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Parasitic Helminths of the Common Loon, *Gavia immer*, on Its Wintering Grounds in Florida

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ABSTRACT: Forty-eight species of helminths (31 trematodes, 5 cestodes, 11 nematodes, and 1 acanthocephalan) were collected from 104 sick or dead common loons collected on Florida beaches between 1971 and 1993. Twenty-three "normal" loons collected in 1984 were infected with 23 species of helminths (13 trematodes, 4 cestodes, 3 nematodes, and 3 acanthocephalans). Two trematodes (*Microphallus forresteri, Amphimerus arcticus*) and 3 cestodes (*Neovalipora parvispinae, Armadoskrjabini rostellata, Tetrabothrius macrocephalus*) were considered common species (>20% prevalence) in both host populations. Of the species shared by the 2 host groups, 1 cestode (*N. parvispinae*) and 1 nematode (*Streptocara crassicauda longispiculatus*) had significantly higher prevalences and 2 trematodes (*Renicola pollaris* and *M. forresteri*) and 2 cestodes (*A. rostellata* and *Microsomacanthus pseudorostellatus*) had significantly higher intensities in the sick loons. The greater species richness in the sick loons and higher numbers of microphallid trematodes are thought to indicate a shift in the loons' diet due to low fish populations.

KEY WORDS: helminths, common loon, parasites, *Gavia immer*, Florida.

Common loons, *Gavia immer* (Brünnich), breed as isolated pairs on freshwater lakes in the northern United States and Canada and overwinter in large numbers in the Gulf and Atlantic coastal waters of northern Florida (Stevenson and Anderson, 1994). Each winter, dead loons are found on both Atlantic and Gulf beaches of Florida, occasionally reaching epizootic levels (Forrester et al., 1997). In one such epizootic episode, which occurred from January to March 1983, more than 13,000 loons were estimated to have died.

The literature on helminths of common loons consists primarily of scattered taxonomic descriptions (e.g., trematodes: Guberlet, 1922; Linton, 1928; Gower, 1939; Dubois and Rausch, 1967; Kinsella and Deblock, 1997; cestodes: Linton, 1927; Joyeux and Baer, 1941, 1950; nematodes: Gibson, 1968; Anderson and Forrester, 1974). Chafel and Pokras (1992) examined a small sample of immature and adult common loons for helminths on their breeding grounds in New England. Forrester et al. (1997) described in general terms the helminth fauna of overwintering common loons in Florida, listing combined intensities and abundances of intestinal trematodes but not identifying helminths to species. Subsequently, Kinsella and Deblock (1997) examined 5 species of microphallid trematodes from this same sample and described 1 species as new, *Microphallus forresteri.*

Herein, we describe the helminth populations of common loons found sick or dead over a 23-yr period in Florida and a smaller sample of "normal" loons collected in the nonepizootic year of 1984.

Materials and Methods

A total of 104 dead or moribund common loons (hereinafter referred to as sick loons) found on Florida beaches were submitted to the Department of Pathobiology, University of Florida, Gainesville, between 1971 and 1993. Diagnostic findings on some of these loons have been presented elsewhere (White et al., 1976; Franson and Cliplef, 1993; Forrester et al., 1997). Carcasses came from the following general areas in Florida: the Atlantic Coast (n = 64), the Gulf Coast (n = 36), inland lakes (Alachua, Broward, and Clay counties) (n = 3), and an unknown locality (n = 1). An additional 23 normal loons were collected by shooting in the vicinity of Dog Island off the coast of Franklin County in 1984 and were used for comparative purposes. Normal loons were defined as healthy birds with ample amounts of body fat and robust pectoral muscles, weighing >2.8 kg.

The 23 normal loons were examined shortly after death; the remainder were frozen and processed later. Techniques for the necropsy of birds and for the collection, fixation, and staining of helminths were similar to those described by Kinsella and Forrester (1972). Microhabitats examined included the trachea, esophagus, proventriculus, Koilon lining of the gizzard, small intestine, cecae, large intestine, cloaca, heart, lungs, liver, gallbladder, pancreas, kidneys, and body cavity.

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Table 1. Helminth parasites of 104 dead or moribund common loons (*Gavia immer*) found on beaches in Florida from 1971 to 1993.

Helminth species (accession no.)	Location*	No. loons infected (%)	Intensity $\bar{x} \pm$ SE	Intensity Range	Abundance ($\bar{x} \pm$ SE)
Trematoda					
Microphallus spp.†	SI	38 (37)	952.8 ± 344.6	1–10,325	348.1 ± 132.7
Apophallus brevis Ransom, 1920 (HWML 38129)	SI	26 (25)	211.9 ± 82.3	1–1,633	53.0 ± 21.8
Plotnikovia fodiens (Linton, 1928) (HWML 38107)	L, P	24 (23)	12.0 ± 3.0	1–53	2.8 ± 0.9
Amphimerus arcticus Kontrimavitschus and Bachmetreva, 1960 (HWML 38108)	L	22 (21)	5.7 ± 1.4	1–29	1.2 ± 0.4
Diplostomum immer Dubois, 1961 (HWML 38111)	SI	19 (18)	20.8 ± 6.2	1–82	3.8 ± 1.4
Renicola pollaris Kontrimavitschus and Bachmetreva, 1960 (HWML 38122)	K	17 (17)	20.2 ± 10.3	1–181	3.3 ± 1.8
Mesostephanus appendiculatoides (Price, 1934) (HWML 38128)	SI	14 (14)	11.4 ± 2.7	1–25	1.5 ± 0.5
Echinochasmus skrjabini Oschmarin, 1946 (HWML 38130)	SI	14 (14)	9.1 ± 2.8	1–28	1.2 ± 0.5
Phagicola longa Ransom, 1920 (HWML 38109)	SI	11 (11)	42.3 ± 20.7	1–230	4.5 ± 2.5
Odhneria odhneri Travassos, 1921 (HWML 38117)	CE	10 (10)	17.6 ± 10.2	1–102	1.7 ± 1.1
Prosthogonimus ovatus (Rudolphi, 1803) (HWML 38120)	CL	10 (10)	9.5 ± 5.3	1–55	0.9 ± 0.6
Mesorchis denticulatus (Rudolphi, 1802) (HWML 38113)	SI	9 (9)	20.1 ± 10.3	1–93	1.7 ± 1.0
Maritrema spp.‡	SI	7 (7)	130.1 ± 113.7	1–810	8.8 ± 7.8
Diplostomum gavium (Guberlet, 1922) (HWML 38110)	SI	7 (7)	4.3 ± 1.4	1–11	0.3 ± 0.1
Austrobilharzia terrigalensis Johnston, 1917 (HWML 38132)	BV	4 (4)	1.3 ± 0.3	1–2	0.1 ± 0.1
Cotylurus platycephalus (Creplin, 1825) (HWML 38124)	SI	2 (2)	1.0	1	<0.1 ± <0.1
Erschoviorchis lintoni (Gower, 1939) (HWML 38125)	P	2 (2)	6.5 ± 3.5	3–10	0.1 ± 0.1
Stictodora lariformicola Sogandares-Bernal and Walton, 1965 (HWML 38582)	SI	1 (1)	12.0	12	0.1 ± 0.1
Parorchis acanthus (Nicoll, 1906) (HWML 38114)	CL	1 (1)	3.0	3	<0.1 ± <0.1
Ribeiroia ondatrae (Price, 1931) (HWML 38121)	PR	2 (2)	5.0 ± 4.0	1–9	0.1 ± 0.1
Cotylurus erraticus (Rudolphi, 1809) (HWML 38112)	SI	1 (1)	2.0	2	<0.1 ± <0.1
Microparyphium facetum Dietz, 1909 (HWML 38123)	CL	1 (1)	1.0	1	<0.1 ± <0.1
Dendritobilharzia pulverulenta (Braun, 1901) (HWML 38131)	BV	1 (1)	1.0	1	<0.1 ± <0.1
Posthodiplostomum minimum (MacCallum, 1921) (HWML 38126)	SI	1 (1)	4.0	4	<0.1 ± <0.1
Posthodiplostomum sp.	SI	1 (1)	20.0	20	0.2 ± 0.2
Himasthla alincia Dietz, 1903 (HWML 38138)	SI	1 (1)	4.0	4	<0.1 ± <0.1
Tanaisia fedtschenkoi Skrjabin, 1924	K	1 (1)	1.0	1	<0.1 ± <0.1
Parvatrema sp. (HWML 38127)	SI	1 (1)	1.0	1	<0.1 ± <0.1
Cestoda					
Armadoskrjabini rostellata§ (Abdilgaard, 1790) (HWML 38133)	SI	67 (64)	107.3 ± 26.9	1–1,164	69.1 ± 17.9
Microsomacanthus pseudorostellatus§ (Joyeux and Baer, 1950) (HWML 38134)	SI	16 (15)			
Neovalipora parvispinae (Linton, 1927) (HWML 38136)	SI	41 (39)	53.6 ± 17.1	1–559	21.1 ± 7.2

Table 1. Continued.

Helminth species (accession no.)	Location*	No. loons infected (%)	Intensity $\bar{x}$ ± SE	Intensity Range	Abundance ($\bar{x}$ ± SE)
Tetrabothrius macrocephalus Rudolphi, 1819 (HWML 38135)	SI	29 (28)	6.9 ± 1.8	1–46	1.9 ± 0.6
Cyclustera ibisae Schmidt and Bush, 1972 (HWML 38137)	SI	8 (8)	4.0 ± 1.6	1–12	0.3 ± 0.2
Nematoda					
Cosmocephalus obvelatus (Creplin, 1825) (HWML 38143)	E	31 (30)	2.2 ± 0.5	1–14	0.7 ± 0.2
Paracuaria adunca (Creplin, 1846) (HWML 38142)	E, PR	31 (30)	2.4 ± 0.5	1–13	0.7 ± 0.2
Streptocara crassicauda longispiculatus Gibson, 1968 (HWML 38144)	KL	30 (29)	4.9 ± 1.9	1–57	1.4 ± 0.6
Contracaecum sp. (immature)	E, PR	19 (18)	4.0 ± 1.1	1–18	0.7 ± 0.3
Capillaria mergi Madsen, 1945 (HWML 38146)	SI	12 (12)	4.0 ± 2.5	1–30	0.5 ± 0.3
Streptocara formosus Sugimoto, 1930 (HWML 38145)	KL	3 (3)	1.0	1	<0.1 ± <0.1
Splendidofilaria fallisensis (Anderson, 1954)	SD	3 (3)	4.7 ± 2.4	1–9	0.1 ± 0.1
Eustrongylides tubifex Nitzch in Rudolphi, 1819 (HWML 38150)	PR	2 (2)	6.5 ± 5.5	1–12	0.1 ± 0.1
Cyathostoma phenisci (Baudet, 1937) (HWML 38147)	T	2 (2)	3.0 ± 2.0	1–5	<0.1 ± <0.1
Sciadiocara rugosa Schmidt and Kinsella, 1972 (HWML 38148)	KL	1 (1)	1.0	1	<0.1 ± <0.1
Stegophorus diomedeae (Johnston and Mawson, 1942) (HWML 38149)	KL	1 (1)	1.0	1	<0.1 ± <0.1
Acanthocephala					
Andracantha gravida Schmidt, 1975 (HWML 37465)	SI	4 (4)	1.5 ± 0.5	1–3	<0.1 ± <0.1

* BV = blood vessels; CE = cecae; CL = cloaca; E = esophagus; K = kidneys; KL = under Koilon lining; L = liver; P = pancreas; PR = proventriculus; SD = subdermal; SI = small intestine; T = trachea.

† A complex of 3 species: *Microphallus forresteri* Kinsella and Deblock, 1997 (HWML 38119), *Microphallus nicolli* (Cable and Hunninen, 1938), and *Microphallus* sp.

‡ A complex of 2 species: *Maritrema* sp. Harkema and Miller, 1962 and *Maritrema* sp. near *eroliae* Yamaguti, 1939 (HWML 38115).

§ *Armadoskrjabini rostellata* and *M. pseudorostellatus* were combined because some scolices lacked hooks and could not be differentiated.

Total counts of intestinal trematodes were made by use of an aliquot system.

Ecological terms used in this paper follow the definitions given by Bush et al. (1997). Common species were arbitrarily defined as those species with >20% prevalence; all other species were considered uncommon. Descriptive statistics are presented as a mean ± 1 SE. Prevalences were compared using chi-square analysis of a 2 × 2 contingency table with Yates continuity correction except where there were fewer than 5 observations per cell, in which case Fisher's exact test was used. Intensity data were not normally distributed and were compared by the nonparametric Mann–Whitney rank sum test using a commercial microcomputer program (SigmaStat® Version 2.00, 1995, Jandel Scientific Software, San Rafael, California). Statistical significance was accepted at $P < 0.05$. Representative specimens of helminths have been deposited in the collection of the Harold W. Manter Laboratory (HWML), University of Nebraska, Lincoln. Accession numbers are listed for each species deposited.

Results

Forty-eight species of helminths (31 trematodes, 5 cestodes, 11 nematodes, and 1 acanthocephalan) were collected from 101 of 104 (97%) sick loons examined from Florida beaches. Infected birds harbored 5.4 ± 0.3 helminth species (range, 1–15). The prevalence, intensity of infection, abundance, and location of each helminth are given in Table 1.

The 23 normal loons collected in 1984 were infected with 23 species of helminths (13 trematodes, 4 cestodes, 3 nematodes, and 3 acantho-

Table 2. Helminth parasites of 23 "normal" common loons from Dog Island, Franklin County, Florida.

Helminth species*	Location*	No. loons infected (%)	Intensity $\bar{x} \pm$ SE	Intensity Range	Abundance ($\bar{x} \pm$ SE)
Trematoda					
Renicola pollaris Kontrimavitschus and Bachmetreva, 1960	K	7 (30)	3.3 ± 1.4	1–10	1.0 ± 0.5
Microphallus spp.†	SI	6 (26)	11.8 ± 6.4	1–32	3.1 ± 1.9
Odhneria odhneri Travassos, 1921	SI	6 (26)	3.0 ± 0.3	2–4	0.8 ± 0.3
Amphimerus arcticus Kontrimavitschus and Bachmetreva, 1960	L	5 (22)	1.8 ± 0.5	1–3	0.4 ± 0.2
Plotnikovia fodiens (Linton, 1928)	L, P	2 (9)	2.5 ± 0.5	2–3	0.2 ± 0.2
Mesorchis denticulatus (Rudolphi, 1802)	SI	2 (9)	1.0	1	<0.1 ± <0.1
Maritrema sp. near *eroliae*	SI	1 (4)	3.0	3	0.1 ± 0.1
Ribeiroia ondatrae (Price, 1931)	PR	1 (4)	4.0	4	<0.1 ± <0.1
Microparyphium facetum Dietz, 1909	C	1 (4)	1.0	1	<0.1 ± <0.1
Dendritobilharzia pulverulenta (Braun, 1901)	H	1 (4)	1.0	1	<0.1 ± <0.1
Austrobilharzia terrigalensis Johnston, 1917	BV	1 (4)	2.0	2	<0.1 ± <0.1
Cestoda					
Neovalipora parvispinae (Linton, 1927)	SI	20 (87)	19.5 ± 5.8	1–116	16.9 ± 5.8
Armadoskrjabini rostellata‡ (Abdilgaard, 1790)	SI	12 (52)	9.8 ± 5.0	1–63	5.1 ± 2.8
Microsomacanthus pseudorostellatus‡ (Joyeux and Baer, 1950)	SI	4 (17)			
Tetrabothrius macrocephalus Rudolphi, 1819	SI	6 (26)	2.0 ± 0.7	1–5	0.5 ± 0.3
Nematoda					
Cyathostoma phenisci (Baudet, 1937)	T	2 (9)	1.0	1	<0.1 ± <0.1
Streptocara crassicauda longispiculatus Gibson, 1968)	KL	1 (4)	1.0	1	<0.1 ± <0.1
Capillaria mergi Madsen, 1945	SI	1 (4)	1.0	1	<0.1 ± <0.1
Acanthocephala					
Andracantha gravida Schmidt, 1975	SI	3 (13)	1.3 ± 0.3	1–2	0.2 ± 0.1
Polymorphus brevis§ (Van Cleave, 1916)	SI	1 (4)	1.0	1	<0.1 ± <0.1
Southwellina hispida§ Van Cleave, 1925	SI	1 (4)	1.0	1	<0.1 ± <0.1

* BV = blood vessels; C = cloaca; H = heart; K = kidneys; KL = under Koilon lining; L = liver; P = pancreas; PR = proventriculus; SI = small intestine; T = trachea.

† A complex of 3 species: *Microphallus forresteri* Kinsella and Deblock, 1997, *Microphallus nicolli* (Cable and Hunninen, 1938), and *Microphallus* sp.

‡ *Armadoskrjabini rostellata* and *M. pseudorostellatus* are combined because some scolices lacked hooks and could not be differentiated.

§ HWML 38139 for *P. brevis* and HWML 38140 for *S. hispida*.

cephalans) (Table 2). Twenty-one of 23 birds (91%) were infected with 4.0 ± 0.4 species (range, 1–8). Only 2 species collected (*Polymorphus brevis* and *Southwellina hispida*) were not found in the first host sample, making a total of 50 species in all.

Immature hymenolepid cestodes of 2 species, *Armadoskrjabini rostellata* and *Microsomacanthus pseudorostellatus,* could be distinguished by the size of their rostellar hooks, 45–47 μm and 56–57 μm, respectively. Because hooks had been lost from many scolices, intensity data for these species were combined; prevalence of each species was based on the presence of at least 1 scolex with hooks. Prevalence and intensities of 3 species of *Microphallus* were combined because many specimens were in poor condition and could not be distinguished. One species, *Microphallus forresteri,* comprised >90% of the 6 species of microphallids collected, including the 2 *Maritrema* species and *Odhneria odhneri.* No adult *Contracaecum* were collected, so the common loon may not be a competent host for this nematode group.

Ten common helminth species (4 trematodes, 3 cestodes, and 3 nematodes) were found in the sick loons and 7 were found in the normal loons (4 trematodes and 3 cestodes). *Apophallus brevis,* *Paracuaria adunca,* and *Cosmocephalus obvelatus* were common in the sick loons but absent in the normal loons. Five species (*M. forresteri, Amphimerus arcticus, Neovalipora parvispinae, A. rostellata,* and *Tetrabothrius macrocephalus*) were common in both host populations. Considering both samples combined, infections with 8 species (4 trematodes, 2 nematodes, and 2 acanthocephalans) consisted of a single specimen in 1 or 2 host individuals. Five other trematode species were found in only 1 host individual but had intensities of 2–20.

Of the species shared by the 2 host groups, 1 cestode (*N. parvispinae*) and 1 nematode (*Streptocara crassicauda longispiculatus*) had significantly higher prevalences but not higher intensities in the sick loons. Two trematodes (*Renicola pollaris* and *M. forresteri*) and 2 cestodes (the combined *A. rostellata* and *Microsomacanthus pseudorostellatus*) had significantly higher intensities but not prevalences in the sick loons. No shared species had higher prevalences or intensities in normal loons.

Discussion

Species diversity in the sick loons (48) was double that in the normal loons (23), as might be expected from the larger sample size, much longer time span, and multiple collection localities. However, 8 of the species found only in the sick loons were from a single host individual and could be considered accidental parasites. Twenty-one of 23 species (93%) found in normal loons were also found in sick loons.

According to Mcintyre and Barr (1997), quantitative data on the diet of the common loon are lacking, but fish are the primary component. When fish are scarce or water is murky, crustaceans constitute a major part of the diet. In an analysis of an epizootic involving up to 13,000 common loons in Florida in 1983, Forrester et al. (1997) speculated that large numbers of microphallid trematodes were an indicator of a major shift in the diet of the loons to crustaceans and shrimp because of low fish populations. In that study, a subset of sick loons different than that used here were infected with a mean of 7,665 intestinal trematodes compared with a mean of only 23 in the nonepizootic year of 1984 (the same normal loons used here). This shift was thought to have led to salt loading and increased physiological stress on the loons, contributing to their death. A species of *Microphallus* that comprised about 99% of the total number of microphallids in that study has subsequently been described as *M. forresteri* by Kinsella and Deblock (1997).

The sick loons examined here also had large numbers of *Microphallus* spp. (Table 1), with significantly higher intensities than normal loons, but the diversity of the sample in time and space makes it difficult to draw any conclusions as to their effect on the health of the hosts. Two species of cestodes had higher intensities in sick loons than in normal loons, but many of the infections consisted of scolices only and probably had little effect on the condition of the host. The high species diversity in the sick loons may indicate that they were utilizing a greater variety of prey items than were the normal loons possibly, as speculated by Forrester et al. (1997), because of a shortage of fish populations during epizootic years.

The only parasite survey of *Gavia immer* on its summer range was by Chafel and Pokras (1992), who examined 20 birds from 4 New England states and reported 9 species of helminths (5 trematodes, 2 cestodes, 1 nematode, and 1 acanthocephalan). Direct comparison is difficult because 3 helminths were not identified to species and intensities were only listed as mild, moderate, or severe. Three species of trematodes (*A. brevis, E. lintoni, C. erraticus*) and 1 cestode (*T. macrocephalus*) were shared between summer and winter ranges, and 1 species of cestode (*Hymenolepis* sp.) and nematode (*Eustrongylides* sp.) are likely also to be species found in Florida. In general, the prevalence of helminths was much lower on the summer range, with only 1 species (*A. brevis*) occurring in >10% of the loons, and species richness was considerably reduced (9 vs. 50). The greater variety in the diet on the winter range may explain these differences, although more study of loons on their summer range is needed.

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