hyla chrysoscelis (urinary bladder) – Bolek and Coggins 1998a

Polystomoides pauli

Chrysemys picta (oral cavity) – Platt 2000

Sphyranuridae

Sphyranura osleri

Necturus maculosus (gills) – Pearse 1921

Necturus maculosus (gills) – Coggins and Sajdak 1982

Cestoda (Tapeworms)

Mesocestoididae

Mesocestoides sp.

Anaxyrus americanus (leg muscles) – Bolek and Coggins 2000

Anaxyrus americanus (leg muscle, body cavity) – Bolek and Coggins 2003

Anaxyrus americanus (leg musculature, organ mesentery) – Yoder and Coggins 2007

Hyla chrysoscelis (body cavity, small and large intestine, liver, musculature) – Bolek and Coggins 1998a

Lithobates clamitans (unspecified) – Williams and Taft 1980

Lithobates clamitans (leg muscle, lung) – Bolek and Coggins 2001

Lithobates clamitans (mesentery) – Yoder et al. 2001

Lithobates clamitans (mesenteries, kidney) – Sutherland 2005

Lithobates pipiens (kidney, intestine, mesenteric tissue) – James and Ulmer 1967

Lithobates pipiens (unspecified) – Williams and Taft 1980

Lithobates pipiens (leg muscle, body cavity) – Bolek and Coggins 2003

Lithobates pipiens (mesenteries, kidneys, outside parietal peritoneum) – Sutherland 2005

Lithobates sylvaticus (leg musculature, organ mesentery) – Yoder and Coggins 2007

Pseudacris crucifer (leg musculature, organ mesentery) – Yoder and Coggins 2007

Thamnophis sirtalis (mesenteric fat deposits) – Sutherland 2005

Proteocephalidae

Ophiotaenia saphena

Lithobates clamitans (unspecified) – Sutherland 2005

Lithobates pipiens (unspecified) – Sutherland 2005

Ophiotaenia sp.

Lithobates pipiens (liver) – Schaefer and Etges 1969

Proteocephalus loennbergii

Necturus maculosus (intestine) – Coggins and Sajdak 1982

Necturus maculosus (intestine) – Cochran et al. 2002⁸

Proteocephalus saphenus

Lithobates clamitans (unspecified) – Williams and Taft 1980

Proteocephalus sp.

Lithobates clamitans (body cavity) – Yoder et al. 2001

⁸ This report represents a probable case. Preservation technique precluded worm identification.

Uncertain Identification

Unidentified plerocercoid

- Hyla chrysoscelis* (body cavity, lungs) – Bolek and Coggins 1998a
- Lithobates pipiens* (unspecified) – Sutherland 2005

Unidentified cestode

- Hyla chrysoscelis* (cyst: stomach) – Bolek and Coggins 1998a
- Lithobates clamitans* (adult: small intestine) – Bolek and Coggins 2001
- Lithobates sylvaticus* (organ mesentery) – Yoder and Coggins 1996

Nematoda (Roundworms)

Camallanidae

Serpinema microcephalus (as *Camallanus microcephalus*)

- Lithobates pipiens* (rectum) – Walton 1935
- Chelydra serpentina* (unspecified) – Guilford 1959
- Chrysemys picta* (unspecified) – Guilford 1959
- Emydoidea blandingii* (unspecified) – Guilford 1959
- Glyptemys insculpta* (unspecified) – Guilford 1959

Serpinema trispinosus (as *Camallanus pipientis* and *C. trispinosus*)

- Lithobates pipiens* (intestine) – Walton 1935
- Chrysemys picta* (intestine) – Wieczorowski 1939
- Chrysemys picta* (small intestine) – Platt 2000
- Trachemys scripta elegans* (intestine) – Wieczorowski 1939

Capillariidae

Amphibiocapillaria serpentina

- Chrysemys picta* (mucosa of small intestine) – Platt 2000

Cosmocercidae

Aplectana americana

- Lithobates catesbeianus* (cecal regions) – Walton 1929
- Lithobates palustris* (cecal regions) – Walton 1929
- Lithobates pipiens* (cecal regions) – Walton 1929

Cosmocercoides dukae

- Anaxyrus americanus* (intestine) – Coggins and Sajdak 1982
- Lithobates clamitans* (unspecified) – Williams and Taft 1980
- Lithobates clamitans* (intestine) – Coggins and Sajdak 1982
- Lithobates palustris* (intestine) – Coggins and Sajdak 1982
- Lithobates pipiens* (unspecified) – Williams and Taft 1980
- Lithobates pipiens* (intestine) – Coggins and Sajdak 1982
- Lithobates sylvaticus* (adults: rectum; larvae: lungs, small intestine) – Yoder and Coggins 1996

Ambystoma laterale (intestine) – Coggins and Sajdak 1982
Ambystoma laterale (small intestine, large intestine) – Bolek 1997
Ambystoma maculatum (intestine) – Coggins and Sajdak 1982
Ambystoma tigrinum (intestine) – Coggins and Sajdak 1982
Hemidactylium scutatum (intestine) – Coggins and Sajdak 1982
Notophthalmus viridescens (intestine) – Coggins and Sajdak 1982
Plethodon cinereus (intestine) – Coggins and Sajdak 1982

Cosmocercoides variabilis

Anaxyrus americanus (lungs, body cavity, small intestine) – Bolek and Coggins 2000
Anaxyrus americanus (lungs, body cavity, large intestine) – Bolek and Coggins 2003
Anaxyrus americanus (larvae: lungs, small intestine; adults: large intestine) – Yoder and Coggins 2007
Hyla chrysoscelis (small intestine, liver, lungs) – Bolek and Coggins 1998a
Pseudacris triseriata (small intestine, liver, lungs) – Bolek and Coggins 1998a

Cosmocercoides sp.

Lithobates clamitans (large intestine, small intestine) – Bolek and Coggins 2001
Lithobates clamitans (colon) – Yoder et al. 2001
Lithobates sylvaticus (larvae: lungs, small intestine; adults: large intestine) – Yoder and Coggins 2007
Pseudacris crucifer (larvae: lungs, small intestine; adults: large intestine) – Yoder and Coggins 2007
Ambystoma laterale (lungs, large intestine) – Bolek and Coggins 2003
Ambystoma laterale (larvae: lungs, small intestine; adults: large intestine) – Yoder and Coggins 2007
Notophthalmus viridescens (larvae: lungs, small intestine; adults: large intestine) – Yoder and Coggins 2007

Gnathostomatidae

Spiroxys constricta

Chelydra serpentina (unspecified) – Guilford 1959
Chrysemys picta (unspecified) – Guilford 1959
Emydoidea blandingii (unspecified) – Guilford 1959

Spiroxys contortus

Chrysemys picta (unspecified) – Hedrick 1935
Chrysemys picta (unspecified) – Wiczorowski 1939
Chrysemys picta (stomach, small intestine, tunica of small intestine) – Platt 2000
Emydoidea blandingii (stomach) – Bolek 2001
Trachemys scripta (unspecified) – Wiczorowski 1939

Spiroxys sp.

Ambystoma laterale (small intestine) – Bolek and Coggins 2003
Anaxyrus americanus (small intestine) – Bolek and Coggins 2003
Lithobates pipiens (small intestine) – Bolek and Coggins 2003



Kathlaniidae

Falcaustra wardi

Chelydra serpentina (large intestine) - Bolek 2001

Spironura affine (as *Falcaustra affinis*)

Chelydra serpentina (unspecified) – Guilford 1959

Molineidae

Oswaldocruzia pipiens

Anaxyrus americanus (intestine) – Coggins and Sajdak 1982

Anaxyrus americanus (small intestine) – Bolek and Coggins 2000

Anaxyrus americanus (small intestine) – Bolek and Coggins 2003

Anaxyrus americanus (small intestine) – Yoder and Coggins 2007

Hyla chrysoscelis (small intestine) – Bolek and Coggins 1998a

Lithobates clamitans (unspecified) – Williams and Taft 1980

Lithobates clamitans (small intestine, stomach) – Bolek and Coggins 2001

Lithobates clamitans (small intestine) – Yoder et al. 2001

Lithobates palustris (small intestine) – Walton 1929

Lithobates pipiens (small intestine) – Walton 1929

Lithobates pipiens (unspecified) – Williams and Taft 1980

Lithobates pipiens (small intestine) – Bolek and Coggins 2003

Lithobates sylvaticus (stomach, small intestine, large intestine) – Yoder and Coggins 1996

Lithobates sylvaticus (small intestine) – Yoder and Coggins 2007

Pseudacris crucifer (small intestine) – Yoder and Coggins 2007

Oswaldocruzia spp.

Lithobates clamitans (unspecified) – Hartson et al. 2011

Onchocercidae

Foleyella sp.

Lithobates pipiens (blood) – Levine and Nye 1977⁹

Waltonella americana (as *Foleyella americana*)

Lithobates pipiens (thoracic cavity) – Walton 1935

Waltonella ranae (as *Foleyella ranae*)

Lithobates catesbeianus (thoracic cavity) – Walton 1935

Waltonella sp.

Lithobates clamitans (body cavity) – Bolek and Coggins 2001

⁹ Levine and Nye's (1977) identification of *Foleyella* sp. in leopard frogs may be in error as members of this genus are known to infect only mammals, birds, and reptiles (Bartlett 1986). The specimen might represent a species of *Waltonella*.

Pharyngodonidae

Batracholandros magnavulvaris

Ambystoma maculatum (small intestine, large intestine) – Bolek and Coggins 1998b

Plethodon cinereus (small intestine, large intestine) – Bolek and Coggins 1998b

"tadpole pinworm" (likely *Gyrinicola batrachiensis*)

Lithobates clamitans (unspecified) – Hartson et al. 2011

Physalopteridae

Physaloptera abjecta

Opheodryx vernalis (intestines, stomach) – Morgan 1942

Thamnophis sirtalis (intestines, stomach) – Morgan 1942

Rhabdiasidae

Rhabdias ambystomae

Ambystoma maculatum (lungs, body cavity) – Kuzmin et al. 2001, 2003

Rhabdias americanus

Anaxyrus americanus (lungs, body cavity) – Bolek and Coggins 2000

Anaxyrus americanus (unspecified, likely lungs) – Kuzmin et al. 2001

Anaxyrus americanus (lungs, body cavity) – Bolek and Coggins 2003

Anaxyrus americanus (lungs) – Kuzmin et al. 2003

Anaxyrus americanus (lungs) – Yoder and Coggins 2007

Rhabdias bufonis

Anaxyrus americanus (unspecified, likely lungs) – Williams and Taft 1980

Rhabdias fuscovenosa

Thamnophis sirtalis (lung) – Kuzmin et al. 2003

Rhabdias ranae

Anaxyrus americanus (adults: lungs; juveniles: body cavity) – Coggins and Sajdak 1982

Lithobates pipiens (adults: lungs) – Walton 1929

Lithobates pipiens (unspecified, likely lungs) – Williams and Taft 1980

Lithobates pipiens (unspecified, likely lungs) – Kuzmin et al. 2001

Lithobates sylvaticus (unspecified, likely lungs) – Williams and Taft 1980

Lithobates sylvaticus (lungs) – Yoder and Coggins 1996

Lithobates sylvaticus (lungs) – Yoder and Coggins 2007

Pseudacris crucifer (lungs) – Yoder and Coggins 1996

Pseudacris crucifer (lungs) – Yoder and Coggins 2007

Plethodon cinereus (adults: lungs; juveniles: body cavity) – Coggins and Sajdak 1982

Rhabdias sp.

Plethodon cinereus (body cavity) – Bolek and Coggins 1998b

Lithobates pipiens (lungs) – Sadinski and Roth 2009

Lithobates sylvaticus (larvae: unspecified) – Sadinski and Roth 2009

Spirurida

Unidentified spirurid

- Ambystoma laterale* (cysts: stomach) – Coggins and Sajdak 1982
- Ambystoma tigrinum* (cysts: stomach) – Coggins and Sajdak 1982
- Lithobates clamitans* (unspecified) – Hartson et al. 2011

Uncertain Identification

Unidentified encysted nematode

- Lithobates clamitans* (small intestine) – Bolek and Coggins 2001
- Lithobates sylvaticus* (small intestine mesentery) – Yoder and Coggins 1996
- Pseudacris crucifer* (small intestine mesentery) – Yoder and Coggins 1996
- Notophthalmus viridescens* (leg musculature, mesentery) – Yoder and Coggins 2007

Unidentified larval/juvenile nematode

- Anaxyrus americanus* (large intestine) – Bolek and Coggins 2003
- Lithobates clamitans* (large intestine) – Bolek and Coggins 2001
- Lithobates pipiens* (large intestine) – Bolek and Coggins 2003
- Lithobates sylvaticus* (rectum, large intestine) – Yoder and Coggins 1996
- Pseudacris crucifer* (rectum, large intestine) – Yoder and Coggins 1996
- Chrysemys picta* (unspecified) – Guilford 1959
- Emydoidea blandingii* (unspecified) – Guilford 1959

Acanthocephala (Spiny Headed Worms)

Echinorhynchidae

Acanthocephalus dirus

- Necturus maculosus* (unspecified) – Amin 1985a

Neoechinorhynchidae

Neoechinorhynchus emydis

- Chrysemys picta* (intestine) – Wieczorowski 1939
- Trachemys scripta elegans* (intestine) – Wieczorowski 1939

Annelida: Hirudinea (Leeches)

Glossiphoniidae

Desserobdella picta

- Anaxyrus americanus* (skin) – Bolek and Janovy 2005
- Hyla chrysoscelis* (skin) – Bolek and Janovy 2005
- Lithobates pipiens* (skin) – Watermolen 1996
- Chelydra serpentina* (skin) – Watermolen 1996

Placobdella ornata

- Chelydra serpentina* (carapace, limbs) - Bolek 2001
- Emydoidea blandingii* (unspecified) – Amin 1981
- Emydoidea blandingii* (carapace, limbs) - Bolek 2001

Placobdella parasitica

- Ambystoma tigrinum* (skin) – Watermolen 1998
- Chelydra serpentina* (carapace, limbs) - Bolek 2001
- Emydoidea blandingii* (carapace, limbs) - Bolek 2001
- Emydoidea blandingii* (unspecified) – Amin 1981
- Glyptemys insculpta* (skin: inguinal cavity, ventral surface of neck, posterior to hind legs) – Brewster and Brewster 1986
- Glyptemys insculpta* (skin) – Cochran et al. 2014
- Graptemys geographica* (skin, leg and neck cavities) – Vogt 1979
- Graptemys ouachensis* (skin, leg and neck cavities) – Vogt 1979, Vogt 1980
- Graptemys pseudogeographica* (skin, leg and neck cavities) – Vogt 1979, Vogt 1980

Mollusca: Bivalvia (Mussels)

Unionidae

- Simpsonaias ambigua*
- Necturus maculosus* (gills) – Pearse 1921

Insecta: Diptera (Flies)

Calliphoridae

Bufo lucilia elongata

- Anaxyrus americanus* (skin and underlying tissue) – Briggs 1975
- Lithobates sylvaticus* (skin and underlying tissue) – Bolek and Janovy 2004

Bufo lucilia silvarum

- Anaxyrus americanus* (skin and underlying tissue) – Bolek and Coggins 2002
- Lithobates sylvaticus* (skin and underlying tissue) – Bolek and Janovy 2004

Bufo lucilia sp.

- Lithobates clamitans* (unspecified) – Sadinski and Roth 2009

Unidentified myiasis

- Lithobates pipiens* (unspecified) – Sadinski and Roth 2009

Culicidae

Aedes canadensis

- Lithobates pipiens* (skin) – Wright and DeFoliart 1970
- Chelydra serpentina* (skin) – Wright and DeFoliart 1970
- Chrysemys picta* (skin) – Wright and DeFoliart 1970
- Emydoidea blandingii* (skin) – DeFoliart 1967
- Emydoidea blandingii* (skin) – Wright and DeFoliart 1970

Aedes cinereus

Chelydra serpentina (skin) – Wright and DeFoliart 1970

Aedes sticticus

Chelydra serpentina (skin) – Wright and DeFoliart 1970

Chrysemys picta (skin) – Wright and DeFoliart 1970

Emydoidea blandingii (skin) – Wright and DeFoliart 1970

Pantherophis vulpinus (skin) – Wright and DeFoliart 1970

Aedes triseriatus

Chrysemys picta (skin) – Wright and DeFoliart 1970

Aedes trivittatus

Chelydra serpentina (skin) – Wright and DeFoliart 1970

Chrysemys picta (skin) – Wright and DeFoliart 1970

Emydoidea blandingii (skin) – Wright and DeFoliart 1970

Pantherophis vulpinus (skin) – Wright and DeFoliart 1970

Aedes vexans

Chelydra serpentina (skin) – Wright and DeFoliart 1970

Chrysemys picta (skin) – Wright and DeFoliart 1970

Culex pipiens

Pantherophis vulpinus (skin) – Wright and DeFoliart 1970

Mansonia perturbans

Chelydra serpentina (skin) – Wright and DeFoliart 1970

Emydoidea blandingii (skin) – Wright and DeFoliart 1970

Sarcophagidae

Tripanurga importuna (as *Metoposarcophaga importuna*)

Graptemys pseudogeographica (eggs) – Vogt 1981

Notes



Table 2. Wisconsin amphibian and reptile species and their parasites. Hosts are listed alphabetically by order. Parasites are listed alphabetically by taxonomic category. County locations of occurrences are indicated in parentheses following the parasite names. Author and year citations refer to the literature source(s) of the records.

Anura (Frogs)

Acris crepitans (Blanchard's Cricket Frog)
No Wisconsin records.

Anaxyrus americanus (American Toad)

Fungus: *Batrachochytrium dendrobatidis* (Dane, Sauk) - Ortiz-Santaliestra et al. 2013

Trematode: Echinostomatid metacercariae (Waukesha) – Bolek and Coggins 2000, Bolek and Coggins 2003

Trematode: *Fibricola* sp. (Waukesha) – Bolek and Coggins 2003

Trematode: *Fibricola texensis* (Ozaukee) – Yoder and Coggins 2007

Trematode: *Gorgoderina bilobata* (Fond du Lac, Waukesha) – Coggins and Sajdak 1982

Trematode: *Gorgoderina bilobata* (Sheboygan, Waukesha) – Tiekotter and Coggins 1982

Trematode: *Gorgoderina bilobata* (Ozaukee) – Yoder and Coggins 2007

Trematode: *Gorgoderina* sp. (Waukesha) – Bolek and Coggins 2000

Trematode: *Haematoloechus varioplexus* (Waukesha) – Bolek and Coggins 2003

Trematode: *Ribeiroia ondatrae* (unspecified) – Johnson and Chase 2004

Trematode: Unidentified metacercariae (Ozaukee) – Yoder and Coggins 2007

Cestode: *Mesocestoides* sp. (Waukesha) – Bolek and Coggins 2000, Bolek and Coggins 2003

Cestode: *Mesocestoides* sp. (Ozaukee) – Yoder and Coggins 2007

Nematode: *Cosmocercoides dukae* (Fond du Lac, Sheboygan, Waukesha) – Coggins and Sajdak 1982

Nematode: *Cosmocercoides variabilis* (Waukesha) – Bolek and Coggins 2000, Bolek and Coggins 2003

Nematode: *Cosmocercoides variabilis* (Ozaukee) – Yoder and Coggins 2007

Nematode: *Oswaldocruzia pipiens* (Fond du Lac, Sheboygan, Waukesha) – Coggins and Sajdak 1982

Nematode: *Oswaldocruzia pipiens* (Waukesha) – Bolek and Coggins 2000, Bolek and Coggins 2003

Nematode: *Oswaldocruzia pipiens* (Ozaukee) – Yoder and Coggins 2007

Nematode: *Rhabdias americanus* (Bayfield) – Kuzmin et al. 2003

Nematode: *Rhabdias americanus* (Waukesha) – Bolek and Coggins 2000, Bolek and Coggins 2003

Nematode: *Rhabdias americanus* (Ozaukee) – Yoder and Coggins 2007

Nematode: *Rhabdias americanus* (unspecified) – Kuzmin et al. 2001

Nematode: *Rhabdias bufonis* (Barron, Dunn) – Williams and Taft 1980

Nematode: *Rhabdias ranae* (Fond du Lac, Sheboygan, Waukesha) – Coggins and Sajdak 1982

Nematode: *Spiroxys* sp. (Waukesha) – Bolek and Coggins 2003

Nematode: Unidentified larva/juvenile (Waukesha) – Bolek and Coggins 2003

Leech: *Desserobdella picta* (Waukesha) – Bolek and Janovy 2005

Fly: *Bufo lucilia elongata* (Walworth) – Briggs 1975

Fly: *Bufo lucilia silvarum* (Waukesha) – Bolek and Coggins 2002

Hyla chrysoscelis (Cope's Gray Treefrog)

Protoctist: *Nyctotherus cordiformis* (Waukesha) – Bolek and Coggins 1998a

Protoctist: *Opalina* sp. (Waukesha) – Bolek and Coggins 1998a

Monogenean: *Polystoma nearcticum* (Waukesha) – Bolek and Coggins 1998a

Trematode: *Glythelmins pennsylvaniensis* (Waukesha) – Bolek and Coggins 1998a

Trematode: Unidentified immature (Waukesha) – Bolek and Coggins 1998a

Trematode: Unidentified metacercariae (Waukesha) – Bolek and Coggins 1998a

Cestode: *Mesocestoides* sp. (Waukesha) – Bolek and Coggins 1998a

Cestode: Unidentified plerocercoid (Waukesha) – Bolek and Coggins 1998a

Cestode: Unidentified cyst (Waukesha) – Bolek and Coggins 1998a

Nematode: *Cosmocercoides variabilis* (Waukesha) – Bolek and Coggins 1998a

Nematode: *Oswaldocruzia pipiens* (Waukesha) – Bolek and Coggins 1998a

Leech: *Desserobdella picta* (Waukesha) – Bolek and Janovy 2005

Hyla versicolor (Eastern Gray Treefrog)

No Wisconsin records.

Lithobates catesbeianus (American Bullfrog)

Bacteria: *Mycobacterium marinum* (Milwaukee, in captivity) - Maslow et al. 2002

Trematode: *Glythelmins quieta* (presumably Winnebago) – Schell 1962

Trematode: *Gorgoderina amplicava* (Waukesha) – Bolek et al. 2009b

Trematode: *Ribeiroia ondatrae* (unspecified) – Johnson and Chase 2004

Trematode: *Ribeiroia*-like metacercaria (Grant) – Sadinski and Roth 2009

Nematode: *Aplectana americana* ("Mississippi basin") – Walton 1929

Nematode: *Waltonella ranae* (unspecified) – Walton 1935

Lithobates clamitans (Green Frog)

Fungus: *Batrachochytrium dendrobatidis* (Bayfield, Buffalo, Burnett, Grant, La Crosse, Pepin, Polk, St. Croix, Sawyer, Vernon, and Washburn) – Sadinski and Roth 2009, Sadinski et al. 2010

Fungus: *Batrachochytrium dendrobatidis* (Barron, Chippewa, Jackson, La Crosse, Lincoln, Marathon, Marinette, Oconto, Polk, Sawyer, Washburn, Washington, Waupaca, Waushara) – Klemish et al. 2012

Trematode: *Alaria* sp. (unspecified) – Hartson et al. 2011

Trematode: *Apharyngostrigea pipientis* (unspecified) – Hartson et al. 2011

Trematode: *Cephalogonimus salamandrus* (Rock) – Coggins and Sajdak 1982

Trematode: *Clinostomum* sp. (Ozaukee) – Yoder et al. 2001

Trematode: *Echinoparaphyium* spp. (unspecified) – Hartson et al. 2011

Trematode: *Echinostoma* spp. (unspecified) – Hartson et al. 2011

Trematode: *Fibricola* sp. (unspecified) – Hartson et al. 2011

Trematode: *Glythelmins quieta* (Barron, Dunn) – Williams and Taft 1980

Trematode: *Glythelmins quieta* (Waukesha) – Bolek and Coggins 2001

Trematode: *Glythelmins quieta* (Ozaukee) – Yoder et al. 2001

Trematode: *Gorgoderina attenuata* (Barron, Dunn) – Williams and Taft 1980

Trematode: *Gorgoderina attenuata* (Rock) – Coggins and Sajdak 1982

Trematode: *Gorgoderina attenuata* (Waukesha) – Bolek et al. 2009a

Trematode: *Gorgoderina bilobata* (Ozaukee) – Yoder et al. 2001

Trematode: *Gorgoderina simplex* (Barron, Dunn) – Williams and Taft 1980

Trematode: *Gorgoderina simplex* (Waukesha) – Bolek et al. 2009b

Trematode: *Haematoloechus complexus* (Waukesha) – Bolek and Janovy 2007b

- Trematode: *Haematoloechus longiplexus* (Barron, Dunn) – Williams and Taft 1980
Trematode: *Haematoloechus parviplexus* (commercial supplier, Winnebago) – Schell 1965
Trematode: *Haematoloechus parviplexus* (Barron, Dunn) – Williams and Taft 1980
Trematode: *Haematoloechus parviplexus* (Waukesha) – Bolek and Janovy 2007a
Trematode: *Haematoloechus varioplexus* (Barron, Dunn) – Williams and Taft 1980
Trematode: *Haematoloechus varioplexus* (Waukesha) – Bolek and Coggins 2001
Trematode: *Haematoloechus varioplexus* (Ozaukee) – Yoder et al. 2001
Trematode: *Haematoloechus* sp. (Barron, Dunn) – Williams and Taft 1980
Trematode: *Haematoloechus* sp. (unspecified) – Hartson et al. 2011
Trematode: *Halipegus occidualis* (Oconto) – Guilford 1961
Trematode: *Halipegus occidualis* (Barron, Dunn) – Williams and Taft 1980
Trematode: *Halipegus occidualis* (Waukesha) – Bolek and Coggins 2001
Trematode: *Halipegus occidualis* (Ozaukee) – Yoder et al. 2001
Trematode: *Halipegus* sp. (unspecified) – Sutherland 2005
Trematode: *Loxogenes arcanum* (Barron, Dunn) – Williams and Taft 1980
Trematode: *Megalodiscus temperatus* (Barron, Dunn) – Williams and Taft 1980
Trematode: *Megalodiscus temperatus* (Ozaukee) – Yoder et al. 2001
Trematode: *Ribeiroia ondatrae* (unspecified) – Johnson and Chase 2004, Johnson et al. 2007
Trematode: *Ribeiroia ondatrae* (unspecified) – Hartson et al. 2011
Trematode: *Ribeiroia*-like metacercaria (Bayfield, Grant, and Sawyer) – Sadinski and Roth 2009
Trematode: Unidentified diplostomid metacercariae (Waukesha) – Bolek and Coggins 2001
Trematode: Unidentified plagiorchid (unspecified) – Hartson et al. 2011
Trematode: Unidentified “lung flukes” (St. Croix) – Sadinski and Roth 2009
Trematode: Unidentified strigeid (unspecified) – Hartson et al. 2011
Trematode: Unidentified metacercariae (Waukesha) – Bolek and Coggins 2001
Trematode: Unidentified metacercariae (Ozaukee) – Yoder et al. 2001
Cestode: *Mesocestoides* sp. (Barron, Dunn) – Williams and Taft 1980
Cestode: *Mesocestoides* sp. (Waukesha) – Bolek and Coggins 2001
Cestode: *Mesocestoides* sp. (Ozaukee) – Yoder et al. 2001
Cestode: *Mesocestoides* sp. (unspecified) – Sutherland 2005
Cestode: *Ophiotaenia saphena* (unspecified) – Sutherland 2005
Cestode: *Proteocephalus saphenus* (Barron, Dunn) – Williams and Taft 1980
Cestode: *Proteocephalus* sp. (Ozaukee) – Yoder et al. 2001
Cestode: Unidentified adult (Waukesha) – Bolek and Coggins 2001
Nematode: *Cosmocercoides dukae* (Barron, Dunn) – Williams and Taft 1980
Nematode: *Cosmocercoides dukae* (Rock) – Coggins and Sajdak 1982
Nematode: *Cosmocercoides* sp. (Waukesha) – Bolek and Coggins 2001
Nematode: *Cosmocercoides* sp. (Ozaukee) – Yoder et al. 2001
Nematode: *Oswaldocruzia pipiens* (Barron, Dunn) – Williams and Taft 1980
Nematode: *Oswaldocruzia pipiens* (Waukesha) – Bolek and Coggins 2001
Nematode: *Oswaldocruzia pipiens* (Ozaukee) – Yoder et al. 2001
Nematode: *Waltonella* sp. (Waukesha) – Bolek and Coggins 2001
Nematode: “tadpole pinworm,” likely *Gyrinicola batrachiensis* (unspecified) – Hartson et al. 2011
Nematode: Unidentified larval (Waukesha) – Bolek and Coggins 2001
Nematode: Unidentified encysted nematode (Waukesha) – Bolek and Coggins 2001
Nematode: Unidentified spirurid (unspecified) – Hartson et al. 2011
Fly: *Bufo locilia* sp. (Grant) – Sadinski and Roth 2009

Lithobates palustris (Pickerel Frog)

- Trematode: *Brachycoelium salamandrae* (Rock) – Coggins and Sajdak 1982
- Trematode: *Ribeiroia ondatrae* (unspecified) - Johnson et al. 2004
- Nematode: *Aplectana americana* ("Mississippi basin") – Walton 1929
- Nematode: *Cosmocercoides dukae* (Rock) – Coggins and Sajdak 1982
- Nematode: *Oswaldocruzia pipiens* (unspecified) – Walton 1929

Lithobates pipiens (Northern Leopard Frog)

- Bacteria: *Aeromonas hydrophila* (unspecified) – Dent and Schuellein 1950
- Bacteria: *Aeromonas hydrophila* (Winnebago) – Hine et al. 1975, Hine et al. 1981
- Bacteria: *Aeromonas* spp. (Kewaunee, Langlade, Sawyer, Winnebago) – Hine et al. 1975, Hine et al. 1981
- Bacteria: *Flavobacterium* sp. (unspecified) – Hine et al. 1975, Hine et al. 1981
- Bacteria: *Pseudomonas* sp. (unspecified) – Hine et al. 1975, Hine et al. 1981
- Fungus: *Batrachochytrium dendrobatidis* (Buffalo, La Crosse, Pepin, and Vernon) – Sadinski and Roth 2009, Sadinski et al. 2010
- Fungus: *Batrachochytrium dendrobatidis* (Dane, Sauk) - Ortiz-Santaliestra et al. 2013
- Fungus: *Blastocystis* sp. (unspecified) - Hine et al. 1975, Hine et al. 1981
- Protoctist: *Babesiosoma stableri* (unspecified) – Schmittner and McGhee 1961
- Protoctist: *Bodo* sp. (unspecified) - Hine et al. 1975, Hine et al. 1981
- Protoctist: *Haemogregarina magna* (unspecified) – Levine and Nye 1977
- Protoctist: *Hexamastix* sp. (unspecified) - Hine et al. 1975, Hine et al. 1981
- Protoctist: *Hyaloklossia lieberkühni* (unspecified) – Levine and Nye 1977¹⁰
- Protoctist: *Leptothea ohlmacheri* (unspecified) – Kudo 1922
- Protoctist: *Leptothea ohlmacheri* (unspecified) – Levine and Nye 1977
- Protoctist: *Nyctotherus* sp. (unspecified) - Hine et al. 1975, Hine et al. 1981
- Protoctist: *Proteromonas* sp. (unspecified) - Hine et al. 1975, Hine et al. 1981
- Protoctist: *Trichomonas* sp. (unspecified) - Hine et al. 1975, Hine et al. 1981
- Protoctist: *Trypanosoma pipientis* (unspecified) – Levine and Nye 1977¹¹
- Protoctist: *Trypanosoma pipientis* (Winnebago) – Woo 1983
- Protoctist: *Trypanosoma ranarum* (Winnebago) – Woo 1983
- Protoctist: *Trypanosoma rotatorium* (Winnebago) – Woo 1983
- Protoctist: Unidentified opalinids (unspecified) - Hine et al. 1975, Hine et al. 1981
- Trematode: *Alaria arisaemoides* (presumably Winnebago) – Hofer and Johnson 1970
- Trematode: *Alaria marciana* (Winnebago) – Schaefer and Etgers 1969
- Trematode: *Alaria marciana* (presumably Winnebago) – Hofer and Johnson 1970
- Trematode: *Alaria mustelae* (presumably Winnebago) – Hofer and Johnson 1970
- Trematode: *Alaria* sp. (unspecified) – Hartson et al. 2011
- Trematode: *Apharyngostrigea pipientis* (unspecified) – Hartson et al. 2011
- Trematode: *Cephalogonimus* sp. (Barron, Dunn) – Williams and Taft 1980
- Trematode: *Echinostoma* spp. (unspecified) – Hartson et al. 2011
- Trematode: Echinostomatid metacercariae (Waukesha) – Bolek and Coggins 2003
- Trematode: *Fibricola* sp. (Waukesha) – Bolek and Coggins 2003
- Trematode: *Fibricola* sp. (unspecified) – Hartson et al. 2011
- Trematode: *Glythelmins quieta* (Barron, Dunn) – Williams and Taft 1980
- Trematode: *Gorgoderina attenuata* ("purchased in Wisconsin") – Goodchild 1954

¹⁰ The authors based this report solely on merozoites seen in the frog's kidney tubules. Duszynski et al. (2007) felt that there was no justification for identifying *Hyaloklossia lieberkühni* solely on this basis and believed the report may actually represent an undescribed apicomplexan.

¹¹ The authors note that although purchased from a Wisconsin vendor, the host specimen may have originated in Mexico.

- Trematode: *Gorgoderina attenuata* (Barron, Dunn) – Williams and Taft 1980
 Trematode: *Gorgoderina attenuata* (Waukesha) – Bolek et al. 2009a
 Trematode: *Gorgoderina attenuata* (Waukesha) – Bolek and Coggins 2003
 Trematode: *Gorgoderina* sp. (“commercial source”) – Burton 1966
 Trematode: *Haematoloechus medioplexus* (“commercial source”) – Burton 1967
 Trematode: *Haematoloechus medioplexus* (unspecified) – Kennedy 1981
 Trematode: *Haematoloechus medioplexus* (Winnebago) – Leon-Regagnon and Brooks 2003
 Trematode: *Haematoloechus varioplexus* (Winnebago) – Cort 1915a, Cort 1915b
 Trematode: *Haematoloechus varioplexus* (Barron, Dunn) – Williams and Taft 1980
 Trematode: *Haematoloechus varioplexus* (Waukesha) – Bolek and Coggins 2003
 Trematode: *Haematoloechus varioplexus* (Winnebago) – Leon-Regagnon and Brooks 2003
 Trematode: *Haematoloechus* sp. (Winnebago) – Dent and Schuellein 1950
 Trematode: *Haematoloechus* sp. (Winnebago) – Schaefer and Etges 1969
 Trematode: *Haematoloechus* sp. (unspecified) – Sutherland 2005
 Trematode: *Halipegus occidualis* (Barron, Dunn) – Williams and Taft 1980
 Trematode: *Langeronia provitellaria* (Winnebago) – Christian 1970
 Trematode: *Megalodiscus temperatus* (Barron, Dunn) – Williams and Taft 1980
 Trematode: *Ribeiroia ondatrae* (Dane) – Schotthoefer et al. 2003
 Trematode: *Ribeiroia ondatrae* (unspecified) - Johnson and Chase 2004, Johnson et al. 2004
 Trematode: *Ribeiroia ondatrae* (unspecified) – Hartson et al. 2011
 Trematode: *Ribeiroia*-like metacercaria (Bayfield, Grant, St. Croix, and Sawyer) – Sadinski and Roth 2009
 Trematode: Unidentified plagiorchid (unspecified) – Hartson et al. 2011
 Trematode: Unidentified strigeid (unspecified) – Hartson et al. 2011
 Cestode: *Mesocestoides* sp. (“supply house”) – James and Ulmer 1967
 Cestode: *Mesocestoides* sp. (Barron, Dunn) – Williams and Taft 1980
 Cestode: *Mesocestoides* sp. (Waukesha) – Bolek and Coggins 2003
 Cestode: *Ophiotaenia saphena* (unspecified) – Sutherland 2005
 Cestode: *Ophiotaenia* sp. (Winnebago) – Schaefer and Etges 1969
 Cestode: Unidentified plerocercoid (unspecified) – Sutherland 2005
 Nematode: *Aplectana americana* (“Mississippi basin”) – Walton 1929
 Nematode: *Cosmocercoides dukae* (Barron, Dunn) – Williams and Taft 1980
 Nematode: *Cosmocercoides dukae* (Rock) – Coggins and Sajdak 1982
 Nematode: *Foleyella* sp. (unspecified) – Levine and Nye 1977¹²
 Nematode: *Oswaldocruzia pipiens* (unspecified) – Walton 1929
 Nematode: *Oswaldocruzia pipiens* (Barron, Dunn) – Williams and Taft 1980
 Nematode: *Oswaldocruzia pipiens* (Waukesha) – Bolek and Coggins 2003
 Nematode: *Oswaldocruzia* spp. (unspecified) – Hartson et al. 2011
 Nematode: *Rhabdias ranae* (unspecified) – Walton 1929
 Nematode: *Rhabdias ranae* (Barron, Dunn) – Williams and Taft 1980
 Nematode: *Rhabdias ranae* (unspecified) – Kuzmin et al. 2001
 Nematode: *Serpinema microcephalus* (unspecified) – Walton 1935
 Nematode: *Serpinema trispinosus* (unspecified) – Walton 1935
 Nematode: *Spiroxys* sp. (Waukesha) – Bolek and Coggins 2003
 Nematode: *Waltonella americana* (unspecified) – Walton 1935
 Nematode: Unidentified spirurid (unspecified) – Hartson et al. 2011
 Nematode: Unidentified larva/juvenile (Waukesha) – Bolek and Coggins 2003

¹² Levine and Nye's (1977) identification of *Foleyella* sp. from leopard frogs may be in error as members of this genus are known to infect only mammals, birds, and reptiles (Bartlett 1986).

Leech: *Desserobdella picta* (Brown, Manitowoc) – Watermolen 1996
Fly: *Aedes canadensis* (Dane, Iowa, Wood) – Wright and DeFoliart 1970
Fly: Unidentified myiasis (St. Croix) – Sadinski and Roth 2009

Lithobates septentrionalis (Mink Frog)

Fungus: *Batrachochytrium dendrobatidis* (Bayfield) – Sadinski and Roth 2009, Sadinski et al. 2010
Trematode: *Ribeiroia ondatrae* (unspecified) - Johnson and Chase 2004, Johnson et al. 2004
Trematode: *Ribeiroia ondatrae* (Bayfield) – Wilson et al. 2005
Trematode: *Ribeiroia*-like metacercaria (Bayfield, Sawyer) – Sadinski and Roth 2009
Trematode: Unidentified flukes (Bayfield, Sawyer) – Sadinski and Roth 2009

Lithobates sylvaticus (Wood Frog)

Fungus: *Batrachochytrium dendrobatidis* (Polk, St. Croix) – Sadinski and Roth 2009, Sadinski et al. 2010
Fungus: *Batrachochytrium dendrobatidis* (Dane, Sauk) - Ortiz-Santaliestra et al. 2013
Trematode: *Alaria mustelae* (Ozaukee) – Yoder and Coggins 1996
Trematode: *Fibricola texensis* (Ozaukee) – Yoder and Coggins 1996, Yoder and Coggins 2007
Trematode: *Haematoloechus medioplexus* (Barron, Dunn) – Williams and Taft 1980
Trematode: *Haematoloechus varioplexus* (Ozaukee) – Bolek and Janovy 2007a
Trematode: *Haematoloechus varioplexus* (Ozaukee) – Yoder and Coggins 1996, Yoder and Coggins 2007
Trematode: *Ribeiroia ondatrae* (unspecified) – Johnson and Chase 2004
Trematode: Unidentified metacercariae (Ozaukee) – Yoder and Coggins 1996, Yoder and Coggins 2007
Cestode: *Mesocestoides* sp. (Ozaukee) – Yoder and Coggins 2007
Cestode: Unidentified cysts (Ozaukee) - Yoder and Coggins 1996
Nematode: *Cosmocercoides dukae* (Ozaukee) - Yoder and Coggins 1996
Nematode: *Cosmocercoides* sp. (Ozaukee) – Yoder and Coggins 2007
Nematode: *Oswaldocruzia pipiens* (Ozaukee) – Yoder and Coggins 1996, Yoder and Coggins 2007
Nematode: *Rhabdias ranae* (Barron, Dunn) – Williams and Taft 1980
Nematode: *Rhabdias ranae* (Ozaukee) – Yoder and Coggins 1996, Yoder and Coggins 2007
Nematode: *Rhabdias* larvae (Bayfield, Sawyer) – Sadinski and Roth 2009
Nematode: Unidentified immature/encysted (Ozaukee) - Yoder and Coggins 1996
Fly: *BufoLucilla elongata* (Ozaukee) – Bolek and Janovy 2004
Fly: *BufoLucilla silvarum* (Ozaukee) – Bolek and Janovy 2004

Pseudacris crucifer (Spring Peeper)

Trematode: *Alaria mustelae* (Ozaukee) – Yoder and Coggins 1996, Yoder and Coggins 2007
Trematode: *Fibricola texensis* (Ozaukee) – Yoder and Coggins 1996, Yoder and Coggins 2007
Trematode: *Glypthelmins pennsylvaniensis* (Portage, Sheboygan) – Coggins and Sajdak 1982
Trematode: *Glypthelmins pennsylvaniensis* (Ozaukee) – Yoder and Coggins 1996, Yoder and Coggins 2007
Trematode: *Haematoloechus varioplexus* (Ozaukee) – Yoder and Coggins 2007
Trematode: Unidentified mesocercariae (Ozaukee) - Yoder and Coggins 1996

- Trematode: Unidentified metacercariae (Ozaukee) – Yoder and Coggins 1996, Yoder and Coggins 2007
Trematode: Unidentified immature (Ozaukee) - Yoder and Coggins 1996
Cestode: *Mesocestoides* sp. (Ozaukee) – Yoder and Coggins 2007
Nematode: *Cosmocercoides* sp. (Ozaukee) – Yoder and Coggins 2007
Nematode: *Oswaldocruzia pipiens* (Ozaukee) – Yoder and Coggins 2007
Nematode: *Rhabdias ranae* (Ozaukee) – Yoder and Coggins 1996, Yoder and Coggins 2007
Nematode: Unidentified encysted (Ozaukee) - Yoder and Coggins 1996

Pseudacris maculata (Boreal Chorus Frog)
No Wisconsin records.

Pseudacris triseriata (Western Chorus Frog)
Protoctist: *Nyctotherus cordiformis* (Waukesha) – Bolek and Coggins 1998a
Trematode: *Glythelminis pennsylvaniensis* (Waukesha) – Bolek and Coggins 1998a
Trematode: Unidentified metacercariae (Waukesha) – Bolek and Coggins 1998a
Nematode: *Cosmocercoides variabilis* (Waukesha) – Bolek and Coggins 1998a

Caudata (Salamanders)

Ambystoma laterale (Blue-spotted Salamander)
Trematode: *Phyllodistomum americanus* (Ozaukee) – Yoder and Coggins 2007
Trematode: Echinostomatid metacercariae (Waukesha) – Bolek and Coggins 2003
Nematode: *Cosmocercoides dukae* (Fond du Lac, Sheboygan, Waukesha) – Coggins and Sajdak 1982
Nematode: *Cosmocercoides dukae* (Waukesha) – Bolek 1997
Nematode: *Cosmocercoides* sp. (Waukesha) – Bolek and Coggins 2003
Nematode: *Cosmocercoides* sp. (Ozaukee) – Yoder and Coggins 2007
Nematode: *Spiroxys* sp. (Waukesha) – Bolek and Coggins 2003
Nematode: Unidentified spirurid cysts (Waukesha) – Coggins and Sajdak 1982

Ambystoma maculatum (Spotted Salamander)
Trematode: *Brachycoelium salamandrae* (Bayfield) – Bolek and Coggins 1998b
Trematode: *Brachycoelium salamandrae* (Rock, Sheboygan) – Coggins and Sajdak 1982
Trematode: *Phyllodistomum coatneyi* (St. Croix) – Meserve 1941, 1943
Nematode: *Batracholandros magnavulvaris* (Bayfield) – Bolek and Coggins 1998b
Nematode: *Cosmocercoides dukae* (Fond du Lac, Sheboygan) – Coggins and Sajdak 1982
Nematode: *Rhabdias ambystomae* (Bayfield) – Kuzmin et al. 2001, 2003

Ambystoma tigrinum (Eastern Tiger Salamander)
Trematode: *Cephalogonimus salamandrus* (Waukesha) – Coggins and Sajdak 1982
Trematode: *Phyllodistomum americanum* (Fond du Lac, Waukesha) – Coggins and Sajdak 1982
Trematode: *Phyllodistomum americanum* (Sheboygan, Waukesha) – Tiekotter and Coggins 1982
Trematode: Unidentified metacercariae (Waukesha) – Coggins and Sajdak 1982
Nematode: *Cosmocercoides dukae* (Waukesha) – Coggins and Sajdak 1982
Nematode: Unidentified spirurid cysts (Waukesha) – Coggins and Sajdak 1982
Leech: *Placobdella parasitica* (Fond du Lac) – Watermolen 1998

Hemidactylium scutatum (Four-toed Salamander)

- Trematode: *Gorgoderina bilobata* (Sheboygan) – Coggins and Sajdak 1982
- Trematode: Unidentified metacercariae (Sheboygan) – Coggins and Sajdak 1982
- Nematode: *Cosmocercoides dukae* (Sheboygan) – Coggins and Sajdak 1982

Necturus maculosus (Mudpuppy)

- Fungi: white growths of fish mold (Wisconsin lakes) – Pearse 1921
- Monogenean: *Sphyranura osleri* (Dane) – Pearse 1921
- Monogenean: *Sphyranura osleri* (Waukesha) – Coggins and Sajdak 1982
- Cestode: *Proteocephalus loennbergii* (Dane) – Pearse 1921
- Cestode: *Proteocephalus loennbergii* (Waukesha) – Coggins and Sajdak 1982
- Cestode: *Proteocephalus loennbergii* (Ashland) – Cochran et al. 2002¹³
- Acanthocephalan: *Acanthocephalus dirus* (Racine) – Amin 1985a.
- Mollusc: *Simpsonaias ambigua* (Mississippi River) – Pearse 1921

Notophthalmus viridescens (Central Newt)

- Trematode: Unidentified metacercariae (Ozaukee) – Yoder and Coggins 2007
- Nematode: *Cosmocercoides dukae* (Sheboygan) – Coggins and Sajdak 1982
- Nematode: *Cosmocercoides* sp. (Ozaukee) – Yoder and Coggins 2007
- Nematode: Unidentified cyst (Ozaukee) – Yoder and Coggins 2007

Plethodon cinereus (Eastern Red-backed Salamander)

- Trematode: *Brachycoelium salamandrae* (Portage, Sheboygan) – Coggins and Sajdak 1982
- Trematode: *Brachycoelium salamandrae* (Bayfield) – Bolek and Coggins 1998b
- Nematode: *Batracholandros magnavulvaris* (Bayfield) – Bolek and Coggins 1998b
- Nematode: *Cosmocercoides dukae* (Portage) – Coggins and Sajdak 1982
- Nematode: *Rhabdias ranae* (Sheboygan) – Coggins and Sajdak 1982
- Nematode: *Rhabdias* sp. (Bayfield) – Bolek and Coggins 1998b

Testudines (Turtles)

Apalone mutica (Smooth Softshell)

No Wisconsin records.

Apalone spinifera (Spiny Softshell)

No Wisconsin records.

Chelydra serpentina (Snapping Turtle)

- Trematode: *Auridistomum chelydrae* (Oconto) – Guilford 1955
- Trematode: *Auridistomum chelydrae* (Marinette) – Guilford 1959
- Trematode: *Eustomos chelydrae* (Marinette) – Guilford 1959
- Trematode: *Hapalorhynchus gracilis* (Marinette) – Guilford 1959
- Trematode: *Spirorchis haematobium* (Brown, Marinette) – Guilford 1959
- Trematode: *Telorchis corti* (Brown, Marinette) – Guilford 1959
- Trematode: *Telorchis* sp. (Marinette) – Guilford 1959
- Nematode: *Falcaustra wardi* (Racine or Waukesha) – Bolek 2001
- Nematode: *Serpinema microcephalus* (Brown) – Guilford 1959
- Nematode: *Spironura affine* (Marinette) – Guilford 1959
- Nematode: *Spiroxys constricta* (Brown, Marinette) – Guilford 1959

¹³ This report represents a probable case. Preservation technique precluded worm identification.

Leech: *Desserobdella picta* (Marinette) – Watermolen 1996
 Leech: *Placobdella ornata* (Milwaukee, Waukesha) – Bolek 2001
 Leech: *Placobdella parasitica* (Milwaukee, Waukesha) – Bolek 2001
 Fly: *Aedes canadensis* (Dane, Iowa, Wood) – Wright and DeFoliart 1970
 Fly: *Aedes cinereus* (Dane, Iowa, Wood) – Wright and DeFoliart 1970
 Fly: *Aedes sticticus* (Dane, Iowa, Wood) – Wright and DeFoliart 1970
 Fly: *Aedes trivittatus* (Dane, Iowa) – Wright and DeFoliart 1970
 Fly: *Aedes vexans* (Dane, Iowa) – Wright and DeFoliart 1970
 Fly: *Mansonia perturbans* (Dane, Iowa, Wood) – Wright and DeFoliart 1970

Chrysemys picta (Painted Turtle)

Protoctist: *Haemoproteus metchnikovi* (unspecified) – De Giusti and Batten 1951
 Trematode: *Allassostomoides chelydrae* (Vilas) – Platt 2000
 Trematode: *Allassostomoides parvum* (Marinette, Oconto) – Guilford 1959
 Trematode: *Eustomos chelydrae* (Door, Marinette, Oconto) – Guilford 1959
 Trematode: *Eustomos chelydrae* (Vilas) – Platt 2000
 Trematode: *Heronimus chelydrae* (presumably Wisconsin) – Guilford 1958
 Trematode: *Heronimus chelydrae* (Marinette, Oconto) – Guilford 1959
 Trematode: *Protenes angustus* (Brown, Door, Oconto) – Guilford 1959
 Trematode: *Spirorchis elegans* (Brown, Door) – Guilford 1959
 Trematode: *Spirorchis kirki* (Vilas) – Platt 2000
 Trematode: *Spirorchis parvus* (Vilas) – Platt 2000
 Trematode: *Spirorchis* sp. (Oconto) – Guilford 1959
 Trematode: *Spirorchis* sp. (presumably Winnebago) – Goodchild and Dennis 1967
 Trematode: *Telorchis attenuatus* (Brown) – Guilford 1959
 Trematode: *Telorchis* sp. (unspecified) – Wieczorowski 1939
 Monogenean: *Neopolystoma elizabethae* (Vilas) – Platt 2000
 Monogenean: *Neopolystoma orbiculare* (Door, Marinette, Oconto) – Guilford 1959
 Monogenean: *Neopolystoma* sp. (Door) – Guilford 1959
 Monogenean: *Polystomoides pauli* (Vilas) – Platt 2000
 Nematode: *Amphibiocapillaria serpentina* (Vilas) – Platt 2000
 Nematode: *Serpinema microcephalus* (Brown, Door, Marinette, Oconto) – Guilford 1959
 Nematode: *Serpinema trispinosus* (unspecified) – Wieczorowski 1939
 Nematode: *Serpinema trispinosus* (Vilas) Platt 2000
 Nematode: *Spiroxys constricta* (Marinette, Oconto) – Guilford 1959
 Nematode: *Spiroxys contortus* (Dane) – Hedrick 1935
 Nematode: *Spiroxys contortus* (unspecified) – Wieczorowski 1939
 Nematode: *Spiroxys contortus* (Vilas) – Platt 2000
 Nematode: Unidentified immature (Oconto) – Guilford 1959
 Acanthocephalan: *Neoechinorhynchus emydis* (unspecified) – Wieczorowski 1939
 Leech: *Placobdella parasitica* (Racine) – Amin 1981
 Fly: *Aedes canadensis* (Dane, Iowa, Wood) – Wright and DeFoliart 1970
 Fly: *Aedes sticticus* (Dane, Iowa, Wood) – Wright and DeFoliart 1970
 Fly: *Aedes triseriatus* (Dane, Iowa) – Wright and DeFoliart 1970
 Fly: *Aedes trivittatus* (Dane, Iowa) – Wright and DeFoliart 1970
 Fly: *Aedes vexans* (Dane, Iowa) – Wright and DeFoliart 1970

Emydoidea blandingii (Blanding's Turtle)

Trematode: *Telorchis corti* (Oconto) – Guilford 1959
 Nematode: *Serpinema microcephalus* (Oconto) – Guilford 1959
 Nematode: *Spiroxys constricta* (Oconto) – Guilford 1959
 Nematode: *Spiroxys contortus* (Racine or Waukesha) – Bolek 2001

Nematode: Unidentified immature (Oconto) – Guilford 1959
Leech: *Placobdella ornata* (Racine) – Amin 1981
Leech: *Placobdella ornata* (Milwaukee, Waukesha) – Bolek 2001
Leech: *Placobdella parasitica* (Racine) – Amin 1981
Leech: *Placobdella parasitica* (Milwaukee, Waukesha) – Bolek 2001
Fly: *Aedes canadensis* (Wood) – DeFoliart 1967
Fly: *Aedes canadensis* (Dane, Iowa, Wood) – Wright and DeFoliart 1970
Fly: *Aedes sticticus* (Dane, Iowa, Wood) – Wright and DeFoliart 1970
Fly: *Aedes trivittatus* (Dane, Iowa) – Wright and DeFoliart 1970
Fly: *Mansonia perturbans* (Dane, Iowa, Wood) – Wright and DeFoliart 1970

Glyptemys insculpta (Wood Turtle)

Trematode: *Dictyogium chelydrae* (Marinette) – Guilford 1959
Trematode: *Telorchis corti* (Oconto) – Guilford 1959
Nematode: *Serpinema microcephalus* (Marinette) – Guilford 1959
Leech: *Placobdella parasitica* (Vilas) – Brewster and Brewster 1986
Leech: *Placobdella parasitica* (Brown) – Cochran et al. 2014

Graptemys geographica (Northern Map Turtle)

Protoctist: *Haemoproteus metchnikovi* (unspecified) – De Giusti and Batten 1951
Leech: *Placobdella parasitica* (Vernon) – Vogt 1979

Graptemys ouachitensis (Southern Map Turtle)

Leech: *Placobdella parasitica* (Vernon) – Vogt 1979, Vogt 1980

Graptemys pseudogeographica (False Map Turtle)

Leech: *Placobdella parasitica* (Vernon) – Vogt 1979, Vogt 1980
Fly: *Metoposarcophaga importuna* (Vernon) – Vogt 1981

Sternotherus odoratus (Eastern Musk Turtle)

No Wisconsin records.

Terrapene ornata (Ornate Box Turtle)

No Wisconsin records.

Trachemys scripta elegans (Pond Slider)

Trematode: *Telorchis* sp. (unspecified) – Wieczorowski 1939
Monogenean: *Neoploystoma obiculare* (Winnebago, biological supply company) – Henke et al. 1990
Nematode: *Serpinema trispinosus* (unspecified) – Wieczorowski 1939
Nematode: *Spiroxys contortus* (unspecified) – Wieczorowski 1939
Acanthocephalan: *Neoechinorhnychus emydis* (“commercial frog farm”) – Wieczorowski 1939

Sauria (Lizards)

Aspidoscelis sexlineata (Six-lined Racerunner)

No Wisconsin records.

Ophisaurus attenuates (Slender Glass Lizard)

No Wisconsin records.

Plestiodon fasciatus (Common Five-lined Skink)

No Wisconsin records.

Plestiodon septentrionalis (Prairie Skink)

No Wisconsin records.

Serpentes (Snakes)

Carphophis vermis (Western Wormsnake)

No Wisconsin records.

Coluber constrictor (North American Racer)

Bacteria: *Mycobacterium marinum* (Milwaukee, in captivity) - Maslow et al. 2002

Crotalus horridus (Timber Rattlesnake)

Bacteria: *Mycobacterium marinum* (Milwaukee, in captivity) - Maslow et al. 2002

Bacteria: *Clostridium mangenotii* (unspecified¹⁴) – McLaughlin et al. 2014

Diadophis punctatus (Ring-necked Snake)

No Wisconsin records.

Heterodon platirhinos (Eastern Hog-nosed Snake)

Bacteria: *Mycobacterium marinum* (Milwaukee, in captivity) - Maslow et al. 2002

Lampropeltis triangulum (Milksnake)

Bacteria: *Mycobacterium marinum* (Milwaukee, in captivity) - Maslow et al. 2002

Nerodia sipedon (Common Watersnake)

Bacteria: *Mycobacterium marinum* (Milwaukee, in captivity) - Maslow et al. 2002

Opheodrys vernalis (Smooth Greensnake)

Nematode: *Physaloptera abjecta* (unspecified) – Morgan 1942

Pantherophis spiloides (Gray Ratsnake)

Bacteria: *Mycobacterium marinum* (Milwaukee, in captivity) - Maslow et al. 2002

Pantherophis vulpinus (Western Foxsnake)

Bacteria: *Mycobacterium marinum* (Milwaukee, in captivity) - Maslow et al. 2002

Fly: *Aedes sticticus* (Dane, Iowa, Wood) – Wright and DeFoliart 1970

Fly: *Aedes trivittatus* (Dane, Iowa) – Wright and DeFoliart 1970

Fly: *Culex pipiens* (Dane, Iowa) – Wright and DeFoliart 1970

Pituophis catenifer (Gophersnake)

Bacteria: *Mycobacterium marinum* (Milwaukee, in captivity) - Maslow et al. 2002

Regina septemvittata (Queensnake)

No Wisconsin records.

¹⁴ It is possible that the source of the specimen analyzed actually originated in Minnesota rather than Wisconsin.

Sistrurus catenatus (Massasauga)

Bacteria: *Mycobacterium marinum* (Milwaukee, in captivity) - Maslow et al. 2002

Storeria dekayi (Dekay's Brownsnake)

No Wisconsin records.

Storeria occipitomaculata (Red-bellied Snake)

No Wisconsin records.

Thamnophis butleri (Butler's Gartersnake)

No Wisconsin records.

Thamnophis proximus (Western Ribbonsnake)

No Wisconsin records.

Thamnophis radix (Plains Gartersnake)

No Wisconsin records.

Thamnophis sauritus (Eastern Ribbonsnake)

No Wisconsin records.

Thamnophis sirtalis (Common Gartersnake) ¹⁵

Bacteria: *Mycobacterium marinum* (Milwaukee, in captivity) - Maslow et al. 2002

Trematode: *Lechriorchis* sp. (unspecified) – Sutherland 2005

Trematode: *Ochetosoma* sp. (unspecified) – Sutherland 2005

Trematode: *Paralechriorchis* sp. (unspecified) – Sutherland 2005

Cestode: *Mesocestoides* sp. (unspecified) – Sutherland 2005

Nematode: *Rhabdias fuscovenosa* (Winnebago) – Kuzmin et al. 2003

Tropicolonion lineatum (Lined Snake)

No Wisconsin records.

Notes



¹⁵ Although no genus-species names are provided, general reports from “garter snakes” by Sutherland (2005) are presumed to be from this species.

Discussion

A considerable amount of scientific work has addressed the parasites and disease-causing organisms found in Wisconsin amphibians and reptiles. The resulting literature is diverse and diffuse. I found more than 70 papers that have addressed some aspect of these organisms. Accumulation of knowledge is a gradual process, with papers dating back to 1915. A small number of investigators associated with the University of Wisconsin-Milwaukee (Bolek [currently at Oklahoma State University], Coggins, Yoder) and their collaborators (Janovy, Reinbold, Snyder, Tiekotter) has conducted most of the important recent parasitological work. Earlier important work was conducted by Amin (UW-Parkside), Guilford (UW-Extension), and Walton (Knox College). Most studies have focused on taxonomic relationships, life histories, or descriptive biology. A number of parasite faunal surveys have been undertaken, but these have been restricted to only a handful of species and localities. Many reports appear to have been made incidental to other work or simply reflect interests of specific investigators. Few studies address host-parasite interactions in natural populations and little experimental work has been done under controlled environmental conditions. In addition, the distribution and persistence of parasites and the mechanisms by which they spread across the landscape and between hosts remain areas to be explored. For example, some species currently thought to be uncommon or rare may have been discovered only in an accidental host(s) and may prove to be more common and widespread when a true host is discovered and life cycles are clarified.

The effects of most parasite species on the health and reproduction of their hosts remain largely uninvestigated and, as a result, largely unknown.¹⁶ In writing about the effects of worm parasites on wildlife, Van Cleave (1937) offered four areas that would benefit from further investigation: 1) lack of knowledge concerning the “normal” health of animals, 2) lack of information as to the species of parasites infesting each wild species and the life histories of the parasites, 3) lack of conclusive evidence linking observed incidences of parasitism with pathological conditions, and 4) lack of knowledge as to what can be done if these first three obstacles are addressed adequately. Considerable progress has been made in addressing these questions for numerous bird and mammal host species over the past century, and certainly we have seen progress in tackling the second as it relates to amphibian and reptile hosts. Nonetheless, wildlife health and veterinary professionals have much yet to contribute to our understanding of background health, epidemiology, and effective control techniques.

Investigators have looked at a wide range of parasites (Table 1), but in many cases only a single parasite species or parasite group has been addressed. At least six bacteria, three fungi, 15 protozoists, 46 trematodes, five monogeneans, four cestodes, 22 nematodes, two acanthocephalans, three leeches, one mollusk, and 11 flies have been reported from Wisconsin amphibians and reptiles. Observations and comments on each of these taxonomic groups are presented below.

The parasites of amphibians have been treated more frequently than those of reptiles (Table 2, Appendix A; 14 papers on salamanders and 49 on frogs versus none on lizards, 16 on turtles, and five on snakes). All but three species of Wisconsin's frogs have been investigated for parasites. Although they have been the subject of fewer studies than those of frogs, parasites have been reported from all seven species of Wisconsin salamander. A few of the helminths found in Wisconsin amphibians are also parasitic in fishes (e.g., *Ribeiroia*, *Clinostomum*, *Proteocephalus*, *Spiroxys*, and *Acanthocephalus*). Reports on the

¹⁶ The potential nature of damage caused by parasites is highly variable and may be quite significant. Yet, many parasites have never been linked with any disease conditions in their hosts.

parasites of turtles have mostly regarded helminths found in select host species and leeches. Almost nothing has been written about the parasites of Wisconsin snakes. Papers addressing Wisconsin snakes are basically limited to reports of a small number of bacterial infections in zoo animals and feeding trials with mosquitoes. None of the four lizard species native to Wisconsin has been investigated for its parasites. The only papers dealing with lizards in the state are reports of *Salmonella* in captive iguanas. I have found no papers or reports addressing the parasites of 21 Wisconsin species (Table 3). This further demonstrates that there is much yet to be learned in our region.

While the digestive tract is often believed to be the principle point of parasite infection, the lungs, heart, blood vessels, liver, kidneys, brain, eyes, muscles, skin, and other tissues and organs support various parasites in their different stages of development. As such, parasites have been reported from various anatomical habitats (Table 1). Relatively little work has carefully examined preferences for anatomical habitats or site selectivity by these organisms.

Table 3. *Amphibian and reptile species for which no published parasite records were found.*

Anura (Frogs)

Acris crepitans (Blanchard's Cricket Frog)
Hyla versicolor (Eastern Gray Treefrog)
Pseudacris maculata (Boreal Chorus Frog)

Testudines (Turtles)

Apalone mutica (Smooth Softshell)
Apalone spinifera (Spiny Softshell)
Sternotherus odoratus (Eastern Musk Turtle)
Terrapene ornata (Ornate Box Turtle)

Sauria (Lizards)

Aspidoscelis sexlineata (Six-lined Racerunner)
Ophisaurus attenuates (Slender Glass Lizard)
Plestiodon fasciatus (Common Five-lined Skink)
Plestiodon septentrionalis (Prairie Skink)

Serpentes (Snakes)

Carphophis vermis (Western Wormsnake)
Diadophis punctatus (Ring-necked Snake)
Regina septemvittata (Queensnake)
Storeria dekayi (Dekay's Brownsnake)
Storeria occipitomaculata (Red-bellied Snake)
Thamnophis butleri (Butler's Gartersnake)
Thamnophis proximus (Western Ribbonsnake)
Thamnophis radix (Plains Gartersnake)
Thamnophis sauritus (Eastern Ribbonsnake)
Tropicolonion lineatum (Lined Snake)

Bacteria: Potentially pathogenic bacteria have been investigated rarely in our area. Reports of *Salmonella* associated with reptiles in Wisconsin (CDC 1999, 2003, 2005, 2010a, and 2010b, Fermaglich et al. 2012) have been case reports of human infections from exposure to captive animals, primarily pet iguanas and small turtles, and possibly African dwarf frogs (*Hymenochirus boettgeri*). *Salmonella* in wild amphibians and reptiles has not been investigated in Wisconsin. Similarly, *Mycobacterium* has been reported only in captive zoo animals. Cases of “red-leg” disease in frogs have been surprisingly rare. The composition of bacterial communities and their effects on hosts are areas that merit further investigation.

Fungi: Fungal pathogens have been investigated only recently, largely due to concerns about the spread and impact of chytridiomycosis and the newly documented snake fungal disease. *Batrachochytrium dendrobatidis* has been reported from four species of frogs in Wisconsin, as well as several others in the surrounding region (Table 1; Sadinski and Roth 2009, Sadinski et al. 2010). The fact that *B. dendrobatidis* appears to have been present historically in the Midwest, but without noticeable impacts (Ouellet et al. 2013, Talley et al. 2015), suggests that lethal outbreaks of chytridiomycosis may have more complex causes than simply the presence of the pathogen. To date, no Midwestern amphibian population declines have been attributed to chytridiomycosis. The recent report of the discovery and spread of *Batrachochytrium salamandrivorans* (Martel et al. 2014), the cause of a form of chytridiomycosis that has extirpated salamander populations in northern Europe, raises new concerns for salamander conservation. Wisconsin salamanders have not been screened for *Batrachochytrium* or other fungal infections. Surveillance for *Chrysosporium* in snakes is only now getting underway.

Protoctists: A variety of microorganisms occur as parasites of amphibians and reptiles, but protoctists have rarely been investigated in our area. Reports have been mostly anecdotal observations made incidental to other work. Schmittner and McGhee (1961) describe the apicomplexan *Babesiosoma stableri* from Wisconsin *Lithobates pipiens*. Barta's (1991) review of the family Dactylosomatidae includes a list of then currently recognized *Babesiosoma* species and their hosts, along with their distributions. His summary table lists several host species for *B. stableri* from Wisconsin based on Schmittner and McGhee's (1961) work. However, all of the host species listed by these authors, except *L. pipiens*, were actually collected in Georgia not Wisconsin, and I therefore omit them from Tables 1 and 2. Numerous coccidians parasitize amphibians (Duszynski et al. 2007), but Wisconsin frogs and salamanders have not been examined for these or related apicomplexans.

Trematodes: Not surprisingly, trematodes are the most frequently reported parasites of amphibians. It is well documented that frogs and salamanders living predominately in aquatic habitats have parasite communities that are dominated by these worms, often with multiple species present in a single host. Depending on the trematode species involved, amphibians may serve as intermediate hosts harboring larval forms (mesocercariae and metacercariae) or as definitive hosts where the adult worms develop in the gastrointestinal tract. Many trematodes use aquatic invertebrates, especially molluscs, as intermediate hosts. These prey animals transmit the immature forms to their amphibian hosts when they are consumed. Some immature trematodes infect the amphibian hosts directly. These forms generally occur in the musculature, liver, etc. It is a bit unusual, however, to find both immature and adult stages of a given trematode species in a single host.

Metacercariae are particularly common in *Lithobates pipiens* tadpoles. The presence of metacercariae has received increasing attention stemming from the links between the metacercariae of *Ribeiroia* and the occurrence of developmental abnormalities in frogs (Johnson and Sutherland 2003, Johnson et al. 2004). Although recent work has helped shed light on these linkages, many interesting questions remain.

Early references to Wisconsin trematodes report their occurrence and distribution in hosts. Bass Lake in St. Croix County is the type locality for Meserve's (1941, 1943) description of *Phyllodistomum coatneyi* from *Ambystoma maculatum*. More recent works have begun to further elucidate the life cycles and ecology of various species. Specimens collected in Wisconsin are used by Bolek et al. (2009a) in their redescription of the trematode *Gorgoderina attenuata*, as well as in their genetic analysis of the life stages of some of its congeners (Bolek et al. 2009b).

Stafford (1904) reported *Crepidostomum laureatum* (Allocreadiidae) from the "mud puppy," but Hopkins (1931) later commented that "brief descriptions do not permit us to say what species Stafford's specimens were, but they do not suggest *C. laureatum*... his record should not be cited as evidence that adult forms of *C. laureatum* inhabit other hosts than the Salmonoidei." *C. laureatum* is a synonym of *C. farionis*, a parasite of various fishes. Hopkins (1934) appears to have later considered Stafford's record to refer to *C. cornutum*, another fish parasite, which he lists from "mud puppy" in Lake Michigan, Wisconsin. I did not include these records in Tables 1 and 2 due to the uncertainty and confusion associated with them.

Monogeneans: Among the parasitic platyhelminths, monogeneans have the simplest life cycle. They are hermaphroditic, have no intermediate hosts (i.e. all life stages are completed on the same host), and are predominantly ectoparasitic on skin and gills (although some are found in the urinary bladder or rectum of amphibians). A heavily ciliated larval stage (oncomiracidium) is generally responsible for active transmission from host to host. While many monogeneans have been reported from Wisconsin fishes, I found only six reports from the state's amphibians and reptiles, one of which came from a commercial supplier of a species (*Trachemys scripta*) that may not be native to Wisconsin. In Michigan, monogeneans have been reported only from turtles (Muzzall 2005).

Cestodes: Compared to trematodes, tapeworms occur far less frequently in amphibians and reptiles. When they are found, larvae generally far outnumber the adults. Only four species have been definitely reported from Wisconsin, mostly from frogs. These species have complex life cycles that require an intermediate invertebrate host. Larvae are transferred to the host amphibian along with infected food. Adult forms are found only in the digestive tract, but larvae may be found in the gut or various parenteral sites, often in the leg musculature or organ mesentery.

Nematodes: Amphibians living a more terrestrial life style tend to be infected primarily with nematodes. As with other taxa, early works addressing nematodes have been primarily taxonomic in nature. Walton's (1929) descriptions of *Rhabdias ranae* and *Oswaldocruzia pipiens* are based, in part, on specimens collected from Wisconsin *Lithobates pipiens* and *L. palustris*, respectively. Similarly, Walton's (1929) description of *Aplectana americana*, a parasite of the cecal regions of *L. catesbeianus*, *L. palustris*, and *L. pipiens*, is based on specimens from the "Mississippi basin from Wisconsin to Louisiana." Pigeon Lake in Bayfield County is the type locality for the nematode *Rhabdias ambystomae*, a parasite of *Ambystoma maculatum* (Kuzmin et al. 2001, Kuzmin et al. 2003).

Ernst and Ernst (2006) listed *Physaloptera obtussima* from the esophagus and stomach of various snakes from a number of states, including Wisconsin. However, I was unable to locate Wisconsin records of this species in any of the cited references. *Coluber constrictor*, *Heterodon platyrhinos*, *Opheodrys vernalis*, and *Thamnophis sirtalis* are potential hosts, and it will not be surprising if this species is found in the state. Nematodes are certainly more common in snakes and turtles than the lack of records might suggest.

Acanthocephalans: Somewhat surprisingly, I found only a single Wisconsin report of an acanthocephalan from *Necturus maculosus* and a single report of another species from *Chrysemys picta* and *Trachemys scripta elegans*. Several acanthocephalans have been reported as common parasites of turtles. Amin (1985b) provides criteria for distinguishing the fish parasite *Neoechinorhynchus robertbaueri* from its eight congeners known to parasitize turtles in North America, based in part on specimens from Wisconsin. Amin (2002) provides a key to all 88 species of the genus.

Leeches: Leeches are frequently reported ectoparasites of turtles, largely because they are visible, conspicuous, and do not require specialized procedures for identification. Although a single host may harbor large numbers of leeches, it is unclear whether these pose health issues for the turtles. As with many other parasites, leeches may serve as vectors for various microorganisms. Vogt (1979) reports an interesting cleaning/feeding symbiosis between grackles (*Quiscalus*) and map turtles (*Graptemys* spp.).

Crustacean Pentastomes: The distribution and occurrence of pentastomes ('tongue worms') in the United States remain poorly known. Five species are reported to occur in the U.S. Riley (1986) notes that many records are recovered from autopsies of deceased zoo animals. I found no reports of pentastomes from Wisconsin amphibians or reptiles.

Other Arthropods: Several species of mites (chiggers) are known to parasitize amphibians and reptiles. Jenkins (1948) summarizes available information concerning three species of trombiculid mites, including their geographic distributions and host records. He reports *Eutrombicula alfreddugesi* from four southern Wisconsin counties (Dane, Dodge, Jefferson, and Milwaukee). He also reports *E. masoni* from Minnesota and Michigan (a single county location for each). Although he does not provide specific localities for hosts, Jenkins (1948) lists at least seven snakes, two lizards, three turtles, and three frogs that occur in Wisconsin as hosts of these ectoparasites. I did not include these records in Tables 1 and 2, however, as too many specifics are lacking in his report. Walters et al. (2011) list six different species of chiggers from Wisconsin, but none of them were reported from amphibians or reptiles. This is an area that would benefit from further investigation. Reptile-feeding ticks are known to be vectors for and reservoirs of various pathogens (e.g., see Eckner et al. 2011), but these have not been investigated in Wisconsin. Some work to discern the host preferences of mosquitoes has been completed in the state, but only a limited number of amphibian and reptile hosts have been tested.

Uncertain Identifications: The reports by Hine et al. (1975) and Hine et al. (1981) include records of organisms recovered from the "upper 1/3 of the large intestine" of *Lithobates pipiens*. Included in these listings is an organism referred to as "*Selenodesmus*." I have been unable to identify any organisms with the genus name *Selenodesmus*. It is unclear if Hine et al.'s (1975, 1981) reports represent a parasite or some other organism that may have been ingested, either through feeding or incidentally. Text in the reports suggests this name may actually refer to a "green/blue-green algae." In which case, it would appear to be a misspelling of the widespread alga genus *Scenedesmus*.

Negative Finds: A few studies have indicated a lack of parasites or disease-causing organisms in Wisconsin amphibians. For example, Hine et al. (1981) report finding sick or dead *L. pipiens* with ventral skin discoloration, dry skin, and hard muscles, but no blood parasites or evidence of viral infection. They note that bacteriological examination revealed pathological symptoms in 39% to 86% of autopsied frogs, but also report finding degenerative liver changes suggestive of ingestion or absorption of a toxic substance. Sadinski and Roth (2009) and Sadinski et al. (2010) present data on the absence of *Batrachochytrium dendrobatidis* at several sites they investigated. Similarly, Bolek (2000)

comments on the absence of coccidian parasites in *Ambystoma laterale* collected in Waukesha County. Coggins and Sajdak (1982) note the absence of helminths from a single *Lithobates sylvaticus* that they examined. Similarly, Amin (1980, 1985b) notes the absence of acanthocephalans in *Necturus* in one southeastern Wisconsin lake. Other reports make mention of the absence of one or more parasite taxa in specific species or locations.

Useful References: Several general references are available to provide useful starting points and guide future efforts. Sutherland (2005) reviews the occurrence of parasites in North American frogs, and Densmore and Green (2007) provide a review of disease-causing organisms in amphibians. Barnard and Upton (1994), Barnard and Durden (2000), and Jacobson (2007) provide excellent general overviews of the parasites of reptiles and discuss appropriate veterinary responses. Duszynski et al. (2007) review the coccidians found in amphibians, and Bardsley and Harmsen (1973) and Telford (1995) summarize what is known about trypanosomes in frogs and reptiles, respectively. Ernst and Ernst (1979) catalog the protozoan parasites of turtles occurring in the U.S. Prudhoe and Bray (1982) review the helminths of amphibians. Hughes et al. (1941, 1942a, 1942b) and Hughes et al. (1941a, 1941b, 1942) discuss trematodes and cestodes recorded in reptiles, respectively. Ernst and Ernst (1977) catalog helminths reported in turtles, and Ernst and Ernst (2006) summarize those from North American snakes. Baker (1987) summarizes records of nematodes in amphibians and reptiles, and McAlpine (1996) reviews the acanthocephalans reported from North American species. Watermolen (1996) tabulates leeches reported from turtles in the United States. Baumgartner (1988) comprehensively reviews flies known to invade tissues of vertebrates. Gardner et al. (2012) provide guidelines for collecting and preserving parasites during reptile surveys.

Concluding Thoughts: Documentation of the composition of the regional parasite fauna helps biologists understand changes brought on by environmental variation and the introduction and spread of invasive species. Such knowledge can be helpful for investigating and explaining the underlying reasons for local population fluctuations (i.e. declines). This catalog and the one by Muzzall (2005), along with Dyer's (1991) Illinois survey of helminths, provide a solid foundation for such work in our area. On a more fundamental level, information on the parasite fauna may contribute to a better understanding of host evolutionary relationships.¹⁷ Although diseases and parasites may raise concerns for individual host animals, these organisms also play an important role in the biological control of populations, a significant ecosystem function yet to be understood fully (Jorgensen 2014). With further work, some parasites potentially could be tapped for antiviral or antimicrobial functions that remain unexplored. As such, these less than charismatic organisms are part of the biological diversity that we must aim to understand and seek to conserve despite their unpopularity and inherent "ick" factor. The present contribution represents a step in documenting the diversity of parasites in Wisconsin amphibians and reptiles. It also identifies gaps in our knowledge, which in turn may guide future studies.

**"... for who knows how we may rue the loss
of yet little-known creatures?"**

- Robert Michael Pyle (1989)

¹⁷ Although, host specificity may be unimportant in determining gastrointestinal communities in some amphibians and reptiles (Aho 1990).

Literature Cited

- Aho, J.M. 1990. Helminth communities of amphibians and reptiles: Comparative approaches to understanding patterns and processes. Pp. 157-195 In G.W. Esch, A.O. Bush, and J.M. Aho (eds.). *Parasite Communities and Processes*. Chapman and Hall, London, UK.
- Amin, O.M. 2002. Revision of *Neoechinorhynchus* Stiles & Hassall, 1905 (Acanthocephala: Neoechinorhynchidae) with keys to 88 species in two subgenera. *Systematic Parasitology* 53(1):1-18.
- Amin, O.M. 1985a. Hosts and geographic distribution of *Acanthocephalus* (Acanthocephala: Echinorhynchidae) from North American freshwater fishes, with a discussion of species relationships. *Proceedings of the Helminthological Society of Washington* 52(2):210-220.
- Amin, O.M. 1985b. Acanthocephala from lake fishes in Wisconsin: *Neoechinorhynchus robertbaueri* n. sp. from *Erimyzon sucetta* (Lacepede), with a key to species of the genus *Neoechinorhynchus* Hamann, 1892, from North American freshwater fishes. *Journal of Parasitology* 71(3):312-318.
- Amin, O.M. 1981. Leeches (Hirudinea) from Wisconsin, and a description of the spermatophore of *Placobdella ornata*. *Transactions of the American Microscopical Society* 100(1):42-51.
- Amin, O.M. 1980. *Fessisentis tichiganensis* sp. nov. (Acanthocephala: Fessisentidae) from Wisconsin fishes, with a key to species. *Journal of Parasitology* 66(6):1,039-1,045.
- Anderson, R.C. 1992. *Nematode Parasites of Vertebrates*. CAB International, Oxon, UK.
- Andrews, K.D., R.L. Lampley, M.A. Gillman, D.T. Corey, S.R. Ballard, M.J. Blasczyk, and W.G. Dyer. 1992. Helminths of *Rana catesbeiana* in southern Illinois with a checklist of helminths in bullfrogs of North America. *Transactions of the Illinois State Academy of Science* 85(3-4):147-172.
- Baker, M.R. 1987. Synopsis of the nematode parasitic in amphibians and reptiles. Memorial University of Newfoundland *Occasional Papers in Biology* (11).
- Bardsley, J.E. and R. Harmsen. 1973. The trypanosomes of Anura. *Advances in Parasitology* 11:1-72.
- Barnard, S.M. and L.E. Durden. 2000. *A Veterinary Guide to the Parasites of Reptiles, Volume 2, Arthropods (Excluding Mites)*. Krieger Publishing Company, Malabar, FL.
- Barnard, S.M. and S.J. Upton. 1994. *A Veterinary Guide to the Parasites of Reptiles, Volume 1, Protozoa*. Krieger Publishing Company, Malabar, FL.
- Barta, J.R. 1991. The Dactylosomatidae. *Advances in Parasitology* 30:1-37.
- Bartlett, C.M. 1986. The reptilian filarioid genus *Foleyella* Seurat, 1917 (Onchocercidae: Dirofiliariinae) and its relationship to other dirofiliariine genera. *Systematic Parasitology* 9:43-56.
- Baumgartner, D.L. 1988. Review of myiasis (Insecta: Diptera: Calliphoridae, Sarcophagidae) of Nearctic wildlife. *Wildlife Rehabilitation* 7:3-46.

- Bolek, M.G. 2001. Natural history notes: *Chelydra serpentina* (Common snapping turtle) and *Emydoidea blandingii* (Blanding's turtle). Parasites. *SSAR Herpetological Review* 32(1): 37-38.
- Bolek, M.G. 2000. Natural history notes: *Ambystoma laterale* (Tiger salamander). Coccidia. *SSAR Herpetological Review* 31(2):97.
- Bolek, M.G. 1998. A seasonal and comparative study of helminth parasites in nine Wisconsin amphibians. M.S. Thesis. University of Wisconsin-Milwaukee, Milwaukee, WI.
- Bolek, M.G. 1997. Seasonal occurrence of *Cosmocercoides dukae* and prey analysis in the blue-spotted salamander, *Ambystoma laterale*, in southeastern Wisconsin. *Journal of the Helminthological Society of Washington* 64(2):292-295.
- Bolek, M.G. and J.R. Coggins. 2003. Helminth community structure of sympatric eastern American toad, *Bufo americanus americanus*, northern leopard frog, *Rana pipiens*, and blue-spotted salamander, *Ambystoma laterale*, from southeastern Wisconsin. *Journal of Parasitology* 89(4):673-680.
- Bolek, M. G. and J.R. Coggins. 2002. Observations on myiasis by the calliphorid, *Bufo lucilia silvarum*, in the eastern American toad (*Bufo americanus americanus*) from southeastern Wisconsin. *Journal of Wildlife Diseases* 38(3):598-603.
- Bolek, M.G. and J.R. Coggins. 2001. Seasonal occurrence and community structure of helminth parasites in green frogs, *Rana clamitans melanota*, from southeastern Wisconsin, U.S.A. *Comparative Parasitology* 68(2):164-172.
- Bolek, M.G. and J.R. Coggins. 2000. Seasonal occurrence and community structure of helminth parasites from the eastern American toad, *Bufo americanus americanus*, from southeastern Wisconsin, U.S.A. *Comparative Parasitology* 67(2):202-209.
- Bolek, M.G. and J.R. Coggins. 1998a. Endoparasites of Cope's gray treefrog, *Hyla chrysoscelis*, and western chorus frog, *Pseudacris t. triseriata*, from southeastern Wisconsin. *Journal of the Helminthological Society of Washington* 65(2):212-218.
- Bolek, M.G. and J.R. Coggins. 1998b. Helminth parasites of the spotted salamander *Ambystoma maculatum* and red-backed salamander *Plethodon c. cinereus* from Northwestern Wisconsin. *Journal of the Helminthological Society of Washington* 65(1):98-102.
- Bolek, M.G. and J. Janovy, Jr. 2007a. Evolutionary avenues for, and constraints on, the transmission of frog lung flukes (*Haematoloechus* spp.) in dragonfly second intermediate hosts. *Journal of Parasitology* 93(3):593-607.
- Bolek, M.G. and J. Janovy, Jr. 2007b. Small frogs get their worms first: the role of nonodonate arthropods in the recruitment of *Haematoloechus coloradensis* and *Haematoloechus complexus* in newly metamorphosed northern leopard frogs, *Rana pipiens*, and Woodhouse's toads, *Bufo woodhousii*. *Journal of Parasitology* 93(2):300-312.
- Bolek, M.G. and J. Janovy, Jr. 2005. New host and distribution records for the amphibian leech *Desserobdella picta* (Rhynchobdellida: Glossiphoniidae) from Nebraska and Wisconsin. *Journal of Freshwater Ecology* 20(1):187-189.

- Bolek, M.G. and J. Janovy, Jr. 2004. Observations on myiasis by the calliphorids, *Bufolucilia silvarum* and *Bufolucilia elongata*, in wood frogs, *Rana sylvatica*, from southeastern Wisconsin. *Journal of Parasitology* 90(5):1,169-1,171.
- Bolek, M.G., S.D. Snyder, and J. Janovy, Jr. 2009a. Redescription of the frog bladder fluke, *Gorgoderina attenuata* from the northern leopard frog, *Rana pipiens*. *Journal of Parasitology* 95(3):665-668.
- Bolek, M.G., S.D. Snyder, and J. Janovy, Jr. 2009b. Alternative life cycle strategies and colonization of young anurans by *Gorgoderina attenuata* in Nebraska. *Journal of Parasitology* 95(3):604-616.
- Brenes, R., M.J. Gray, T.B. Waltzek, R.P. Wilkes, and D.L. Miller. 2014. Transmission of ranavirus between ectothermic vertebrate hosts. *PLOS ONE* 9(3):e92476.
- Brewster, K.N. and C.M. Brewster. 1986. Life history notes. *Clemmys insculpta* (wood turtle). *SSAR Herpetological Review* 17(2):48.
- Briggs, J.L. 1975. A case of *Bufolucilia elongata* Shannon 1924 (Diptera: Calliphoridae) myiasis in the American toad, *Bufo americanus* Holbrook 1836. *Journal of Parasitology* 61(3):412.
- Burton, P.R. 1967. Fine structure of the reproductive system of a frog lung fluke. I. Mehlis' gland and associated ducts. *Journal of Parasitology* 53(3):540-555.
- Burton, P.R. 1966. The ultrastructure of the integument of the frog bladder fluke, *Gorgoderina* sp. *Journal of Parasitology* 52(5):926-934.
- Bychowsky, B.E. (P.C. Oustinoff, translator). 1957 (1961). *Monogenetic Trematodes: Their Systematics and Phylogeny*. American Institute of Biological Sciences, Washington, DC.
- Carey, C., D.F. Bradford, J.L. Brunner, J.P. Collins, E.W. Davidson, J.E. Longcore, M. Ouellet, A.P. Pessier, and D.M. Schock. 2003. Biotic factors in amphibian population declines. Pp. 153-208 In G. Linder, S.K. Krest, and D.W. Sparling (eds.). *Amphibian Decline: An Integrated Analysis of Multiple Stressor Effects*. Society of Environmental Toxicology and Chemistry, Pensacola, FL.
- Casper, G.S. and T.G. Anton. 2013. Current scientific and standard common names of Wisconsin amphibians and reptiles. Miscellaneous Publication PUB-SS-1121. Bureau of Science Services, Wisconsin Department of Natural Resources, Madison, WI.
- Centers for Disease Control and Prevention (CDC). 2010a. Multistate outbreak of human *Salmonella* Typhimurium infections associated with aquatic frogs – United States, 2009. *MMWR Morbidity and Mortality Weekly Report* 58(51&52):1,433-1,436.
- Centers for Disease Control and Prevention (CDC). 2010b. Multistate outbreak of human *Salmonella* Typhimurium infections associated with pet turtle exposure – United States, 2008. *MMWR Morbidity and Mortality Weekly Report* 59(07):191-196.
- Centers for Disease Control and Prevention (CDC). 2005. Salmonellosis associated with pet turtles—Wisconsin and Wyoming, 2004. *MMWR Morbidity and Mortality Weekly Report* 54(9):223–226.

- Centers for Disease Control and Prevention (CDC). 2003. Reptile-associated salmonellosis – selected states, 1998-2002. *MMWR Morbidity and Mortality Weekly Report* 52(49): 1,206-1,209.
- Centers for Disease Control and Prevention (CDC). 1999. Reptile-associated salmonellosis – selected states, 1996-1998. *MMWR Morbidity and Mortality Weekly Report* 48(44): 1,009-1,013. [Errata appear in 48(45):1,051.]
- Chinchar, V.G. and T.B. Waltzek. 2014. Ranavirus: not just for frogs. *PLOS Pathogens* 10(1): e1003850.
- Christian, F.A. 1970. *Langeronia parva* sp. n. (Trematoda: Lecithodendriidae) with revision of the genus *Langeronia* Caballero and Bravo-Hollis, 1949. *Journal of Parasitology* 56(2): 321-324.
- Cochran, P.A., B.D. Jones, and M. Brosig. 2014. Observations on the ecology of the wood turtle (*Glyptemys insculpta*) in northeastern Wisconsin. *Bulletin of the Chicago Herpetological Society* 49(1): 4-7.
- Cochran, P.A., J. Lyons, and M.G. Bolek. 2002. Geographic distribution: *Necturus maculosus maculosus* (Common mudpuppy). *SSAR Herpetological Review* 33(2): 144.
- Coggins, J.R. and R.A. Sajdak. 1982. A survey of helminth parasites in the salamanders and certain anurans from Wisconsin. *Proceedings of the Helminthological Society of Washington* 49(1): 99-102.
- Cort, W.W. 1915a. Egg variation in a trematode species. *Journal of Parasitology* 2(1): 25-26.
- Cort, W.W. 1915b. North American frog lung flukes. *Transactions of the American Microscopical Society* 34(4): 203-240 + 3 plates.
- Davies, A.J. and M.R.L. Johnston. 2000. The biology of some intraerythrocytic parasites of fishes, Amphibia and reptiles. *Advances in Parasitology* 45: 1-107.
- DeFoliart, G.R. 1967. *Aedes canadensis* (Theobald) feeding on Blanding's turtle. *Journal of Medical Entomology* 4(1): 31.
- De Giusti, D.L. and P.J. Batten. 1951. Notes on *Haemoproteus metchnikovi* in turtles from Wisconsin, Michigan, and Louisiana (abstract). *Journal of Parasitology* 37(5, Sect. 2, Suppl.): 12.
- Densmore, C.L. and D.E. Green. 2007. Diseases of amphibians. *ILAR Journal* 48 (3): 235-254.
- Dent, J.N. and R.J. Schuellein. 1950. A consideration of the prothrombin times of several amphibians, with notes on effects of parasitization and disease. *Physiological Zoology* 23(1): 23-27.
- Dlutkowski, L.A., P. Cochran, and M.J. Mossman. 1987. Bibliography of Wisconsin herpetology. Wisconsin Endangered Resources Report (28): 1-17. Bureau of Endangered Resources, Wisconsin Department of Natural Resources, Madison, WI.

- Duffus, A.L.J., M.J. Gray, D.L. Miller, and J.L. Brunner. 2014. Second International Symposium on Ranaviruses: a North American herpetological perspective. *Journal of North American Herpetology* 2014(1):105-107.
- Duszynski, D.W., M.G. Bolek, and S.J. Upton. 2007. Coccidia (Apicomplexa: Eimeriidae) of amphibians of the world. *Zootaxa* 1667: 1-77.
- Dyer, W.G. 1991. Helminth parasites of amphibians from Illinois and adjacent Midwestern states. *Transactions of the Illinois State Academy of Science* 84(3-4):125-143.
- Earl, J.E. and M.J. Gray. 2014. Introduction of ranavirus to isolated wood frog populations could cause local extinction. *EcoHealth* (2014):1-12. DOI: 10.1007/s10393-014-0950-y.
- Elkner, A., K. Dudek, Z. Sajkowska, V. Majlathova, I. Majlath, and P. Tryjanowski. 2011. Anaplasmataceae and *Borrelia burgdorferi* sensu lato in the sand lizard *Lacerta agilis* and co-infection of these bacteria in hosted *Ixodes ricinus* tick. *Parasites and Vectors* 4:182.
- Ernst, C.H. and E.M. Ernst. 2006. Synopsis of helminths endoparasitic in snakes of the United States and Canada. *SSAR Herpetological Circular* (334):1-86.
- Ernst, C.H. and E.M. Ernst. 1979. Synopsis of protozoans parasitic in native turtles of the United States. *Bulletin of the Maryland Herpetological Society* 15(1):1-15.
- Ernst, E.M. and C.H. Ernst. 1977. Synopsis of helminths endoparasitic in native turtles of the United States. *Bulletin of the Maryland Herpetological Society* 13(1):1-75.
- Fajfer, M. 2012. Acari (Chelicerata) – parasites of reptiles. *Acarina* 20(2):108-129.
- Fermaglich, L.J., J.M. Routes, P.S. Lye, S.C. Kehl, and P.L. Havens. 2012. *Salmonella* cervical lymphadenitis in an immunocompetent child exposed to a snake at an educational exhibit. *Infectious Disease in Clinical Practice* 20(4):289-290.
- Gardner, S.L., R.N. Fisher, and S.J. Barry. 2012. Collecting and preserving parasites during reptile biodiversity surveys. Pp. 114-121 In R.W. McDiarmid, M.S. Foster, C. Guyer, J.W. Gibbons, and N. Chernoff (eds.). *Reptile Biodiversity: Standard Methods for Inventory and Monitoring*. University of California Press, Berkeley, CA.
- Goodchild, C.G. 1954. Survival of Gorgoderine trematodes in experimentally altered environments. *Journal of Parasitology* 40(5, Sect. 1):591-602.
- Goodchild, C.G. and E.S. Dennis. 1967. Comparative egg counts and histopathology in turtles infected with *Spirorchis* (Trematoda: Spirorchidae). *Journal of Parasitology* 53(1):38-45.
- Green, D.E., K.A. Converse, and A.K. Schrader. 2002. Epizootiology of sixty-four amphibian morbidity and mortality events in the USA, 1996–2001. *Annals of the New York Academy of Sciences* 969:323-339.
- Guilford, H.G. 1961. Gametogenesis, egg-capsule formation, and early miracidial development in the digenetic trematode *Halipegus eccentricus* Thomas. *Journal of Parasitology* 47(5):757-764.

- Guilford, H.G. 1959. Some helminth parasites found in turtles from northeastern Wisconsin. *Transactions of the Wisconsin Academy of Sciences, Arts and Letters* 48: 121-124.
- Guilford, H.G. 1958. Observations on the development of the miracidium and the germ cell cycle in *Heronimus chelydrae* MacCallum (Trematoda). *Journal of Parasitology* 44(1): 64-74.
- Guilford, H.G. 1955. Gametogenesis in *Heronimus chelydrae* MacCallum. *Transactions of the American Microscopical Society* 74(2): 182-190.
- Harris, J.R., D. Bergmire-Sweat, J.H. Schlegel, K.A. Winpisinger, R.F. Klos, C. Perry, R.V. Tauxe, and M.J. Sotir. 2009. Multistate outbreak of *Salmonella* infections associated with small turtle exposure, 2007-2008. *Pediatrics* 124: 1,388-1,394.
- Hartson, R.B., S.A. Orlofske, V.E. Melin, R.T. Dillon, Jr., and P.T.J. Johnson. 2011. Land use and wetland spatial position jointly determine amphibian parasite communities. *EcoHealth* 8: 485-500.
- Hedrick, L.R. 1935. The life history and morphology of *Spiroxys contortus* (Rudolphi): Nematoda: Spiruridae. *Transactions of the American Microscopical Society* 54(4): 307-335.
- Heller, G. 1974. The fine structure of *Lankesterella* sp. sporozoites parasitic in the frog *Rana pipiens*. *Acta Vet. Acad. Sci. Hungar.* 24: 151-157. (not seen, but cited in Levine and Nye 1977).
- Heller, G. 1973. Elektronemikroskopische Untersuchungen zur Wechselwirkung zwischen einer Haemogregarine und ihrer Wirtszelle. *Prog. Protozool.* 4: 177. (not seen, but cited in Levine and Nye 1977).
- Henke, S.E., D.B. Pence, and R.M. Tran. 1990. Urinary bladders of fresh-water turtles as a renal physiology model potentially biased by monogenean infections. *Laboratory Animal Science* 40(2): 172-178.
- Hidalgo-Vila, J., A. Martinez-Silvestre, A. Ribas, J.C. Casanova, and N. Perez-Santigosa, and C. Diaz-Paniagua. 2011. Pancreatitis associated with the helminth *Serpinema microcephalus* (Nematoda: Camallanidae) in exotic red-eared slider turtles (*Trachemys scripta elegans*). *Journal of Wildlife Diseases* 47(1): 201-205.
- Hine, R.L., B.L. Les, and B.F. Hellmich. 1981. Leopard frog populations and mortality in Wisconsin, 1974-76. Technical Bulletin 122. Bureau of Research, Wisconsin Department of Natural Resources, Madison, WI.
- Hine, R.L., B.L. Les, B.F. Hellmich, and R.C. Vogt. 1975. Preliminary report on leopard frog (*Rana pipiens*) populations in Wisconsin. Research Report 81. Bureau of Research, Wisconsin Department of Natural Resources, Madison, WI.
- Hofer, D.P. and A.D. Johnson. 1970. *Alaria mustelae*, *A. marci*, and *A. arisaemoides*: chemical nature of mesocercarial capsule. *Transactions of the American Microscopical Society* 89(2): 254-259.
- Hopkins, S.H. 1934. The papillose Alloeocreadiidae — a study of their morphology, life histories, and relationships. *Illinois Biological Monographs* 13(2): 1-80.

- Hopkins, S.H. 1931. Studies on *Crepidostomum*. II. The "*Crepidostomum laureatum*" of A.R. Cooper. *Journal of Parasitology* 18(2):79-91.
- Hughes, R.C., J.R. Baker, and C.B. Dawson. 1942. The tapeworms of reptiles. Part III. *Proceedings of the Oklahoma Academy of Sciences* 22:81-89.
- Hughes, R.C., J.R. Baker, and C.B. Dawson. 1941a. The tapeworms of reptiles. Part II. Host catalogue. *Wasmann Collector* 4(3):97-104.
- Hughes, R.C., J.R. Baker, and C.B. Dawson. 1941b. The tapeworms of reptiles. Part I. *American Midland Naturalist* 25(2):454-468.
- Hughes, R.C., J.W. Higginbotham, and J.W. Clary. 1941. The trematodes of reptiles, part II, host catalogue. *Proceedings of the Oklahoma Academy of Sciences* 21:35-43.
- Hughes, R.C., J.W. Higginbotham, and J.W. Clary. 1942a. The trematodes of reptiles, part III, conclusion. *Proceedings of the Oklahoma Academy of Sciences* 22:90-114.
- Hughes, R.C., J.W. Higginbotham, and J.W. Clary. 1942b. The trematodes of reptiles, part I, systematic section. *American Midland Naturalist* 27(1):109-134.
- Jacobson, E.R. 2007. Parasites and parasitic diseases of reptiles. Pp. 571-665 In E.R. Jacobson (ed.). *Infectious Diseases and Pathology of Reptiles: Color Atlas and Text*. CRC/Taylor and Francis, Boca Raton, FL.
- James, H.A. and M.J. Ulmer. 1967. New amphibian host records for *Mesocestoides* sp. (Cestoda: Cyclophyllidae). *Journal of Parasitology* 53(1):59.
- James, T.Y., A.P. Litvintseva, R. Vilgalys, J.A.T. Morgan, J.W. Taylor, M.C. Fisher, et al. 2009. Rapid global expansion of the fungal disease chytridiomycosis into declining and healthy amphibian populations. *PLoS Pathogens* 5:e1000458.
- Jenkins, D.W. 1948. Trombiculid mites affecting man. I. Bionomics with reference to epidemiology in the United States. *American Journal of Hygiene* 48(1):22-35.
- Johnson, P.T.J. and J.M. Chase. 2004. Parasites in the food web: linking amphibian malformations and aquatic eutrophication. *Ecology Letters* 7:521-526.
- Johnson, P.T.J., J.M. Chase, K.L. Dosch, R.B. Hartson, J.A. Gross, D.J. Larson, D.R. Sutherland, and S.R. Carpenter. 2007. Aquatic eutrophication promotes pathogenic infection in amphibians. *Proceedings of the National Academy of Sciences* 104(40):15,781-15,786.
- Johnson, P.T.J., K.B. Lunde, E.M. Thurman, E.G. Ritchie, S.N. Wray, D.R. Sutherland, J.M. Kapfer, T.J. Frest, J. Bowerman, and A.R. Blaustein. 2002. Parasite (*Ribeiroia ondatrae*) infection linked to amphibian malformations in the western United States. *Ecological Monographs* 72(2):151-168.
- Johnson, P.T.J. and D.R. Sutherland. 2003. Amphibian deformities and *Ribeiroia* infection: an emerging helminthiasis. *Trends in Parasitology* 19(8):332-335.

- Johnson, P.T.J., D.R. Sutherland, J.M. Kinsella, and K.B. Lunde. 2004. Review of the trematode genus *Ribeiroia* (Psilostomidae): ecology, life history and pathogenesis with special emphasis on the amphibian malformation problem. *Advances in Parasitology* 57: 191-253.
- Jorgensen, D. 2014. Conservation implications of parasite co-reintroduction. *Conservation Biology*. Doi: 10.1111/cobi.12421.
- Kennedy, M.J. 1981. A revision of species of the genus *Haematoleuchus* Looss, 1899 (Trematoda: Haematoleuchidae) from Canada and the United States. *Canadian Journal of Zoology* 59(9): 1,836-1,846.
- Kerby, J.L., A.J. Hart, and A. Storfer. 2011. Combined effects of virus, pesticide, and predator cue on the larval tiger salamander (*Ambystoma tigrinum*). *EcoHealth* 8: 46-54.
- Kerby, J.L. and A. Storfer. 2009. Combined effects of atrazine and chlorpyrifos on susceptibility of the tiger salamander to *Ambystoma tigrinum* virus. *EcoHealth* 6: 91-98.
- Kleemish, J.L., B.L. Johnson, S.R. Siddons, and E.R. Wild. 2012. Occurrence of *Batrachochytrium dendrobatidis* among populations of *Lithobates clamitans* and *L. pipiens* in Wisconsin, USA. *SSAR Herpetological Review* 43(2): 282-288.
- Kudo, R. 1922. On the morphology and life history of a myxosporidian, *Leptotheca ohlmacheri*, parasitic in *Rana clamitans* and *R. pipiens*. *Parasitology* 14(3-4): 221-241 + 8 plates.
- Kuzmin, Y., V.V. Tkach, and S.D. Snyder. 2003. The nematode genus *Rhabdias* (Nematoda: Rhabdiasidae) from amphibians and reptiles of the Nearctic. *Comparative Parasitology* 70(2): 101-114.
- Kuzmin, Y., V.V. Tkach, and S.D. Snyder. 2001. *Rhabdias ambystomae* sp. n. (Nematoda: Rhabdiasidae) from the North American spotted salamander *Ambystoma maculatum* (Amphibia: Ambystomatidae). *Comparative Parasitology* 68(2): 228-235.
- Lee, D.S. 2013. A primer on ranavirus. *Bulletin of the Chicago Herpetological Society* 48(11): 141-148.
- Leon-Regagnon, V. and D.R. Brooks. 2003. Molecular phylogeny of *Haematoleuchus* Looss, 1899 (Digenea: Plagiorchiidae), with emphasis on North American species. *Journal of Parasitology* 89(6): 1,206-1,211.
- Levine, N.D. 1988. *The Protozoan Phylum Apicomplexa*, Vol. 1. CRC Press, Boca Raton, FL.
- Levine, N.D. and R.R. Nye. 1977. A survey of blood and other tissue parasites of leopard frogs, *Rana pipiens*, in the United States. *Journal of Wildlife Diseases* 13(1): 17-23.
- Marcogliese, D.J. and L. Giamberini. 2013. Parasites and Ecotoxicology: Fish and Amphibians. Pp 815-826 In J.-F. Férard and C. Blaise (eds.). *Encyclopedia of Aquatic Ecotoxicology*. Springer, New York, NY.
- Margulis, L., J.O. Corliss, M. Melkonian, and D.J. Chapman (eds.). 1990. *Handbook of Protozoa*. Jones and Bartlett Publishers, Boston, MA.

- Martel, A., M. Blooi, C. Adriaensen, P. Van Rooij, W. Beukema, M.C. Fisher, R.A. Farrer, B.R. Schmidt, U. Tobler, K. Goka, K.R. Lips, C. Muletz, K.R. Zamudio, J. Bosch, S. Lötters, E. Wombwell, T.W.J. Garner, A.A. Cunningham, A. Spitzen-van der Sluijs, S. Salvidio, R. Ducatelle, K. Nishikawa, T.T. Nguyen, J.E. Kolby, I. Van Bocxlaer, F. Bossuyt, and F. Pasmans. 2014. Recent introduction of a chytrid fungus endangers Western Palearctic salamanders. *Science* 346(6209):630-631.
- Maslow, J.N., R. Wallace, M. Michaels, H. Foskett, E.A. Maslow, and J.A. Kiehlbauch. 2002. Outbreak of *Mycobacterium marinum* infection among captive snakes and bullfrogs. *Zoo Biology* 21:233-241.
- McAlpine, D.F. 1996. Acanthocephala parasitic in North American amphibians: a review with new records. *Alytes* 14:115-121.
- McAlpine, D.F. and M.B. Burt. 1998. Taxonomic status of *Halipegus* spp. (Digenea: Derogenidae) parasitic in the mouth and eustacian tubes of North American and Mexican amphibians. *Journal of the Helminthological Society of Washington* 65(1):10-15.
- McLaughlin, R.W., P.A. Cochran, S.E. Dowd, et al. 2014. Draft genome sequence of *Clostridium mangenotii* TR, isolated from the fecal material of a timber rattlesnake. *Genome Announcements* 2(1):e01107-13.
- Meserve, F.G. 1943. *Phyllodistomum coatneyi* n. sp., a trematode from the urinary bladder of *Ambystoma maculatum* (Shaw). *Journal of Parasitology* 29(3):226-228.
- Meserve, F.G. 1941. *Phyllodistomum coatneyi* n. sp., a trematode from the urinary bladder of *Ambystoma maculatum* (Shaw). (abstract). *Journal of Parasitology* 27(Supp.):14.
- Miller, M. 2013. Snake fungal disease: the white-nose syndrome for reptiles? The Nature Conservancy's Cool Green Science blog (June 11, 2013). Available online at <http://blog.nature.org/science/2013/06/11/snake-fungal-disease-the-white-nose-syndrome-for-reptiles/>.
- Morgan, B.B. 1942. The Physaloptera (Nematoda) of reptiles. *Naturaliste Canadien* 70:179-185.
- Muzzall, P.M. 2005. Parasites of amphibians and reptiles from Michigan: a review of the literature 1916-2003. Fisheries Research Report 2077. Michigan Department of Natural Resources, Lansing, MI.
- Nigrelli, R.F. 1945. Trypanosomes from North American amphibians, with a description of *Trypanosoma grylli* Nigrelli (1944) from *Acris gryllus* (Le Conte). *Zoologica: Scientific Contributions of the New York Zoological Society* 30(1):47-56 + 1 plate.
- Origi, F.C. 2006. Herpesvirus in tortoises. Pp. 814-821 In D.R. Mader (ed.). *Reptile Medicine and Surgery*, 2nd ed. Saunders/Elsevier, St. Louis, MO.
- Ortiz-Santaliestra, M.E., T.A.G. Rittenhouse, T.L. Cary, and W.H. Karasov. 2013. Interspecific and postmetamorphic variation in susceptibility of three North American anurans to *Batrachochytrium dendrobatidis*. *Journal of Herpetology* 47(2):286-292.

- Ouellet, M., I. Mikaelian, B.D. Pauli, J. Rodrigue, and D.M. Green. 2005. Historical evidence of widespread chytrid infection in North American amphibian populations. *Conservation Biology* 19(5):1,431–1,440.
- Overstreet, R.M. 1997. Parasitological data as monitors of environmental health. *Parassitologica* 39: 169-175.
- Pearse, A.S. 1921. Habits of the mud-puppy *Necturus*, an enemy of food fishes. Economic Circular (49): 1-8. Bureau of Fisheries, U.S. Department of Commerce.
- Petrochenko, V.I. (R. Lavoott, translator). 1971. *Acanthocephala of Domestic and Wild Animals*. Israel Program for Scientific Translations Ltd. and Keter Press, Jerusalem.
- Platt, T.R. 2000. Helminth parasites of the western painted turtle, *Chrysemys picta belli* (Gray), including *Neopolystoma elizabethae* n. sp. (Monogenea: Polystomatidae), a parasite of the conjunctival sac. *Journal of Parasitology* 86(4):815-818.
- Price, S.J., T.W.J. Garner, R.A. Nichols, F. Balloux, C. Ayres, A. Mora-Cabello de Alba, and J. Bosch. 2014. Collapse of amphibian communities due to an introduced ranavirus. *Current Biology* 24(21):2,586-2,591.
- Prudhoe, S. and R.A. Bray. 1982. *Platyhelminth Parasites of the Amphibia*. British Museum (Natural History)/Oxford University Press, London, UK.
- Pyle, R.M. 1989. Spineless wonders. *International Wildlife* 19(5):15-17.
- Reiber, R.J., E.E. Byrd, and M.V. Parker. 1940. Certain new and already known nematodes from Amphibia and Reptilia. *Lloydia* 3: 125-144.
- Riley, J. 1986. The biology of pentastomids. *Advances in Parasitology* 25: 45-128.
- Sadinski, W. and M. Roth. 2009. Surveys of amphibians, abnormalities, pathogens, triazines, breeding-site characteristics, and reptiles in five areas managed by the National Park Service and the U.S. Fish and Wildlife Service in the Upper Midwest, 2002-2007. Natural Resource Technical Report NPS/GLKN/NRTR—2009/179. National Park Service, Fort Collins, CO. Available at <http://science.nature.nps.gov/im/units/glkn/publications.cfm>. [Data supplement with figures and tables available as a separate document.]
- Sadinski, W., M. Roth, S. Treleven, J. Theyerl, and P. Dummer. 2010. Detection of chytrid fungus, *Batrachochytrium dendrobatidis*, on recently metamorphosed amphibians in the North-Central United States. *SSAR Herpetological Review* 41(2): 170-175.
- Schacher, J.F. and W.J. Crans. 1973. *Foleyella flexicauda* sp. n. (Nematoda: Filarioidea) from *Rana catesbeiana* in New Jersey, with a review of the genus and erection of two new subgenera. *Journal of Parasitology* 59(4):685-691.
- Schaefer, F.W. and F.J. Etges. 1969. Hyperparasitism of a larval cestode by a larval fluke. *Journal of Parasitology* 55(2):462.
- Schell, S.C. 1985. *Trematodes of North America North of Mexico*. University Press of Idaho, Moscow, ID.

- Schell, S.C. 1965. The life history of *Haematoloechus breviflexus* Stafford, 1902 (Trematoda: Haplometridae McMullen, 1937), with emphasis on the development of the sporocysts. *Journal of Parasitology* 51(4):587-593.
- Schell, S.C. 1962. Development of the sporocyst generations of *Glyphelminis quieta* (Stafford, 1900) (Trematoda: Plagiorchioidea), a parasite of frogs. *Journal of Parasitology* 48(3, Sect. 1):387-394.
- Schmittner, S.M. and B. McGhee. 1961. The intra-erythrocytic development of *Babesiosoma stableri* n. sp. in *Rana pipiens pipiens*. *Journal of Protozoology* 8(4):381-386.
- Schotthoefer, A.M., A.V. Koehler, C.U. Meteyer, and R.A. Cole. 2003. Influence of *Ribeiroia ondatrae* (Trematoda: Digenea) infection on limb development and survival of northern leopard frogs (*Rana pipiens*): effects of host stage and parasite-exposure level. *Canadian Journal of Zoology* 81(7):1,144-1,153.
- Skerratt, L.F., L. Berger, R. Speare, S. Cashins, K.R. McDonald, A.D. Phillott, H.B. Hines, and N. Kenyon. 2007. Spread of chytridiomycosis has caused the rapid global decline and extinction of frogs. *EcoHealth* 4:125-134.
- Sleeman, J. 2013. Snake fungal disease in the United States. *Wildlife Health Bulletin* 2013-02. National Wildlife Health Center, U.S. Geological Survey, Madison, WI.
- Stafford, J. 1904. Trematodes from Canadian fishes. *Zoologischer Anzeiger* 27:481-495.
- Sutherland, D. 2005. Parasites of North American frogs. Pp.109-123 In M. Lannoo (ed.). *Amphibian Declines: The Conservation Status of United States Species*. University of California Press, Berkeley, CA.
- Talley, B.L., C.R. Muletz, V.T. Vredenburg, R.C. Fleischer, and K.R. Lips. 2015. A century of *Batrachochytrium dendrobatidis* in Illinois amphibians (1888–1989). *Biological Conservation* 182:254–261.
- Telford, S.R. 1995. The kinetoplastid hemoflagellates of reptiles. Pp. 161-223 In J.P. Kreier (ed.). *Parasitic Protozoa*, 2nd ed., Vol. 10. Academic Press, San Diego, CA.
- Tiekotter, K.L. and J.R. Coggins. 1982. Redescription of *Phyllodistomum americanum* Osborn, 1903 with a discussion of the taxonomic status of *Phyllodistomum coatneyi* Meserve, 1943 and *Phyllodistomum bufonis* Frandsen, 1957 (Trematoda: Gorgoderidae). *Proceedings of the Helminthological Society of Washington* 49(2):189-195.
- Van Cleave, H.J. 1937. Worm parasites in their relations to wildlife investigations. *Journal of Wildlife Management* 1(1-2):21-27.
- Vogt, R.C. 1981. Turtle egg (*Graptemys*: Emydidae) infestation by fly larvae. *Copeia* 1981 (2):457-459.
- Vogt, R.C. 1980. Natural history of the map turtles *Graptemys pseudogeographica* and *G. ouachitensis* in Wisconsin USA. *Tulane Studies in Zoology and Botany* 22(1):17-48.
- Vogt, R.C. 1979. Cleaning/feeding symbiosis between grackles (*Quiscalus*: Icteridae) and map turtles (*Graptemys*: Emydidae). *The Auk* 96(3):608-609.

- Vredenburg, V.T., R.A. Knapp, T. Tunstall, and C.J. Briggs. 2010. Dynamics of an emerging disease drive large-scale amphibian population extinctions. *Proceedings of the National Academy of Sciences* 107:9,689–9,694.
- Walters, B.L., J.O. Whitaker, Jr., N.S. Gikas, and W.J. Wrenn. 2011. Host and distribution lists of chiggers (Trombiculidae and Leeuwenhoekiidae), of North American wild vertebrates north of Mexico. Paper 697. *Faculty Publications from the Harold W. Manter Laboratory of Parasitology*. University of Nebraska, Lincoln.
- Walton, A.C. 1938. The Nematoda as parasites of Amphibia. IV. *Transactions of the American Microscopical Society* 57(1):38-53.
- Walton, A.C. 1935. The Nematoda as parasites of Amphibia. II. *Journal of Parasitology* 21(1):27-50.
- Walton, A.C. 1933. The Nematoda as parasites of Amphibia. *Journal of Parasitology* 20(1):1-32.
- Walton, A.C. 1929. Studies on some nematodes of North American frogs. I. *Journal of Parasitology* 15(4):227-240.
- Watermolen, D.J. 2013. Wisconsin herpetology, 2001-2010: a bibliography with taxonomic, geographic, and subject indices. Miscellaneous Publication PUB-SS-1127. Bureau of Science Services, Wisconsin Department of Natural Resources, Madison, WI.
- Watermolen, D.J. 1998. A new parasite record from the tiger salamander (*Ambystoma tigrinum*). *Bulletin of the Chicago Herpetological Society* 33(12):262.
- Watermolen, D.J. 1996. Notes on the leech *Desserobdella picta* (Hirudinea: Glossiphoniidae). *Journal of Freshwater Ecology* 11(2):211-217.
- Watermolen, D.J. 1992. Wisconsin herpetology: a bibliographical update with taxonomic, subject and geographic indices. Wisconsin Endangered Resources Report (87):1-15. Bureau of Endangered Resources, Wisconsin Department of Natural Resources, Madison, WI.
- Wheelwright, N.T., M.J. Gray, R.D. Hill, and D.L. Miller. 2014. Sudden mass die-off of a large population of wood frog (*Lithobates sylvaticus*) tadpoles in Maine, USA, likely due to Ranavirus. *SSAR Herpetological Review* 45(2):240-242.
- Whittle, P. 2014. Scientists probe mass frog deaths in Maine, beyond. Associated Press (October 6, 2014). Available online at www.ledger-enquirer.com/2014/10/06/3341638_scientists-probe-mass-frog-deaths.html?rh=1. Accessed October 18, 2014.
- Wieczorowski, E. 1939. Lesions in turtles. *Journal of Parasitology* 25(5):395-399.
- Williams, D.D. and S.J. Taft. 1980. Helminths of anurans from NW Wisconsin. *Proceedings of the Helminthological Society of Washington* 47(2):278.
- Wilson, W.D., P.T.J. Johnson, D.R. Sutherland, H. Mone´, and E.S. Loker. 2005. A molecular phylogenetic study of the genus *Ribeiroia* (Digenea): trematodes known to cause limb malformations in amphibians. *Journal of Parasitology* 91(5):1,040–1,045.

- Wolff, B.G., E. Wurm, and L. Tracy. 2013. Natural history notes: *Pseudacris crucifer* (Spring peeper). Myiasis. *SSAR Herpetological Review* 44(3):498-499.
- Woo, P.T.K. 1983. Sensitivity of diagnostic-techniques in determining the prevalence of anuran trypanosomes. *Journal of Wildlife Diseases* 19(1):24-26.
- Wright, R.E. and G.R. DeFoliart. 1970. Associations of Wisconsin mosquitoes and woodland vertebrate hosts. *Annals of the Entomological Society of America* 63(3):777-786.
- Yamaguti, S. 1971. *Synopsis of Digenetic Trematodes of Vertebrates*. Keigaku Publishing Co., Tokyo.
- Yoder, H.R. 1998a. Community ecology of helminth parasites infecting molluscan and amphibian hosts. Ph.D. Thesis. University of Wisconsin–Milwaukee, Milwaukee, WI.
- Yoder, H.R. 1998b. Community ecology of helminth parasites infecting molluscan and amphibian hosts (abstract). Pp. 22-23 In Annual Report. University of Wisconsin-Milwaukee Field Station, Sauville, WI.
- Yoder, H.R. 1997. Ecology of helminth parasite communities in molluscan and amphibian hosts (abstract). P. 26 In Annual Report. University of Wisconsin-Milwaukee Field Station, Sauville, WI.
- Yoder, H.R. 1996. Ecology and population dynamics of parasitic worms in molluscan and amphibian hosts (abstract). Pp. 26-27 In Annual Report. University of Wisconsin-Milwaukee Field Station, Suakville, WI.
- Yoder, H.R. 1995. Ecology and population dynamics of parasitic worms in molluscan and amphibian hosts (abstract). Pp. 31-32 In Annual Report. University of Wisconsin-Milwaukee Field Station, Suakville, WI.
- Yoder, H.R. 1994. Ecology and population dynamics of parasitic worms in molluscan and amphibian hosts (abstract). P. 36 In Annual Report. University of Wisconsin-Milwaukee Field Station, Sauville, WI.
- Yoder, H.R. 1993. Ecology and population dynamics of parasitic worms with molluscan and amphibian hosts (abstract). Pp. 39-40 In Annual Report. University of Wisconsin-Milwaukee Field Station, Sauville, WI.
- Yoder, H.R. and J.R. Coggins. 2007. Helminth communities in five species of sympatric amphibians from three adjacent ephemeral ponds in southeastern Wisconsin. *Journal of Parasitology* 93(4):755-760.
- Yoder, H.R. and J.R. Coggins. 1996. Helminth communities in the northern spring peeper, *Pseudacris c. crucifer* Weid, and the wood frog, *Rana sylvatica* Le Conte, from southeastern Wisconsin. *Proceedings of the Helminthological Society of Washington* 63(2):211-214.
- Yoder, H.R., J.R. Coggins, and J.C. Reinbold. 2001. Helminth parasites of the green frog (*Rana clamitans*) from southeastern Wisconsin, U.S.A. *Comparative Parasitology* 68(2):269-272.

Yoder, H.R., J.R. Coggins, and C.J. Reinbold. 2000. Helminth parasites of the green frog (*Rana clamitans*) from southeastern Wisconsin (abstract). P. 30 In Annual Report. University of Wisconsin-Milwaukee Field Station, Saukville, WI.

Notes

Appendix A: References That Address the Parasites of Wisconsin Amphibians and Reptiles

Anurans (Frogs)

Bolek and Coggins 1998a
Bolek and Coggins 1998b
Bolek and Coggins 2000
Bolek and Coggins 2001
Bolek and Coggins 2002
Bolek and Coggins 2003
Bolek and Janovy 2004
Bolek and Janovy 2005
Bolek and Janovy 2007a
Bolek and Janovy 2007b
Bolek et al. 2009a
Bolek et al. 2009b
Briggs 1975
Coggins and Sajdak 1982
Cort 1915a
Cort 1915b
Guilford 1961
Hartson et al. 2011
Hine et al. 1975
Hine et al. 1981
Hofer and Johnson 1970
Johnson and Chase 2004
Johnson et al. 2004
Johnson et al. 2007
Kennedy 1981
Klemish et al. 2012
Kudo 1922
Kuzmin et al. 2001
Kuzmin et al. 2003
Levine and Nye 1977
Maslow et al. 2002
Sadinski and Roth 2009
Sadinski et al. 2010
Schaefer and Etges 1969
Schell 1962
Scell 1965
Schmittner and McGhee 1981
Schottheofer et al. 2003
Sutherland 2005
Walton 1929
Walton 1935
Watermolen 1996
Williams and Taft 1980
Wilson et al. 2005
Woo 1983
Wright and DeFoliart 1970
Yoder and Coggins 1996

Yoder and Coggins 2007
Yoder et al. 2001

Caudata (Salamanders)

Amin 1985a
Bolek 1997
Bolek and Coggins 1998b
Bolek and Coggins 2003
Cochran et al. 2002
Coggins and Sajdak 1982
Kuzmin et al. 2001
Kuzmin et al. 2003
Meserve 1941
Meserve 1943
Pearse 1921
Tiekotter and Coggins 1982
Watermolen 1998
Yoder and Coggins 2007

Testudines (Turtles)

Amin 1981
Bolek 2001
Brewster and Brewster 1986
Cochran et al. 2014
DeFoliart 1967
De Giusti and Batten 1951
Goodchild and Dennis 1967
Guilford 1955
Guilford 1958
Guilford 1959
Platt 2000
Vogt 1979
Vogt 1980
Vogt 1981
Watermolen 1996
Wright and DeFoliart 1970

Serpentes (Snakes)

Kuzmin et al. 2003
Maslow et al. 2002
McLaughlin et al. 2014
Sutherland 2005
Wright and DeFoliart 1970

Notes

Notes

About the Author

Dreux Watermolen is an ecologist/zoologist who currently serves as the Chief of Science Information Services for the Wisconsin DNR. He is interested in the zoogeography, life history, and taxonomy of Wisconsin's rich biological diversity.

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