

Helminth Parasites of Amphibians From Illinois and Adjacent Midwestern States

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ABSTRACT

Few comprehensive surveys have been conducted on the helminths of amphibians from the midwestern states of Illinois, Indiana, Iowa, Kentucky, Michigan, Missouri and Wisconsin. With the exception of Illinois, the majority of reports are confined primarily to the helminths of anurans while little is known of salamander parasites. Nematodes and trematodes are probably the most common parasites, while the occurrence of tapeworms appears to be essentially correlated with an aquatic environment. Acanthocephalans are rarely found in terrestrial salamanders. Although some species of helminths have been studied experimentally primarily in life cycle investigations, most information concerning the helminths of amphibians is of a descriptive nature, based on taxonomic surveys and morphological investigations.

INTRODUCTION

While the literature on the helminth parasites of amphibians of the contiguous United States is extensive, the majority of reports are confined primarily to the parasites of anurans. One reason for this may be that salamanders are more secretive animals, hiding under rocks and logs and in some instances confined to caves. The reports of Yamaguti ³⁴⁻³⁸, Walton ³², and Ulmer ³⁰ are excellent review sources.

The purpose of the present report is to tabulate the helminth parasites reported from anuran and caudate amphibians in the midwestern states of Illinois, Indiana, Iowa, Kentucky, Michigan, Missouri and Wisconsin.

RESULTS

Helminth parasites have been reported from 9 families of amphibians, namely, 3 in the order Anura and 6 in the Caudata (Table 2). Anuran hosts include 2 members of the family Bufonidae and 5 species each of the families Hylidae and Ranidae. Caudate amphibian hosts include 7 members of the family Ambystomatidae, 8 of the family Plethodontidae and 1 each of the families Cryptobranchidae, Necturidae, Salamandridae and Sirenidae.

Of the 12 species of anuran hosts, 11 were infected with trematodes, 4 with cestodes and 6 with nematodes (Table 2). Three of these species were infected with trematodes, cestodes and nematodes, 2 with trematodes and nematodes, 1 with trematodes and cestodes, 5 with trematodes only, and 1 with nematodes only. None was infected with acanthocephalans.

Nineteen species of caudate amphibians were reported infected with helminths (Table 2). These included 16 with trematodes, 18 with nematodes and 4 each with cestodes and acanthocephalans. One species was infected with trematodes, cestodes, nematodes and acanthocephalans, 1 with trematodes, cestodes and nematodes, 2 with trematodes, nematodes and acanthocephalans, 1 with cestodes, nematodes and acanthocephalans, 1 with trematodes and cestodes, 11 with trematodes and nematodes and 2 with nematodes only.

Of the 15 species of trematodes reported from caudate amphibians, 14 were digenetic flukes and only 1 a monogenetic fluke, namely, *Sphyranura olseri* Wright, 1879, in *Necturus maculosus* from Wisconsin (Table 1). None was reported from anuran hosts.

Hosts are usually infected with either the adult or larval stage of the parasite. However, some hosts have been reported to house both stages whereby they could serve as either the definitive or intermediate host or possibly both at the same time.

Helminths reported from the combined total of anuran and caudate amphibians reveal representatives from 33 families (Table 1). These include species from 1 family of monogenetic flukes, 11 families of adult digenetic flukes, 6 families of larval digenetic flukes, 3 families of adult tapeworms, 2 families of larval tapeworms, 7 families of adult nematodes, 2 families of larval nematodes and 1 family of adult acanthocephalans.

Thirty-eight genera of helminths were recorded (Table 1). These included 1 genus of adult monogenetic flukes, 14 genera of adult digenetic flukes, 7 genera of larval digenetic flukes, 4 genera of adult tapeworms, 1 genus of larval tapeworms, 10 genera of adult nematodes, 1 genus of larval nematodes and 1 genus of adult acanthocephalans.

Fifty-five of the 73 reported helminths were identified to the species level. This included 1 species of adult monogenetic flukes, 28 species of adult digenetic flukes, 4 species of larval digenetic flukes, 8 species of adult tapeworms, 13 species of adult nematodes and 1 species of adult acanthocephalans.

DISCUSSION

A survey of the literature pertaining to the helminths of amphibians in Illinois reveals that the majority of reports are confined to salamander parasites. Most of the information on anuran parasites is concerned with life history studies. Landewe examined 200 salamanders representing 11 species but did not publish his results.¹⁹ One hundred and twenty-two (61%) salamanders representing 10 of the 11 host species were infected. This included 7 species of trematodes, one of cestode, 6 of nematodes and 2 of acanthocephalans. Dyer described the nematode (*Falcaustra chabaudi*) from *Siren intermedia* and the same year Dyer and Brandon investigated the helminths of 3 sympatric species of cave-dwelling salamanders in southern Illinois.^{5,8} Two species of nematodes and 1 trematode were recovered from 46 of 322 specimens of *Plethodon dorsalis* and 4 of 17 *Eurycea lucifuga*. One species of trematode was found in 10 of 41 *Plethodon glutinosus*. Tapeworms and acanthocephalans were absent from species of *Plethodon* which have a completely terrestrial life cycle. The occurrence of cestodes in salamanders appears to be correlated with an aquatic environment. Their absence from *E. lucifuga*, which has an aquatic larval stage, may be an artifact of small sample size. Dyer and Peck in a study of the gastrointestinal parasites of *Eurycea lucifuga* from the southeastern United States reported the nematode (*Oswaldocruzia pipiens*) from salamanders taken in Union County.¹¹ Jilek and Wolff reported a nematode (*Spinitectus gracilis*) in a toad (*Bufo woodhousii fowleri*) collected in Jackson County.¹⁶ However, *B. woodhousii fowleri* may be an erratic host as it is aquatic as a tadpole with terrestrial feeding habits and *S. gracilis* requires an aquatic intermediate host. In a study of the gastrointestinal helminths in relation to sex and age of *Desmognathus fuscus*, Dyer et al. reported 2 species of nematodes, one of trematode, and a few unidentified juvenile acanthocephalans in 149 (33.7%) of 442 animals examined.¹⁰ There was no significant difference in the frequency of occurrence of helminths between the sexes. One hundred twenty hosts were positive for one parasitic species (27.3%), 28 for two (6.4%) and 1 for three (0.2%). Price and St. John reported 3 species of flukes and 2 species of nematodes in 54 of 57 *Ambystoma texanum* taken in Williamson County.²⁵ Price and Buttner examined 76 adult and 19 immature *Notophthalmus viridescens louisianensis* from southern Illinois and reported a 43% prevalence of infection in adults with no parasites recovered from immature salamanders.²⁴ More recently, Dyer reported *Phyllodistomum solidum* in the dusky salamander (*Desmognathus fuscus*) from southern Illinois.⁷

It is evident that while information on helminths of salamander, especially from the southern region of Illinois, is accruing, a paucity of information exists on anuran helminths.

The only extensive survey of helminths of amphibians in Iowa is that published by Ulmer who examined 542 amphibians from 40 areas of northwest Iowa during 1953 to 1967 and reported an incidence of 52.8% infection with fifteen species of digenetic flukes.²⁸ Hosts examined included *Ambystoma tigrinum*, *Bufo americanus*, *Bufo cognatus*, *Acris crepitans*, *Hyla versicolor*, *Pseudacris triseriata*, *Rana catesbeiana*, and *Rana pipiens*. Later, Ulmer and James examined 706 amphibians representing the same 8 species, collected during the summer of 1953 to 1974 from 24 areas of northwestern Iowa and reported an incidence of 13.6% infection with cestodes.³⁰ The 3 species of adult cestodes encountered included *Cylindrotaenia americana*, *Ophiotaenia saphena* and *Nematotaenoides ranae*. Two types of larval cestodes were found, namely, tetrathyridia of *Mesocestoides* and proteocephalan plerocercoids. *Rana pipiens*, the most abundant host in the region, harbored all 5 species of cestodes recovered. Each of 7 hosts (5 *R. pipiens* and 2 *B. americanus*) harbored more than one type of tapeworm infection.

Surveys of amphibian cestodes often refer to the paucity of these helminths. Results presented by Ulmer and James reveal that larval cestodes are considerably more abundant than are adults in amphibian hosts.³⁰

Published accounts of the helminth fauna of amphibians from Kentucky are regrettably meager. Del Fosse and Whittaker reported 3 of 24 newts (*Notophthalmus viridescens*) infected with the cestode (*Bothriocephalus rarus*) and 24 of 24 newts infected with the nematode (*Capillaria tenua*).³ Later, Dyer and Peck found cave salamanders (*Eurycea lucifuga*) from Edmonson County infected with *Capillaria inequalis*, *Cosomercoides dukae* and *Oswaldocruzia pipiens*.¹¹

Published accounts of the helminth fauna of amphibians from Missouri likewise appear regrettably meager. Smith found larval *Typhlotriton spelaeus* heavily infected with cestodes of the genus *Ophiotaenia*, probably *O. amphiumae*.²⁶ The bladder fluke, *Gorgoderia amplicava*, has been reported from the Wolffian ducts and mesonephroi of *Rana catesbeiana* by Goodchild.¹⁵ Dyer and Brandon found hellbenders, *Cryptobranchus alleganiensis*, in Dallas County to be infected with the nematode (*Falcaustra variabilis*), the cestode (*Ophiotaenia cryptobranchi*) and the acanthocephalan (*Acanthocephalus acutululus*).⁹ Later, Dyer found *Typhlotriton spelaeus* collected in Wet Cave, Shannon County to be infected with the fluke (*Brachycoelium salamandrae*) and the nematodes (*Capillaria inequalis*, *C. sp.*, *Falcaustra catesbeianae* and *Oswaldocruzia sp.*).⁶ Comparison of parasitological findings and feeding habits revealed a correlation between intestinal parasitocenos of postmetamorphic *T. spelaeus* and food sources in the habitat.

Few published reports on the helminths of amphibians of Indiana are available. Cort observed the lung flukes (*Haematoloechus longiplexus* and *H. breviplexus*)

in the bullfrog (*Rana catesbeiana*).² Walton found cysts of the nematode (*Physaloptera ranae*) in the stomach and intestinal wall of *Rana catesbeiana* from northern Indiana.³¹ Krull reported the lung fluke (*Pneumonoeces medioplexus*) from *Rana pipiens* in North Judson, Indiana.¹⁷ Later, Lank examined 72 *Rana catesbeiana* from four Indiana areas and found 91.7% infected.²⁰ Several flukes including *Gorgoderina amplicava*, *Gorgoderina attenuata*, *Haematoloechus breviplexus*, *Haematoloechus longiplexus* and *Glythelmins quieta* and a nematode (*Cryosomatium longicaudata*) were detected in *R. catesbeiana*.

Studies on the helminth parasites of amphibians from Michigan are confined to anurans. Fortner examined 208 frogs in the Douglas Lake Region, Cheboygan County, Michigan.¹³ Flukes representing *Diplodiscus temperatus*, *Gorgoderina attenuata*, *Pneumonoeces medioplexus*, *P. similiplexus*, *Cephalogonimus americanus* and *Clinostomum attentatum* were found in *Rana pipiens*. *Gorgoderina attenuata* and *Pneumonoeces similiplexus* were detected in *Rana clamitans*. Krull reported *Pneumobites parviplexus* from *Rana clamitans* from Ann Arbor and Douglas Lake and *Pneumonoeces medioplexus* from *Rana pipiens* from the same localities.¹⁷ In their studies on the life history of the fluke *Diplodiscus temperatus* from the frog, Krull and Price reported this parasite from naturally infected frogs, including *Rana pipiens*, *R. clamitans*, *R. sylvatica cantabrigensis*, and *R. catesbeiana*.¹⁸ Lawler described the tapeworm *Cylindrotaenia quadrijugosa* from *Rana pipiens*.¹⁹ Najarian found 11 species of adult trematodes and 4 species of metacercariae in 9 species of frogs.²² Later Esch and Kocan reported finding 4 specimens of the trematode *Teloporina aspidonectes* in the lungs of *Rana catesbeiana*.¹²

Helminths of both anuran and caudate amphibians have been reported from Wisconsin. The first report of the parasites of Wisconsin anurans was that given by Williams and Taft in 1980 who examined 4 *Bufo americanus*, 412 *Rana clamitans*, 22 *R. pipiens* and 5 *R. sylvatica* from the Red Cedar River and 5 adjacent ponds in S. Barron County and N. Dunn County.³³ *Rana clamitans* was infected with 11 species of flukes, 2 species of cestodes and 2 species of nematodes, *R. pipiens* with 6 species of flukes, 3 species of cestodes and 3 species of nematodes and *R. sylvatica* with 1 species of fluke and 3 species of nematodes. Coggins and Sajdak examined 117 salamanders and 18 anurans representing 14 host species collected from 7 localities in Wisconsin for helminths.¹ Forty-two percent of salamanders and 89% of anurans were infected with one or more species of parasite including 4 nematodes, 7 digeneans, 1 cestode and 1 monogenean. The same year, Tiekotter and Coggins reported the fluke (*Phyllodistomum americanum*) from the urinary bladder of *Ambystoma tigrinum* in southeastern Wisconsin.²⁷

With the exception of Illinois, the majority of reports are confined primarily to the helminths of anurans. Nematodes and trematodes are probably the most common parasites of amphibians in the midwestern region. The occurrence of tapeworms appears to be correlated with an aquatic environment. Few reports

are given for acanthocephalans. Although some species of helminths have been studied experimentally, most information concerning the helminths of amphibians is of a descriptive nature, based on taxonomic surveys and morphological investigations.

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Table 1. List of helminths reported in amphibians from Illinois, Indiana, Iowa, Kentucky, Michigan, Missouri and Wisconsin. The classification of each parasite is based on that of Yamaguti³⁴⁻³⁸. Numerals following geographic localities refer to authors as listed in the Literature Cited.

Trematoda:

Monogenea:

Sphyranuridae Poche, 1926.

Sphyranura olseri Wright, 1879.

Host: *Necturus maculosus* (Wisconsin - 1).

Adult Digenea:

Brachycoeliidae (Looss, 1899) Johnston, 1912.

Brachycoelium obesum Nicoll, 1914.

Syn: *B. ovale* Byrd, 1937.

Host: *Desmognathus fuscus* (Illinois - 10).

Brachycoelium salamandrae (Froelich, 1789) Lühe, 1909.

Syn: *B. crassicolle* (Rud., 1809) Stiles and Hassall, 1898; *B. daviesi*, Harwood, 1932; *B. dorsale* Byrd, 1937; *B. georgianum* Byrd, 1937; *B. hospitale* (Stafford, 1900) Looss, 1902; *B. louisiana* Byrd, 1937; *B. mesorchium* Byrd, 1937; *B. storeriae* Harwood, 1932.

Host: *Acris crepitans* (Michigan - 22), *Ambystoma maculatum* (Illinois - 19, Wisconsin - 1), *A. opacum* (Illinois - 19), *A. talpoideum* (Illinois - 19), *Eurycea longicauda* (Illinois - 19), *E. lucifuga* (Illinois - 19), *Plethodon cinereus* (Wisconsin - 1), *P. glutinosus* (Illinois - 19), *Rana palustris* (Wisconsin - 1), *R. sylvatica* (Michigan - 22), *Typhlotriton spelaeus* (Missouri - 6).

Brachycoelium sp.

Host: *Ambystoma texanum* (Illinois - 25), *Eurycea lucifuga* (Illinois - 8), *Notophthalmus viridescens* (Illinois - 24), *Plethodon dorsalis* (Illinois - 8), *P. glutinosus* (Illinois - 8).

Cephalogonimidae (Looss, 1899) Nicoll, 1914.

Cephalogonimus americanus Stafford, 1902.

Syn: *C. restusus* of Walton, 1938.

Host: *Rana clamitans* (Michigan - 22), *R. pipiens* (Michigan - 13, 22).

Cephalogonimus salamandrus Dronen and Lang, 1974.

Host: *Ambystoma tigrinum* (Wisconsin - 1), *Rana clamitans* (Wisconsin - 1),

Cephalogonimus vesicaudus Nickerson, 1912.

Host: *Rana clamitans* (Michigan - 22).

Cephalogonimus sp.

Host: *Rana pipiens* (Wisconsin - 33).

- Gorgoderidae (Looss, 1899) Looss, 1901.
Gorgoderia amplicava Looss, 1899.
 (*Distoma cygnoides* var. A. of Bensley, 1897, renamed).
 Host: *Rana catesbeiana* (Indiana - 20, Missouri - 15), *R. clamitans* (Michigan - 22), *R. pipiens* (Iowa - 28).
- Gorgoderina attenuata* (Stafford, 1902) Stafford, 1905.
 Host: *Eurycea lucifuga* (Illinois - 19), *Rana catesbeiana* (Indiana - 20), *R. clamitans* (Michigan - 13), *R. pipiens* (Iowa - 25, Michigan - 13, Wisconsin - 26).
- Gorgoderina bilobata* Rankin, 1937.
 Host: *Ambystoma texanum* (Illinois - 19, 25), *Bufo americanus* (Wisconsin - 1, 27), *Eurycea lucifuga* (Illinois - 19), *Hemidactylium scutatum* (Wisconsin - 1).
- Gorgoderina simplex* (Looss, 1899) Looss, 1902.
 (*Distoma cygnoides* var. B. of Bensley, renamed).
 Host: *Rana catesbeiana* (Michigan - 22), *R. clamitans* (Wisconsin - 33, Michigan - 22), *R. pipiens* (Iowa - 28).
- Phyllodistomum americanum* Osborn, 1903.
 Host: *Ambystoma tigrinum* (Wisconsin - 1, 27).
- Phyllodistomum solidum* Rankin, 1937.
 Host: *Desmognathus fuscus* (Illinois - 7).
- Haematoloechidae Odening, 1964.
- Haematoloechus breviflexus* Stafford, 1902.
 Host: *Rana catesbeiana* (Indiana - 2, 20), *R. clamitans* (Michigan - 22).
- Haematoloechus complexus* (Seely, 1906) Krull, 1933.
 Syn: *Ostiolum complexus* (Seely, 1906).
 Host: *Rana pipiens* (Iowa - 28).
- Haematoloechus longiflexus* Stafford, 1902.
 Syn: *Pneumobites longiflexus* (Stafford, 1902) Ward, 1917.
 Host: *Rana catesbeiana* (Indiana - 2, 20, Iowa - 28, Michigan - 22), *R. clamitans* (Wisconsin - 33), *R. pipiens* (Iowa - 28).
- Haematoloechus medioplexus* Stafford, 1902.
 Syn: *Ostiolum formosum* Pratt, 1903; *O. medioplexus* (Stafford, 1902).
 Host: *Bufo americanus* (Iowa - 28), *Rana pipiens* (Indiana - 17, Iowa - 28, Michigan - 13, 17), *R. sylvatica* (Wisconsin - 33).
- Haematoloechus parviflexus* (Irwin, 1929) Harwood, 1932.
 Syn: *Pneumobites parviflexus* Irwin, 1929.
 Host: *Rana clamitans* (Michigan - 17, 22, Minnesota - 17, Wisconsin - 33).
- Haematoloechus similiflexus* Stafford, 1902.
 Host: *Bufo americanus* (Iowa - 28), *Rana pipiens* (Iowa - 25, Michigan - 13), *R. clamitans* (Michigan - 13).
- Haematoloechus varioplexus* Stafford, 1902.
 Host: *Rana clamitans* (Michigan - 22, Wisconsin - 33), *R. pipiens* (Wisconsin - 33).
- Haematoloechus* sp.
 Host: *Rana clamitans* (Wisconsin - 33), *R. pipiens* (Iowa - 28).

Hemiuridae Lühe, 1901.

Halipegus eccentricus Thomas, 1937.

Host: *Rana clamitans* (Wisconsin - 33), *R. pipiens* (Wisconsin - 33).

Halipegus sp.

Host: *Rana pipiens* (Iowa - 28).

Lecithodendriidae (Lühe, 1901) Odhner, 1910.

Loxogenes arcanum (Nickerson, 1900) Stafford, 1905.

Syn: *Distoma arcanum* Nickerson, 1900; *D. medians* Olson of Stafford, 1900; *Pleurogenes arcanum* of Pratt, 1902; *Pleurogenoides arcanum* of Kaw, 1943.

Host: *Rana clamitans* (Wisconsin - 33).

Macroderoididae McMullen 1937.

Glyphelmins pennsylvaniensis Cheng, 1961.

Host: *Hyla crucifer* (Wisconsin - 1).

Glyphelmins quieta (Stafford, 1900) Stafford, 1905.

Syn: *Opisthioglyphe endoloba* Duj. of Stafford, 1901.

Host: *Acris crepitans* (Iowa - 28), *Hyla crucifer* (Michigan - 22), *Pseudacris triseriata* (Iowa - 28), *Rana catesbeiana* (Indiana - 20, Iowa - 28, Michigan - 22), *R. clamitans* (Wisconsin - 33), *R. pipiens* (Iowa - 28, Wisconsin - 33).

Paramphistomidae Fiscoeder, 1901.

Megalodiscus rankini Bravo-Hollis, 1941.

Host: *Notophthalmus viridescens* (Illinois - 1).

Megalodiscus temperatus (Stafford, 1905) Harwood, 1932.

Syn: *Diplodiscus subclavatus* Dies. of Leiby, 1856; *D. temperatus* Stafford, 1905; *Megalodiscus ranophilus* Milzner, 1924.

Host: *Bufo americanus* (Iowa - 28), *Hyla crucifer* (Michigan - 22), *Rana catesbeiana* (Iowa - 28, Michigan - 22), *R. clamitans* (Michigan - 22, Wisconsin - 33), *R. pipiens* (Iowa - 28, Michigan - 13, Wisconsin - 33).

Pseudopisthodiscus sp.

Host: *Ambystoma texanum* (Illinois - 19).

Plagiorchiidae (Lühe, 1901) Ward, 1917.

Monodistomum parvum (Stunkard, 1933) Yamaguti, 1958.

Syn: *Plagitura parvum* Stunkard, 1933.

Host: *Notophthalmus viridescens* (Illinois - 19).

Monodistomum salamandra (Holl, 1928) Yamaguti, 1958.

Syn: *Plagitura salamandra* Holl, 1928.

Host: *Notophthalmus viridescens* (Illinois - 24).

Pronocephalidae Looss, 1902.

Teloporia aspidonectes (MacCallum, 1917) Fukui, 1933.

Host: *Rana catesbeiana* (Michigan - 12)

Telorchidae (Looss, 1899) Stunkard, 1924.

Telorchis bonnerensis Waitz, 1960.

Host: *Ambystoma tigrinum* (Iowa - 28).

Larval Digenea:

Clinostomatidae Lühe, 1901.

Clinostomum attenuatum Cort, 1913, metacercaria.

Syn: *C. marginatum* Wright, 1879.

Host: *Rana clamitans* (Michigan - 13, 22), *R. pipiens* (Iowa - 28).

Diplostomidae Poirier, 1886.

Diplostomum ambystomae Rankin and Hughes, 1937, metacercaria.

Host: *Ambystoma texanum* (Illinois - 19, 25).

Fibricola crater (Baker and Noll, 1915) Dubois, 1932, diplostomula.

Syn: *Hemistomum craterum* Baker and Noll, 1915; *Fibricola laruei*

Miller, 1940; *F. nana* Chandler and Rausch, 1946.

Host: *Pseudacris triseriata* (Iowa - 28), *Rana pipiens* (Iowa - 28).

Neodiplostomum sp., metacercaria.

Host: *Ambystoma maculatum* (Illinois - 19), *A. opacum* (Illinois - 19).

Eurycea lucifuga (Illinois - 19),

Siren intermedia (Illinois - 19).

Echinostomatidae (Looss, 1902) Poche, 1926.

echinostome metacercaria.

Host: *Bufo americanus* (Iowa - 28), *Hyla crucifer* (Michigan - 22), *Rana clamitans* (Michigan - 22), *R. pipiens* (Iowa - 28), *R. sylvatica* (Michigan - 22).

Gorgoderidae (Looss, 1899) Looss, 1901.

Gorgoderina sp., metacercaria.

Host: *Eurycea lucifuga* (Illinois - 19), *Hyla crucifer* (Michigan - 22),

Rana clamitans (Michigan - 22), *R. pipiens* (Iowa - 28), *R.*

sylvatica (Michigan - 22).

Plagiorchiidae (Lühe, 1901) Ward, 1917.

Ochetosoma sp., metacercaria.

Syn: *Renifer* sp.

Host: *Rana pipiens* (Michigan - 22).

plagiorchid metacercaria

Host: *Rana pipiens* (Iowa - 28).

Strigeidae Railliet, 1919.

Apharyngostrigea pipientis (Faust, 1918) Oliver, 1940, metacercaria.

Host: *Rana pipiens* (Iowa - 28).

tetracotyle metacercaria.

Host: *Rana pipiens* (Iowa - 28).

Unidentified metacercaria

Host: *Ambystoma tigrinum* (Wisconsin - 1), *Bufo americanus* (Iowa -

28), *Hemidactylium scutatum* (Wisconsin - 1), *Hyla versicolor*

(Iowa - 28), *Rana pipiens* (Iowa - 28).

Cestoda:

Bothriocephalidae Blanchard, 1849

Bothriocephalus rarus Thomas, 1937.

Host: *Notophthalmus viridescens* (Kentucky - 3).

Nematotaeniidae Lühe, 1910.

Cylindrotaenia americana Jewell, 1916.

Host: *Acris crepitans* (Iowa - 30), *Bufo americanus* (Iowa - 30), *Rana pipiens* (Iowa - 30).

Cylindrotaenia quadrijugosa Lawler, 1939.

Host: *Rana pipiens* (Michigan - 21).

Nematotaenoides ranae Ulmer and James, 1976.

Host: *Rana pipiens* (Iowa - 29, 30).

Proteocephalidae La Rue, 1911.

Ophiotaenia amphiumae Zeff, 1932.

Host: *Typhlotriton spelaeus* (Missouri - 26).

Ophiotaenia cryptobranchii La Rue, 1914.

Host: *Cryptobranchus alleganiensis* (Missouri - 9).

Ophiotaenia loennbergi (Fuhrmann, 1895) La Rue, 1911.

Host: *Necturus maculosus* (Wisconsin - 1).

Ophiotaenia saphena Osler, 1931.

Host: *Bufo americanus* (Iowa - 30), *Rana clamitans* (Wisconsin - 30), *R. pipiens* (Iowa - 30).

Ophiotaenia sp.

Host: *Siren intermedia* (Illinois - 19).

Larval Cestoda:

Mesocestoididae Perrier, 1897.

Mesocestoides sp., tetrathyridium.

Host: *Bufo americanus* (Iowa - 30), *Rana clamitans* (Wisconsin - 33), *R. pipiens* (Iowa - 30, Wisconsin - 33).

Proteocephalidae Mola, 1929.

proteocephalan plerocercoid.

Host: *Bufo americanus* (Iowa - 30), *Notophthalmus viridescens* (Illinois - 19), *Rana pipiens* (Iowa - 30).

Nematoda:

Kathlaniidae York and Maplestone, 1926.

Falcaustra catesbeiana Walton, 1929.

Host: *Typhlotriton spelaeus* (Missouri - 6).

Falcaustra chabaudi Dyer, 1973.

Host: *Siren intermedia* (Illinois - 5).

Falcaustra variabilis (Walton, 1935) Chabaud and Golvan, 1957.

Syn: *Zanclorhynchus variabilis* Walton, 1935.

Host: *Cryptobranchus alleganiensis* (Missouri - 9). Oxyuridae
Cobbold, 1864.

Aplectana sp.

Host: *Plethodon cinereus* (Illinois - 19).

- Cosmocercoides dukae* (Holl, 1928) Wilkie, 1930.
 Host: *Ambystoma laterale* (Wisconsin - 1), *A. maculatum* (Illinois - 19, Wisconsin - 1), *A. opacum* (Illinois - 19), *A. talpoideum* (Illinois - 19), *A. texanum* (Illinois - 19, 25), *A. tigrinum* (Wisconsin - 1), *A. tremblayi* (Wisconsin - 1), *Bufo americanus* (Wisconsin - 1), *Desmognathus fuscus* (Illinois - 10), *Eurycea lucifuga* (Illinois - 8, 19, Kentucky - 11), *Hemidactylium scutatum* (Wisconsin - 1), *Notophthalmus viridescens* (Illinois - 24, Wisconsin - 1), *Plethodon cinereus* (Illinois - 19, Wisconsin - 1), *P. dorsalis* (Illinois - 8), *P. glutinosus* (Illinois - 19), *Rana clamitans* (Wisconsin - 1, 33), *R. palustris* (Wisconsin - 1), *R. pipiens* (Wisconsin - 1, 33).
- Oxysomatium longicaudata* (Walton, 1929) Walton, 1933.
 Host: *Rana catesbeiana* (Indiana - 20).
- Oxysomatium* sp.
 Host: *Eurycea lucifuga* (Illinois - 5), *Thelandros magnavulvaris* (Rankin, 1937) Shad, 1960.
 Syn: *Oxyuris magnavulvaris* Rankin, 1937.
 Host: *Desmognathus fuscus* (Illinois - 10), *Plethodon cinereus* (Illinois - 19).
- Physalopteridae Leiper, 1908.
Physaloptera ranae
 Host: *Rana catesbeiana* (Indiana - 31).
- Physaloptera* sp.
 Host: *Plethodon dorsalis* (Illinois - 8).
- Rhabdiasidae Railliet, 1945.
Rhabdias bufonis (Schränk, 1788).
 Host: *Bufo americanus* (Wisconsin - 33).
- Rhabdias ranae* (Walton, 1929).
 Host: *Bufo americanus* (Wisconsin - 1), *Plethodon cinereus* (Wisconsin - 1), *Rana pipiens* (Wisconsin - 33), *R. sylvatica* (Wisconsin - 33).
- Rhabdias* sp.
 Host: *Ambystoma maculatum* (Illinois - 19), *A. opacum* (Illinois - 19), *A. texanum* (Illinois - 25), *Eurycea lucifuga* (Illinois - 19).
- Rhabdochonidae Skrjabin, 1946.
Spinitectus gracilis Ward and Magath, 1916.
 Host: *Bufo woodhousii* (Illinois - 16).
- Trichostrongylidae Leiper, 1912.
Oswaldocruzia pipiens Walton, 1929.
 Host: *Bufo americanus* (Wisconsin - 1), *Eurycea lucifuga* (Illinois - 11, Kentucky - 11), *Rana clamitans* (Wisconsin - 33), *R. pipiens* (Wisconsin - 33).
- Oswaldocruzia* sp.
 Host: *Eurycea longicaudata* (Illinois - 19), *Plethodon glutinosus* (Illinois - 19), *Typhlotriton spelaeus* (Missouri - 6).

Trichuridae Railliet, 1915.

Capillaria inequalis Walton, 1935.

Host: *Eurycea lucifuga* (Kentucky, 11), *Typhlotriton spelaeus* (Missouri - 6).

Capillaria tenua Mueller, 1932.

Host: *Notophthalmus viridescens* (Kentucky - 3).

Capillaria sp.

Host: *Ambystoma maculatum* (Illinois - 19), *A. opacum* (Illinois - 19), *A. talpoideum* (Illinois - 19), *Typhlotriton spelaeus* (Missouri - 6).

Larval Nematoda:

Rhabdiasidae Railliet, 1945.

Rhabdias sp. larva

Host: *Ambystoma texanum* (Illinois - 25).

Spiruridae Oerley, 1885.

spirurid cysts.

Host: *Ambystoma laterale* (Wisconsin - 1), *A. tigrinum* (Wisconsin - 1).

Acanthocephala:

Echinorhynchidae Cobbold, 1879

Acanthocephalus acutulus Van Cleave, 1931.

Host: *Cryptobranchus alleganiensis* (Missouri - 9).

Acanthocephalus sp.

Host: *Ambystoma talpoideum* (Illinois - 19), *Siren intermedia* (Illinois - 19).

Fessisentidae Van Cleave, 1931

Fessisentis fessus Van Cleave, 1931

Host: *Siren intermedia* (Illinois - 4, 23).

Juvenile Acanthocephala:

Host: *Desmognathus fuscus* (Illinois - 10).

Table 2. List of of amphibians from Illinois, Indiana, Iowa, Kentucky, Michigan, Missouri and Wisconsin for which helminths have been reported. The material on which the list is based is derived from the preceding table of helminths. The classification of hosts is based on that of Frost.¹⁴

Orda Anura (Salientia)

Bufonidae

Bufo americanus

Trematoda: *Gorgoderina bilobata* (Wisconsin - 27), *Gorgoderina bilobata* (Wisconsin - 1), *Haematoloechus similiplexus* (Iowa - 28), *Megalodiscus temperatus* (Iowa - 28), *Ostiolum medioplexus* (Iowa - 28), *Echinostoma metacercariae* (Iowa - 28), Metacercariae (Iowa - 28).

Cestoda: *Cylindrotaenia americana* (Iowa - 29), *Ophiotaenia saphena* (Iowa - 29), *Mesocestoides tetrathyridia* (Iowa - 29), Proteocephalan plerocercoids (Iowa - 29).

Nematoda: *Cosmocercoides dukae* (Wisconsin - 1), *Oswaldocruzia pipiens* (Wisconsin - 1), *Rhabdias bufonis* (Wisconsin - 33), *R. ranae* (Wisconsin - 1).

Bufo woodhousii

Nematoda: *Spinitectus gracilis* (Illinois - 16).

Hylidae

Acris crepitans

Trematoda: *Glythelmins quieta* (Illinois - 28),

Cestoda: *Cylindrotaenia americana* (Iowa - 30). *Brachycoelium salamandrae* (Michigan - 22).

Hyla crucifer

Trematoda: *Glythelmins pennsylvaniensis* (Wisconsin - 1), *G. quieta* (Michigan - 22), *Megalodiscus temperatus* (Michigan - 22), Echinostome cysts (Michigan - 22), Gorgoderid cysts (Michigan - 22).

Hyla versicolor

Trematoda: Metacercariae (Iowa - 28).

Pseudacris triseriata

Trematoda: *Fibricola cratera diplostomula* (Iowa - 28),

Glythelmins quieta (Iowa - 28).

Ranidae

Rana catesbeiana

Trematoda: *Glythelmins quieta* (Indiana - 20, Iowa - 28, Michigan - 22), *Gorgoderina amplicava* (Indiana - 20, Missouri - 15), *Gorgoderina attenuata* (Indiana - 20), *G. simplex* (Michigan - 22), *Haematoloechus breviplextus* (Indiana - 2, 20), *H. longiplextus* (Indiana - 2, 20, Iowa - 28, Michigan - 22), *Megalodiscus temperatus* (Iowa - 28, Michigan - 22). *Teloporia aspidonectes* (Michigan - 12).

Nematoda: *Oxysomatium longicaudata* (Indiana - 20). *Physaloptera ranae* (Indiana - 31).

Rana clamitans

- Trematoda: *Cephalogonimus americanus* (Michigan - 22), *C. salamandrus* (Wisconsin - 1), *C. vesicaudus* Michigan - 22), *Clinostomum attenuatum* cysts (Michigan - 22), *Glypthelmins quieta* (Michigan - 22, Wisconsin - 33), *Gorgodera amplicava* (Michigan - 22), *Gorgoderina attenuata* (Wisconsin - 1, 33, Michigan - 13), *G. simplex* (Michigan - 22, Wisconsin - 33), *Haematoloechus breviplexus* (Michigan - 22), *H. longiplexus* (Wisconsin - 33), *H. parviplexus* (Michigan - 22, Wisconsin - 33), *H. similiplexus* (Michigan - 13), *H. sp.* (Wisconsin - 33), *H. varioplexus* (Wisconsin - 33), *Halipegus eccentricus* (Wisconsin - 33), *Loxogenes arcanum* (Wisconsin - 33), *Megalodiscus temperatus* (Michigan - 22, Wisconsin - 33), *Pneumobitis parviplexus* (Michigan - 17, Minnesota - 17), Echinostome cysts (Michigan - 22), Gorgoderid cysts (Michigan - 22).
- Cestoda: *Mesocestoides* sp. tetrathyridia (Wisconsin - 33), *Ophiotaenia saphenus* (Wisconsin - 33).
- Nematoda: *Cosmocercoides dukae* (Wisconsin - 1, 33), *Oswaldocruzia pipiens* (Wisconsin - 33).

Rana palustris

- Trematoda: *Brachycoelium salamandrae* (Wisconsin - 1).
- Nematoda: *Cosmocercoides dukae* (Wisconsin - 1).

Rana pipiens

- Trematoda: *Apharyngostrigea pipientis* tetracotyles (Iowa - 28), *Cephalogonimus americanus* (Michigan - 13, 22), *C. sp.* (Wisconsin - 33), *Clinostomum attenuatum* metacercariae (Iowa - 28, Michigan - 13), *Fibricola cratera* diplostomula (Iowa - 28), *Glypthelmins quieta* (Iowa - 28, Wisconsin - 33), *Gorgodera amplicava* (Iowa - 28), *G. attenuate* (Iowa - 28, Michigan - 13), *Gorgoderina attenuata* (Wisconsin - 33), *G. simplex* (Iowa - 28), *Haematoloechus longiplexus* (Iowa - 28), *H. similiplexus* (Iowa - 28, Michigan - 13), *H. sp.* (Iowa - 28), *H. varioplexus* (Wisconsin - 33), *Halipegus eccentricus* (Wisconsin - 33), *H. sp.* (Iowa - 28), *Megalodiscus temperatus* (Iowa - 28, Michigan - 13, Wisconsin - 31), *Ostiolum complexus* (Iowa - 28), *O. medioplexus* (Iowa - 28), *Pneumonoeces medioplexus* (Indiana - 17, Michigan - 13, 17), *Renifer* cysts (Michigan - 22), Diplostomula metacercariae (Iowa - 28), Echinostome metacercariae (Iowa - 28), Gorgoderids immature (Iowa - 28), Plagiorchid metacercariae (Iowa - 28), Tetracotyle metacercariae (Iowa - 28), Unidentified metacercariae (Iowa - 28).

- Cestoda: *Cylindrotaenia americana* (Iowa - 30), *C. quadrijungosa* (Michigan - 21), *Mesocestoides tetrathyridia* (Iowa - 30, Wisconsin - 33), *Nematotaenoides ranae* (Iowa - 29, 30), *Ophiotaenia saphena* (Iowa - 30), Proteocephalan plerocercoids (Iowa - 30).
- Nematoda: *Cosmocercoides dukae* (Wisconsin - 1, 33), *Oswaldocruzia pipiens* (Wisconsin - 33), *Rhabdias ranae* (Wisconsin - 33).

Rana sylvatica

- Trematoda: *Brachycoelium salamandrae* (Michigan - 22), *Haematoloechus medioplexus* (Wisconsin - 33), *H. varioplexus* (Michigan - 22), *Rhabdias ranae* (Wisconsin - 33), Echinostome cysts (Michigan - 22), Gorgoderid cysts (Michigan - 22).

Order Caudata (Urodela)

Ambystomatidae

Ambystoma laterale

- Nematoda: *Cosmocercoides dukae* (Wisconsin - 1), Spirurid cysts (Wisconsin - 1).

Ambystoma maculation

- Trematoda: *Brachycoelium salamandrae* (Illinois - 19, Wisconsin - 1), *Neodiplostomum* sp. metacercariae (Illinois - 19).
- Nematoda: *Capillaria* sp. (Illinois - 19), *Cosmocercoides dukae* (Illinois - 19, Wisconsin - 1), *Rhabdias* sp. (Illinois - 19).

Ambystoma opacum

- Trematoda: *Brachycoelium salamandrae* (Illinois - 19), *Neodiplostomum* sp. metacercariae.
- Nematoda: *Capillaria* sp. (Illinois - 18), *Cosmocercoides dukae* (Illinois - 19), *Rhabdias* sp. (Illinois - 19).

Ambystoma talpoideum

- Trematoda: *Brachycoelium salamandrae* (Illinois - 19).
- Nematoda: *Capillaria* sp. (Illinois - 19), *Cosmocercoides dukae* (Illinois - 19).
- Acanthocephala: *Acanthocephalus* sp. (Illinois - 19).

Ambystoma texanum

- Trematoda: *Brachycoelium* sp. (Illinois - 25), *Diplostomulum ambystomae* (Illinois - 25), *Gorgoderina bilobata* (Illinois - 19, 25), *Neodiplostomum* sp. metacercariae (Illinois - 19), *Pseudopisthodiscus* sp. (Illinois - 19).
- Nematoda: *Cosmocercoides dukae* (Illinois - 19, 25), *Rhabdias* sp. (Illinois - 19, 25).

Ambystoma tigrinum

- Trematoda: *Cephalogonimus salamandrus* (Wisconsin - 1), *Phyllodistomum americanum* (Wisconsin - 1, 27), *Teleorchis bonnerensis* (Iowa - 28), Metacercariae (Wisconsin - 1).

Nematoda: *Cosmocercoides dukae* (Wisconsin - 1), Spirurid cysts (Wisconsin - 1).

Ambystoma tremblayi

Nematoda: *Cosmocercoides dukae* (Wisconsin - 1).

Cryptobranchidae

Cryptobranchus alleganiensis

Cestoda: *Ophiotaenia cryptobranchi* (Missouri - 9).

Nematoda: *Falcaustra variabilis* (Missouri - 9).

Acanthocephala: *Acanthocephalus acutululus* (Missouri - 9).

Necturidae

Necturus maculosus

Trematoda: *Sphyranura osleri* (Wisconsin - 1).

Cestoda: *Proteocephalus lonnbergii* (Wisconsin - 1).

Plethodontidae

Desmognathus fuscus

Trematoda: *Brachycoelium obesum* (Illinois - 10), *Pyllostomum solidum* (Illinois - 7).

Nematoda: *Cosmocercoides dukae* (Illinois - 10), *Thelandros magnavulvaris* (Illinois - 10).

Acanthocephala: Juvenile acanthocephalans (Illinois - 10).

Eurycea longicauda

Trematoda: *Brachycoelium salamandrae* (Illinois - 19).

Nematoda: *Oswaldocruzia* sp. (Illinois - 19).

Eurycea lucifuga

Trematoda: *Brachycoelium salamandra* (Illinois - 19), *Brachycoelium* sp. (Illinois - 8), *Gorgoderina attenuata* (Illinois - 19), *G. bilobata* (Illinois - 19), *G. sp.* (Illinois - 19), *Neodiplostomum* sp. (Illinois - 19).

Nematoda: *Capillaria inequalis* (Kentucky - 11), *Cosmocercoides dukae* (Illinois 8, 19, Kentucky - 11), *Oswaldocruzia pipiens* (Illinois - 11, Kentucky - 11), *O. sp.* (Illinois - 19), *Oxysomatium* sp. (Illinois - 8), *Rhabdias* sp. (Illinois - 19).

Hemidactylium scutatum

Trematoda: *Gorgoderina bilobata* (Wisconsin - 1), Metacercariae (Wisconsin - 1).

Nematoda: *Cosmocercoides dukae* (Wisconsin - 1).

Plethodon cinereus

Trematoda: *Brachycoelium salamandrae* (Wisconsin - 1).

Nematoda: *Aplectana* sp. (Illinois - 19), *Cosmocercoides dukae* (Illinois - 19, Wisconsin - 1), *Oxyuris magnavulvaris* (Illinois - 19), *Rhabdias ranae* (Wisconsin - 1).

Plethodon dorsalis

Trematoda: *Brachycoelium* sp. (Illinois - 8).

Nematoda: *Cosmocercoides dukae* (Illinois - 8), *Physaloptera* sp. (Illinois - 8).

Plethodon glutinosus

Trematoda: *Brachycoelium salamandrae* (Illinois - 19), *B. sp.* (Illinois - 8).

Nematoda: *Cosmocercoides dukae* (Illinois - 19), *Oswaldocruzia sp.* (Illinois - 19).

Typhlotriton spelaeus

Trematoda: *Brachycoelium salamandrae* (Missouri - 6).

Nematoda: *Capillaria inequalis* (Missouri - 6), *C. sp.* (Missouri - 6), *Falcaustra catesbeiana* (Missouri - 6), *Oswaldocruzia sp.* (Missouri - 6).

Salamandridae

Notophthalmus viridescens

Trematoda: *Brachycoelium sp.* (Illinois - 24), *Manodistomum parvum* (Illinois - 19), *Megalodiscus rankini* (Illinois - 24), *Plagitura salamandra* (Illinois - 24).

Cestoda: *Bothriocephalus varus* (Kentucky - 3), Proteocephalid cysts (Illinois - 19).

Nematoda: *Capillaria tenua* (Kentucky - 3), *Cosmocercoides dukae* (Illinois - 24), Wisconsin - 1).

Sirenidae

Siren intermedia

Trematoda: *Neodiplostomum sp. metacercariae* (Illinois - 19).

Cestoda: *Ophiotaenia sp.* (Illinois - 19).

Nematoda: *Falcaustra chabaudi* (Illinois - 5).

Acanthocephala: *Acanthocephalus sp.* (Illinois - 19), *Fessisentis fessus* (Illinois - 4, 23).