PARASITES OF FISHES IN THE CANADIAN WATERS OF THE GREAT LAKES

Great Lakes Fishery Commission

TECHNICAL REPORT No. 51

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PARASITES OF FISHES IN THE CANADIAN WATERS OF THE GREAT LAKES

edited by

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TECHNICAL REPORT No. 51

Great Lakes Fishery Commission
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April 1988

A few of us had the privilege of saying a final "Thank you" to Dr. Alex Dechtiarenko when he passed along in March 1986, after a brief semi-retirement and a lengthy illness. Alex was a quiet, sensitive and perceptive man with generous and fierce loyalties to his family, his colleagues and his science. His career in fisheries was interrupted and foreshortened by the imperatives of family survival during the 1940s and 1950s and the complexities of their move from the Ukraine to, eventually, Toronto, Ontario. These papers concerning the parasites of fish of the Great Lakes are representative of the substantial contribution he made to fisheries science and ecology in Ontario during his brief career here. Many other contributions appear in the Canadian Journal of Zoology and the Journal of the Fisheries Research Board of Canada under the authorship of Alex 0. Dechtiar, and in national museums in Ottawa and Washington.

K.H. Loftus
May 1986

FOREWORD

In this series of 4 papers on the parasite fauna of fishes in the Ontario Great Lakes-Superior, Huron, Erie, and Ontario-the authors have attempted to provide a catalogue of the parasites found in extended surveys by the Ontario Ministry of Natural Resources since 1960. Information is presented on the prevalence of parasites, site of infection, intensity of infection, life cycle stages of parasites, and the relative importance of the parasites as fish pathogens. Relationships between parasite fauna and the degree of eutrophication of lake habitats are discussed. The papers also contain references to parasites not encountered in these surveys, but reported in the scientific literature by other authors.

The reports will provide baseline data for biologists who are concerned with research and management of the Great Lakes ecosystems. By recording the parasites extant at the particular time period for each lake it is hoped that more rigorous comparisons of the parasite fauna of fishes between lakes and between time periods for individual lakes will be possible in future.

"A parasite for instance, is a shocking and a baneful monster, yet still Nature has infused into his blandishments a not unpolished charm."

PLATO.

CONTENTS

Survey of the Parasite Fauna of Lake Superior Fishes, 1969 to 1975 [1]

by
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ABSTRACT

This study was the first extensive survey of the parasites of fishes from Lake Superior. During the seven year period (1969-1975 inclusive) over 700 fish representing 27 species were examined and 123 parasite species were recorded. Every species of fish and 88% of all fish examined harboured at least one species of parasite. No parasites considered hazardous to human health were found. Thirty-two pathogenic parasites reported elsewhere as contributors to fish mortalities were recorded.

INTRODUCTION

The parasite fauna of fish of Lake Superior, a classical oligotrophic lake and one of the largest freshwater lakes in the world (Lawrie and Rahrer 1972, 1973) is poorly known. Virtually no extensive surveys of the parasite fauna of fishes of the lake have been conducted and only a few studies of parasites of Lake Superior have been published (Leidy 1886; Linton 1898; Hoffman 1941; Welch 1950, 1952; Warren 1952; Smith and Lankester 1979; Lankester and Smith 1980 and Black and Lankester 1980). These authors recorded a total of 12 parasite species for the lake.

This study was initiated to increase our understanding of the prevalence and intensity of infection of parasites of commercially important and other fish species and to examine parasitism as a factor in the ecology of the lake.

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[1] Contribution No. 86-12 of the Ontario Ministry of Natural Resources, Research Section, Fisheries Branch, Box 50, Maple, Ontario LOJ 1EO.
[2] Deceased
[3] Retired

MATERIALS AND METHODS

Fish specimens were collected during 1969-1975 from the following areas of Lake Superior: Batchawana Bay, Saw Pit Bay, Jackfish Bay, Rossport Bay, Stokely Creek, and Michipicoten Island (eastern Lake Superior). Most of the fishes were from the catches of commercial fishermen, and some came from experimental nets fished by the staff of the Lake Superior Research Unit, Ontario Ministry of Natural Resources, Sault Ste. Marie, Ontario. About half of the fishes were examined as fresh material and the rest as frozen. Each fish was subjected to standard examination procedures for external and internal parasites (Dechtiar 1972b). The parasites from this study are temporarily housed under the care of Dr. M. Beverley-Burton, College of Biological Sciences, University of Guelph, Guelph, Ontario pending their final destination at the National Museum of Natural Sciences, Ottawa, Ontario.

RESULTS

Findings are arranged in a host-parasite checklist, and summarized in Tables 1 and 2. The host fish species are arranged in order according to Robins et al. (1980). For each species, the number of fish examined, the prevalence (%) of infection, and the site and intensity of infection are given. Intensity of infection is indicated as: L (light, l-9 parasites/host); M (medium, 10-49 parasites/host); H (heavy, ⩾ 50 parasites/host). Parasites are listed in decreasing order of prevalence and taxonomy is according to Margolis and Arthur (1979) and Beverley-Burton (1984) except where noted. An asterisk before a parasite name indicates its presence in a larval or immature stage.

Acipenser fulvescens Rafinesque - lake sturgeon
Examined 3: Prevalence 100%

Metechinorhynchus salmonis [1]	100%	H	intestine
Crepidostomum lintoni	100%	H	intestine
Metechinorhynchus lateralis	67%	M	intestine
Diclybothrium armatum	67%	M	gills
Cucullanus clitellarius	67%	M	intestine
Spinitectus gracilis	67%	M	intestine
**Diplostomum spathaceum*	67%	L	eye
Skrjabinopsolus manteri	67%	L	intestine
Piscicola punctata	33%	L	fins

Due to the small number of fish specimens, the species listed here may represent only part of the parasite fauna of lake sturgeon.

[1] Nomenclature according to Amin (1985)

TABLE I. Numbers of major parasitic taxa in species of fish sampled in Lake Superior during 1969-75.

Host Species	No. fish Examined	Protozoa	Trematoda	Monogenea	Cestoidea	Nematoda	Acantho-cephala	Mollusca	Arthropoda	Other[1]	No. Taxa
Lake sturgeon	3		3	1		2	2			1	9
Alewife	12		1				1			1	3
Lake herring	36	1	3	1	5	2	4		2		18
Cisco-bloater	8	1	1	1	4	1	1		1		10
Lake whitefish	23		3	1	5	3	2				14
Round whitefish	56		4	2	1	3	3			1	14
Coho salmon	7		1			2	2				5
Pink salmon	53		1		2	2	1			1	7
Rainbow trout	9		2			2	2				6
Brook trout	11		1		2	1	1				5
Lake trout	40		1	1	4	2	2		1	1	12
Rainbow smelt	82		1			1	2				4
Northern pike	13			1	3	3	1		1		9
Longnose dace	30		3	2	1	2	1				9
Common shiner	11	1	3	3		1					8
Bluntnose minnow	14	1	1	1			1				4
Spottail shiner	34	1	8	1	1	1	2		1	1	16
White sucker	47	1	4	5			2		1	1	14
Longnose sucker	36	1	5	4	3		2		1	1	17
Brown bullhead	6		1	1	1						3
Trout perch	13		3	1		2	3	1	1		11
Burbot	69	1	5		1	2	2			1	12
Rock bass	19	3	6	3		2	3		2	1	20
Smallmouth bass	2		1	2	1	1	1		1		7
Yellow perch	24	2	5	1	1	5	2	1	1		18
Walleye	15	1	2		1		2		1	1	8
Mottled sculpin	30		2	1		2	2				7

[1]Lamprey scars and leeches.

TABLE 2. Checklist of parasites of Lake Superior fishes, 1969-75

Virus
Pox virus (Lymphocystis disease)
Fungus
Saprolegnia sp.
Protozoa
Henneguya sp.
Myxosoma bibullatum Kudo, 1934
Myxobolus grandis Fantham, Porter and Richardson, 1939
Myxobolus sp.
Thelohanellus notatus (Mavor, 1916) Kudo, 1933
Trichodina sp.
Trichodina urinaria Dogiel, 1940
Trematoda - Digenea
Allocreadium lobatum Wallin, 1909
**Aphophallus brevis* Ransom, 1920
Azygia angusticauda (Stafford, 1904) Manter, 1926
**Bucephalus* sp.
**Centrovarium lobotes* (MacCallum, 1895) Stafford, 1904
**Clinostomum marginatum* (Rudolphi, 1818) Braun, 1899
**Crassiphiala bulboglossa* Haitsma, 1925
Crepidostomum cornutum (Osborn, 1903) Stafford, 1904
Crepidostomum farionis (Muller, 1780) Luhe, 1909
Crepidostomum isostomum Hopkins, 1931
Crepidostomum lintoni (Pratt and Linton, 1901) Hopkins, 1933
**Diplostomum scheuringi* Hughes, 1929
**Diplostomum spathaceum* (Rudolphi, 1819) Olsson, 1876
Lissorchis attenuatum (Mueller and Van Cleave, 1932) Krygier and Macy, 1969
Phyllodistomum coregoni Dechtiar, 1966
Phyllodistomum lysteri Miller, 1940
Phyllodistomum staffordi Pearse, 1924
Phyllodistomum superbum Stafford, 1904
Phyllodistomum sp.
**Posthodiplostomum minimum* (MacCallum, 1921) Dubois, 1936
Proterometra macrostoma (Faust, 1918) Horsfall, 1933
Sanguinicola occidentalis Van Cleave and Mueller, 1932
Sanguinicola sp.
Skrjabinopsolus manteri (Cable, 1952) Cable, 1955
**Tetracotyle diminuta* Hughes, 1928
**Tetracotyle intermedia* Hughes, 1928
**Tetracotyle* sp
**Uvulifer ambloplitis* (Hughes 1927) Dubois, 1938
Monogenea
Acolpenteron catostomi Fischthal and Allison, 1942
Anonchohaptor anomalus Mueller, 1938
Dactylogyrus banghami Mizelle and Donahue, 1944
Dactylogyrus bifurcatus Mizelle, 1937
Dactylogyrus cornutus Mueller, 1938
Dactylogyrus sp.
Diclybothrium armatum Leuckart, 1835
Discocotyle sagittata (Leuckart, 1842) Diesing, 1850
Gyrodactylus bairdi Wood and Mizelle, 1957
Gyrodactylus dechtiari Hanek and Fernando, 1971
Gyrodactylus sp.

Ligictaluridus pricei (Mueller, 1936) Beverley-Burton, 1984
Lyrodiscus rupestris Dechtiar, 1973
Octomacrum lanceatum Mueller, 1934
Octomacrum microconfibula Hargis, 1952
Onchocleidus ferox (Mueller, 1934) Mueller, 1936
Pellucidhaptor catostomi Dechtiar, 1969
Pseudomurraytrema copulatum (Mueller, 1938) Bychowsky, 1957
Tetracleidus banghami Mueller, 1936
Tetracleidus stentor (Mueller, 1937) Beverley-Burton, 1984
Tetraonchus monenteron (Wagener, 1857) Diesing, 1858
Tetraonchus variabilis Mizelle and Webb, 19.53
Urocleidus aculeatus (Van Cleave and Mueller, 1932) Mueller, 1934
Urocleidus adspectus Mueller, 1936
"Urocleidus" alatus (Mueller, 1938) Price, 1968
Urocleidus baldwini (Dechtiar, 1974) Beverley-Burton, 1984

Cestoidea

Bothriocephalus cuspidatus Cooper, 1917
Corallobothrium fimbriatum Essex, 1927
Cyathocephalus truncatus (Pallas, 1781) Kessler, 1868
**Diphyllobothrium ditremum* (Creplin, 1825) Luhe, 1910
**Diphyllobothrium* sp.
Eubothrium rugosum (Batsch, 1786) Nybelin, 1922
Eubothrium salvelini (Schrank, 1790) Nybelin, 1922
Glaridacris catostomi Cooper, 1920
**Ligula intestinalis* (Linnaeus, 1758) Gmelin, 1790
Proteocephalus exiguus LaRue, 1911
Proteocephalus laruei, Faust, 1920
Proteocephalus parallacticus MacLulich, 1943
Proteocephalus pearsei LaRue, 19 19
Proteocephalus pinguis LaRue, 1911
**Proteocephalus* sp.
Proteocephalus sp.
**Triaenophorus crassus* Forel, 1868
Triaenophorus crassus Forel, 1868
**Triaenophorus nodulosus* (Pallas, 1760) Rudolphi, 1819
Triaenophorus nodulosus (Pallas, 1760) Rudolphi, 1819

Nematoda

Camallanus oxycephalus Ward and Magath, 1917
Capillaria salvelini Polyansky, 1952
Cucullanelus cotylophora (Ward and Magath, 1917) Petter, 1974
Cucullanus clitellarius Ward and Magath, 1917
Cystidicola cristivomeri White, 1941
Cystidicola farionis Fischer, 1798
Haplonema hamulatum Moulton, 193 1
**Hysterothylacium brachyurum* Ward and Magath, 1917
Hysterothylacium brachyurum Ward and Magath, 1917
Metabronema salvelini (Fujita, 1920)
Philonema oncorhynchi Kuitunen-Ekbaum, 1933
Rhabdochona canadensis Moravec and Arai, 1971
Rhabdochona cotti Gustafson, 1949
Rhabdochona decaturensis, Gustafson, 1949
Rhabdochona ovifilamenta Weller, 1938
Rhabdochona sp
**Raphidascaris* acus (Bloch, 1779) Ralliet and Henry, 1915

continued

Spinitectus carolini Holl, 1928
Spinitectus gracilis Ward and Magath, 1917
**Spiroxys sp.*
Acanthocephala
Acanthocephalus jacksoni Bullock, 1962
Leptorhynchoides thecatus (Linton, 1891) Kostylew, 1924
Metechinorhynchus lateralis (Leidy, 1851) Golvan, 1969
Metechinorhynchus salmonis (Muller, 1784) Petrochenko, 1956
Neoechinorhynchus crassus Van Cleave, 1919
Neoechinorhynchus cristatus Lynch, 1936
Neoechinorhynchus cylindrutus (Van Cleave, 1913) Van Cleave, 1919
Neoechinorhynchus notemigoni Dechtiar, 1967
Neoechinorhynchus rutili (Muller, 1780) Hamann, 1892
Neoechinorhynchus tenellus (Van Cleave, 1913) Van Cleave, 1919
Neoechinorhynchus tumidus Van Cleave and Bangham, 1949
Neoechinorhynchus cylindratus (Van Cleave, 1913) Van Cleave, 1919
**Pomphorhynchus bulbocolli* Linkins in Van Cleave, 1919
Pomphorhynchus bulbocolli Linkins in Van Cleave, 1919
Annelida-Hirudinea
Actinobdella inequiannulata Moore, 1901
Illinobdella alba Meyer, 1940
Myzobdella moorei (Meyer, 1940) Meyer and Moore, 1954
Piscicola milneri (Verrill, 1874) Ryerson, 1915
Piscicola punctatu (Verrill, 1871) Moore, 1912
Mollusca-Pelecypoda
*Glochidia
Arthropoda-Crustacea-Copepoda
Achtheres ambloplitis Kellicott, 1880
Ergasilus caeruleus Wilson, 1911
Ergasilus centrarchidarum Wright, 1882
Ergasilus cotti Kellicott, 1879
Ergasilus luciopercarum Henderson, 1926
"Ergasilus sp.
Salmincola extumescens (Gadd, 1901) Wilson, 1915
Salmincola siscowet (Smith, 1874) Wilson, 1915
Pisces: Agnatha: Petromyzontidae
Petromyzon marinus Linnaeus

Alosa pseudoharengus (Wilson&--alewife
Examined 12: Prevalence 42%

**Diplostomum spathaceum*	*42%*	L	eye
Acanthocephalus jacksoni	*25%*	L	intestine
Saprolegnia sp.	*25%*	H	body surface

Coregonus artedii Le Sueur - lake herring
Examined 36: Prevalence 100%

Discocotyle sagittata	*83%*	L-M	gills
Proteocephalus laruei	78%	M-H	intestine
Cystidicola farionis	*69%*	H	swim bladder
Proteocephalus *exiguus*	64%	L-M	intestine

Metechinorhynchus lateralis	56%	H	intestine
Metechinorhynchus salmonis	42%	H	intestine
Crepidostomum farionis	28%	H	intestine, gall bladder
**Tetracotyle intermedia*	22%	M	heart
**Diphyllobothrium ditremum*	22%	M	stomach wall
**Triaenophorus crassus*	22%	M	muscle
Salmincola extumescens [2]	22%	L	gills
Metabronema salvelini	19%	L	intestine
Neoechinorhynchus tumidus	17%	L	intestine
**Diplostomum spathaceum*	14%	L	eye
Henneguya sp.	14%	H	gills

Coregonus *hoyi* (Gill)-bloater
Examined 8: Prevalence 100%

Discocotyle sagittata	75%	L	gills
Cystidicola farionis	75%	M	swim bladder
Proteocephalus laruei	63%	M	intestine
Crepidostomum farionis	63%	M	intestine
Proteocephalus exiguus	50%	L	intestine
Metechinorhynchus salmonis	50%	L	intestine
**Diphyllobothrium ditremum*	50%	M	intestinal wall, stomach
Henneguya sp.	38%	M	gills
Salmincola extumescens	38%	L	gills
**Triaenophorus crassus*	38%	M	*muscles*

Coregonus clupeaformis (Mitchill) - lake whitefish
Examined 23: Prevalence 96%

Metechinorhynchus salmonis	87%	M-H	Intestine
Cystidicola farionis	87%	H	swim bladder
Proteocephalus laruei	83%	H	intestine
Proteocephalus exiguus	43%	L-M	intestine
Discocotyle sagittata	43%	L-M	gills
**Tetracotyle intermedia*	39%	L-M	heart
Phyllodistomum coregoni	35%	L-M	ureters
Cyathocephalus truncatus	35%	M	pyloric caeca
Metabronema salvelini	30%	M	intestine
Neoechinorhynchus tumidus	30%	L	intestine
Capillaria salvelini	30%	L	intestine
**Diphyllobothrium* sp.	30%	L-M	stomach wall
Crepidostomum farionis	26%	L-M	gall bladder
**Triaenophorus crassus*	26%	M	muscles

Prosopium cylindraceum (Pallas)-round whitefish
Examined 56: Prevalence 89%

**Diplostomum spathaceum*	73%	L	eye
Salmincola extumescens	63%	L	gills
Cystidicola farionis	59%	M	swim bladder

[2]Nomenclature according to Kabata (1969)

Metechinorhynchus salmonis	41%	M	intestine
**Tetracotyle intermedia*	*36%*	L	heart
Metechinorhynchus lateralis	*34%*	L	intestine
Crepidostomum farionis	*27%*	M	intestine
Tetraonchus variabilis	*27%*	M	gills
Discocotyle sagittata	21%	L	gills
Phyllodistomum sp.	18%	M	ureters
Spinitectus gracilis	18%	M	intestine
Capillaria salvelini	16%	L	intestine
**Pomphorhynchus bulbocolli*	14%	L	intestine
Eubothrium salvelini	11%	M	intestine
Piscicola milneri	*4%*	L	fins

Oncorhynchus kisutch (Walbaum) - coho salmon
Examined 7: Prevalence 100%

Cystidicola farionis	71%	M	swim bladder
Metechinorhynchus salmonis	*57%*	M	intestine
Metechinorhynchus lateralis	*57%*	L	intestine
Metabronema salvelini	*43%*	L	intestine
**Diplostomum spathaceum*	*29%*	L	eye

Oncorhynchus gorbuscha (Walbaum) - pink salmon
Examined 53: Prevalence 100%

Cystidicola farionis	*83%*	M	swim bladder
Philonema oncorhynchi	*28%*	M	body cavity
Crepidostomum farionis	*28%*	M	intestine
Metechinorhynchus salmonis	*26%*	M-H	intestine
Lamprey scars	*9%*	L	skin surface
**Triaenophorus nodulosus*	*6%*	L	liver
**Triaenophorus crassus*	*6%*	L-M	muscles

Salmo gairdneri Richardson-rainbow trout
Examined 9: Prevalence 100%

Acanthocephalus jacksoni	*67%*	M	intestine
Metechinorhynchus lateralis	*56%*	L	intestine
**Tetracotyle intermedia*	44%	L	heart
**Diplostomum spathaceum*	44%	L	eye
Cystidicola farionis	44%	L	swim bladder
Capillaria salvelini	*22%*	L	intestine

Salvelinus fontinalis (Mitchill)--brook trout
Examined 11: Prevalence 73%

Crepidostomum farionis	64%	M	intestine
**Proteocephalus* sp.	64%	M	intestine

Eubothrium salvelini	*55%*	L	intestine
Hysterothylacium brachyurum [3]	*27%*	L	intestine
Neoechinorhynchus rutili	*27%*	L	intestine

Salvelinus namaycush (Walbaum) - lake trout
Examined 40: Prevalence 88%

Eubothrium salvelini	*75%*	M	intestine
Cystidicola cristivomeri	*75%*	M-H	swim bladder
Metechinorhynchus lateralis	*63%*	M-H	intestine
Metechinorhynchus salmonis	*60%*	H	intestine
Discocotyle sagittata	*50%*	L	gills
Proteocephalus parallacticus	*38%*	L	intestine
**Diphyllobothrium sp.*	*25%*	L-M	stomach wall
Metabronema salvelini	*20%*	L	intestine
Salmincola siscowet	18%	L	fins
**Triaenophorus crassus*	*5%*	L	muscles
Crepidostomum farionis	*5%*	L	gall bladder
Lamprey scars	*5%*	L	skin

Leidy (1886) also found *Crepidostomum cristivomeri* in the swim bladder of lake trout from Lake Superior. We found these parasites in lake trout (fork lengths 30.5-34.6 cm) caught by commercial fishermen in the east end of the lake, near Michipicoten Island. Ten of 14 fish examined were infected.

Osmerus mordax (Mitchill)-rainbow smelt
Examined 82: Prevalence 91%

Cystidicola farionis	48%	L-M	swim bladder
Metechinorhynchus salmonis	*43%*	L	intestine
**Diplostomum spathaceum*	31%	L	eye
Acanthocephalus jacksoni	18%	L	intestine

Esox lucius Linnaeus - northern pike
Examined 13: Prevalence 100%

Tetraonchus monenteron	*92%*	M	gills
Proteocephalus pinguis	*85%*	M-H	intestine
Triaenophorus nodulosus	*77%*	L-M	intestine
Triaenophorus crassus	*69%*	L-M	intestine
Hysterothylacium brachyurum	*62%*	M	intestine
Spinitectus carolini	31%	L	intestine
Ergasilus caeruleus	31%	L	gills
Acanthocephalus jacksoni	*23%*	L	intestine
Neoechinorhynchus tenellus	*23%*	H	intestine

[3]Nomenclature according to Deardorff and oOverstreet (1980)

Rhinichthys cataractae (Valenciennes) - longnose dace
Examined 30: Prevalence 83%

Dactylogyrus banghami	83%	M	gills
**Posthodiplostomum minimum*	83%	M	liver
**Crassiphiala bulboglossa*	83%	M	skin, fins
Gyrodactylus dechtiari	80%	M	fins
Rhabdochona canadensis	33%	L	intestine
Pomphorhynchus bulbocolli	27%	L	intestine
**Triaenophorus nodulosus*	13%	L	liver
Allocreadium lobatum	13%	L	intestine
**Spiroxys sp.*	10%	L	mesentery

Notropis cornutus (Mitchill)-common shiner
Examined 11: Prevalence 9 1%

Dactylogyrus cornutus	91%	M	gills
*Crassiphiala *bulboglossa*	91%	L	skin, fins
Gyrodactylus sp.	82%	M	tins
**Diplostomulum scheuringi*	64%	L	eye
**Diplostomum spathaceum*	54%	L	eye
Rhabdochona decaturensis	36%	L	intestine
Thelohanellus notatus	36%	M	muscles
Octomacrum microconfibula	36%	L	gills

Pimephales notatus (Rafinesque) - bluntnose minnow
Examined 14: Prevalence 86%

Dactylogyrus bifurcatus	8 6 %	L	gills
**Diplostomum spathaceum*	3 6 %	L	eye
Thelohanellus notatus	2 1 %	M	muscles
Neoechinorhynchus rutili	21%	L	intestine

Notropis hudsonius (Clinton)--spottail shiner
Examined 34: Prevalence 88%

Rhabdochona decaturensis	*44%*	L	intestine
Dactylogyrus sp.	*44%*	L-M	gills
**Centrovarium lobotes*	29%	L	muscles
**Posthodiplostomum minimum*	*26%*	*M*	*liver*
**Tetracotyle* sp.	15%	M	kidney
**Diplostomum spathaceum*	15%	L	eye
Neoechinorhynchus rutili	15%	L	intestine
**Tetracotyle* sp.	15%	M	kidney
Pomphorhynchus bulbocolli	12%	L	intestine
**Ligula intestinalis*	12%	L	body cavity
**Crassiphiala bulboglossa*	12%	L	skin
Myxobolus grandis	9%	M	liver
Sanguinicola sp.	9%	L	blood

Neoechinorhynchus notemigoni	9%	L	intestine
Ergasilus sp.	6%	L	intestine
Allocreadium lobatum	6%	L	intestine
**Clinostomum marginatum*	3%	L	muscles

Catostomus commersoni (LacCpbde) - white sucker
Examined 47: Prevalence 85%

**Diplostomum spathaceum*	68%	L	eye
Pomphorhynchus bulbocolli	60%	L-M	intestine
Neoechinorhynchus cristatus	32%	L-M	intestine
Acolpenteron catostomi	26%	L	ureters
Phyllodistomum lysteri	26%	L	ureters
Anonchohaptor anomalus	21%	L	gills
Pseudomurraytrema copulatum	19%	L	gills
Gyrodactylus sp.	19%	M	*gills*
Octomacrum lanceatum	17%	L	gills
Lissorchis attenuatum	17%	L	intestine
Myxosoma bibullatum	17%	M	gills
Actinobdella inequiannulata[4]	11%	L	gill chambers
**Tetracotyle* sp.	6%	L	mesentery
Ergasilus caeruleus	6%	L	gills

Catostomus Catostomus (Forster) - longnose sucker
Examined 36: Prevalence 83%

Ergasilus caeruleus	47%	L-M	gills
**Diplostomum spathaceum*	42%	L	eye
Octomacrum lanceatum	28%	L	gills
Sanguinicola sp.	28%	L	blood
Pseudomurraytrema copulatum	25%	L	gills
Neoechinorhynchus crassus	25%	M	intestine
**Ligula intestinalis*	14%	L	body cavity
Glaridacris catostomi	14%	L	intestine
Acanthocephalus jacksoni	14%	L	intestine
**Bucephalus* sp.	11%	M	gills
Pellucidhaptor catostomi	8%	L	fins, nasal cavity
Pomphorhynchus bulbocolli	8%	M	intestine
Acolpenteron catostomi	8%	M	ureters
Lissorchis attenuatum	6%	L	intestine
Proteocephalus sp.	6%	L	intestine
Myxosoma bibullatum	6%	M	gills
Actinobdella inequiannulata	6%	L	gill chambers

Ictalurus nebulosus (Lesueur) - brown bullhead
Examined 6: Prevalence 67%

Ligictaluridus pricei	67%	M	gills
Phyllodistomum staffordi	50%	L	ureters
Corallobothrium fimbriatum	50%	L	intestine

[4]Nomenclature according to Daniels and Freeman (1976)

Percopsis omiscomaycus (Walbaum) - trout perch
Examined 13: Prevalence 100%

Urocleidus baldwini	69%	M	gills
**Diplostomum spathaceum*	62%	L	eye
Crepidostomum isostomum	62%	M	intestine
**Tetracotyle sp.*	62%	M	mesentery , kidney
Metechinorhynchus salmonis	62%	L	intestine
Ergasilus caeruleus	54%	L-M	gills
*Glochidia	38%	L	gills
Rhabdochona sp.	23%	L	intestine
Acanthocephalus jacksoni	23%	L	intestine
Pomphorhynchus bulbocolli	23%	L	intestine
Spinitectus gracilis	15%	L	intestine

Lota lota (Linnaeus) - burbot
Examined 69: Prevalence 78%

Eubothrium rugosum	72%	L-M	intestine
Haplonema hamulatum	59%	L-M	intestine
Hysterothylacium brachyurum	51%	L-M	intestine
**Diplostomum spathaceum*	30%	L	eye
**Tetracotyle sp.*	22%	L	kidney, mesentery
Metechinorhynchus salmonis	14%	L	intestine
Azygia angusticauda	7%	L	intestine
Myzobdella moorei	6%	L	fins
Lamprey scars	6%	L	body surface
Pomphorhynchus bulbocolli	4%	L	intestine
Myxobolus sp.	3%	H	gills

Ambloplitis rupestris (Rafinesque) - rock bass
Examined 19: Prevalence 89%

"Urocleidus" alatus	79%	M	gills
Tetracleidus stentor	76%	M	gills
**Posthodiplostomum minimum*	74%	M	intestine
Leptorhynchoides thecatus	74%	M	liver, mesentery
Neoechinorhynchus cylindratus	74%	M	intestine
Crepidostomum cornutum	74%	M	intestine
*Tetracotyle sp.	63%	M	mesentery , kidney
Illinobdella alba	53%	L	fins
**Clinostomum marginatum*	47%		muscles
Proterometra macrostoma	37%	L	intestine
Ergasilus centrarchidarum	37%	L-M	gills
**Uvulifer ambloplitis*	32%	L-M	fins, skin
Hysterothylacium brachyurum	32%	L	intestine
**Raphidascaris acus*[5]	32%	M	liver
Lyrodiscus rupestris	26%	L	fins, nares
Trichodina sp.	16%	H	gills

[5]Nomenclature according to Arthur et al. (1976).

Achtheres ambloplitis	16%	L	gills
Metechinorhynchus salmonis	16%	L	intestine
**Pomphorhynchus bulbocolli*	16%	L	intestine
Virus (Lymphocystis)	11%	H	fins

Micropterus dolomieui LackppZde - smallmouth bass
Examined 2: Prevalence 100%

Tetracleidus banghami	100%	M	gills
Onchocleidus ferox[6]	100%	L	gills
Leptorhynchoides thecatus	100%	M	intestine
Azygia angusticauda	50%	L	intestine
Ergasilus centrarchidarum	50%	L	intestine
**Proteocephalus* sp.	50%	L	intestine
**Camallanus oxycephalus*	50%	L	intestine

Perca flavescens (Mitchill)-yellow perch
Examined 24: Prevalence 83%

Urocleidus adspectus	83%	L-M	gills
**Apophallus brevis*	75%	L-M	muscles
**Raphidascaris acus*	63%	M	liver
Ergasilus luciopercarum	58%	L	gills
Metechinorhynchus salmonis	50%	L	intestine
**Tetracotyle diminuta*	50%	M	kidney
Cucullanelus cotylophora	42%	L	intestine
**Hysterothylacium brachyurum*	33%	L	liver
Acanthocephalus jacksoni	29%	L	intestine
Trichodina urinaria[7]	29%	L	ureters
Proteocephalus pearsei	29%	L	intestine
Phyllodistomum superbum	25%	L	ureters
Crepidostomum cornutum	25%	L	intestine
**Diplostomum spathaceum*	21%	L	eye
Myxobolus sp.	13%	H	heart
*Glochidia	13%	M	tins, gills
Rhabdochona ovifilamenta	8%	L	intestine
Spinitectus carolini	8%	L	intestine

Stizostedion vitreum vitreum (Mitchill)-walleye
Examined 15: Prevalence 100%

Urocleidus aculeatus[8]	93%	M	gills
Bothriocephalus cuspidatus	93%	M-H	intestine
Ergasilus luciopercarum	87%	L-M	gills
Neoechinorhynchus tenellus	67%	L-M	intestine
Metechinorhynchus salmonis	53%	L	intestine

[6]Nomenclature according to Beverley-Burton and Suriano (1981).
[7]Identification confirmed by Dr. J. Lom, Czechoslovakia Academy of Science.
[8]Nomenclature according to Suriano and Beverly-Burton (1981).

**Tetracotyle diminuta*	47%	M	kidney, mesentery
Sanguinicola occidentalis	40%	L	blood
Virus (Lymphocystis)	13%	M	fins

Cottus bairdi Girard - mottled sculpin
Examined 30: Prevalence 83%

*Tetracotyle sp.	67%	L-M	kidney, mesentery
Ergasilus cotti	60%	L-M	gills
Rhabdochona cotti	50%	L-M	intestine
Gyrodactylus bairdi	27%	L-M	fins, gills
Metechinorhynchus salmonis	27%	L-M	intestine
**Diplostomum spathaceum*	17%	L	eye
Acanthocephalus jacksoni	17%	L	intestine

A total of 123 parasite species associated with 27 species of fish were found. The main taxa of parasite fauna were: virus and fungus-l species each; Protozoa-7; Trematoda (Digenea) - 28; Monogenea-26; Nematoda-18; Cestoidea-17; Acanthocephala-12; Arthropoda (Crustacea) - 8; Annelida (Hirudinia) - 5; Mollusca-1; Pisces (Agnatha) - 1.

PROTOZOA

Protozoans were found on 10 different species of fish, including the commercially important lake herring, bloater and yellow perch. Potentially dangerous parasites which may cause mortalities are *Henneguya* sp., *Trichodina urinaria, Trichodina* sp., *Thelohanellus notatus* and *Myxobolus* spp. These parasites cause weight loss, extensive damage to the hosts and possible mortalities among fishes (Dogiel et al., 1961; Reichenbach-Klinke and Elkan 1965; Reichenbach-Klinke 1973).

TREMATODA: DIGENEA

Adult trematodes, and encysted metacercariae (larvae), occur in muscle, internal organs, eyes and/or skin and may cause mortality in fishes. Of economic importance are: **Diplostomum spathaceum, *Posthodiplostomum minimum, Crepidostomum farionis, *Tetracotyle intermedia, *T. diminuta, *Apophallus brevis, *Clinostomum marginatum, Phyllodistomum* spp., *Centrovarium lobotes.* Pathological effects and mortalities of fishes, especially young, caused by digenetic trematodes have been reported by Meyer (1958), Wales (1958), Kozicka (1958), Bychovskaya-Pavlovskaya and Petrushevski (1963) and Dukes (1975).

MONOGENEA

Monogeneans were found on 20 species of fish. Most common were *Discocotyle sagittata, Tetraonchus monenteron, T. variabilis, Dactylogyrus*

spp., *Gyrodactylus* spp., and ancyrocephalid species. These monogeneans are considered dangerous, particularly for young fish (Mizelle 1938; Tripathi 1959; Dogiel et al. 1961; Lester and Adams 1974). It is important to note that the most potentially harmful, *Discocotyle sugittata,* is one of the most characteristic oligotrophic forms of the parasite fauna of salmonines and coregonines. It was found on 5 species of fish.

CESTOIDEA

Tapeworms were found in 16 species of fish. The most dangerous parasites *are: Proteocephalus laruei, *Diphyllobothrium ditremum, *Triaenophorus crassus, *T. nodulosus, *Ligula intestinalis, Proteocephalus parallacticus, Eubothrium salvelini, E. rugosum* and *Cyathocephalus truncatus.* Both the larval and adult stages may cause serious damage to the tissue of the fish and result in some mortalities (Lawler 1969; Matthey 1963; Dechtiar 1972a, 1972b; Nümann 1972; Harris and Wheeler 1974). Smith and Margolis (1970) reported that *Eubothrium salvelini* causes indirect damage to young salmonid fishes. Boyce (1979) reported that it had reduced the growth, survival and swimming performance of sockeye salmon. Vik (1954, 1958) reported that *Cyathocephalus truncatus* causes serious damage to salmonid fishes which may result in mortality. Miller (1945, 1952), Hoffman (1941), Welch (1950, 1952) and Warren (1952) reported that the occurrence of plerocercoids of *Triaenophorus crassus* in the muscles of salmonid fishes can create difficulties in marketing these fish. Duguid and Sheppard (1944) and Hoffman and Dunbar (1961) reported that epizootics among trouts have been caused by **Diphyllobothrium* spp. Vik (1965) considered that larvae of **Diphyllobothrium* spp. caused a major decline of *Salmo trutta* and *Salvelinus alpinus* in Norway.

NEMATODA

Adults and larval stages of 18 species were encountered in this survey. The most dangerous parasites *are* larvae of *Hysterothylacium brachyurum* and *Raphidascaris* acus. These parasites are found in the mesenteries, liver and kidney. Massive infection causes inflammation, moderate to heavy liver damage and fibrosis.

ACANTHOCEPHALA

Acanthocephalans were found in 25 species of fish. The most dangerous parasites for the salmonid community *are: Metechinorhynchus salmonis, M. lateralis* and *Acanthocephalus jacksoni.* All these are gut dwelling and detrimental, as they can reduce the state of nutrition of the hosts and cause hemorrhage and inflamation of the posterior part of the intestine (Petrushevski and Kogteva 1954; Bullock 1963; Pippy and Sandeman 1967; Schmidt et al. 1974).

ANNELIDA: HIRUDINEA

Five species of leeches were found on the fishes examined. These parasites are of minor importance for fish in Lake Superior. They may occasionally cause mortalities of fish (Rupp and Meyer, 1954). Only one leech, *Actinobdella inequiannulata,* merits special attention since it causes serious damage to the gills and operculum of white and longnose suckers.

MOLLUSCA: PELECYPODA

Glochidia were found on 2 species of fish. These parasites may occasionally cause mortality by markedly impairing respiratory function in heavy infections (Karna and Millemann 1978).

ARTHROPODA: CRUSTACEA: COPEPODA

Seven copepod species were found. The most dangerous parasites are *Salmincola* spp. and *Ergasilus* spp. Our observations during 1969-75 showed that species of both genera produce mechanical damage due to the attachment mechanisms so that hemorrhage and epithelial hyperplasia occur in heavy infections. These parasites may be considered to be of the highest epizootological importance (Hoffman 1967; Kabata 1970).

PISCES: AGNATHA: PETROMYZONTIDAE

Sea lamprey *(Petromyzon marinus* Linnaeus) scars were present on 3 species of fish (pink salmon, lake trout and burbot).

DISCUSSION

Among the parasites occurring in Lake Superior fishes many are considered to be pathogens and of potential economic importance. For the salmonid community, the most dangerous parasites are *Discocotyle sagitatta, Proteocephalus laruei, Eubothrium salvelini, Metechinorhynchus salmonis, M. lateralis, Henneguya* sp., *Crepidostomum farionis, *Diphyllobothrium ditremum, *Triaenophorus crassus, Cyathocephalus truncatus, *Tetracotyle intermedia,* and *Salmincola extumescens.* When prevalence and intensity of infection increase, death of the more heavily infected fish (particularly the young) occurs. Death could be caused either directly from heavy infections or indirectly through the loss of vitality in the host.

For warm-water fishes like percids, catostomids and centrarchids the most dangerous parasites are: **Diplostomum spathaceum, Tetraonchus momenteron, *Triaenophorus nodulosus, Ergasilus luciopercarum, E. caeruleus, *Clinostomum marginatum, *Posthodiplostomum minimum, *Crassiphiala bulboglossa, *Uvulifer ambloplitis, *Ligula intestinalis, Sanguinicola occidentalis,* and some

ancryocephalid species as well as *Dactylogyrus* spp. The dominant parasites of warm, shallow-water fishes in Lake Superior are digenean trematodes which are the most characteristic species of eutrophic habitats (Wisniewski 1958; Chubb 1963).

To date, no mortalities have been observed in adult fishes of the lake as a result of parasitic (protozoan or helminth) infection except for attacks by *Petromyzon marinus.* Parasitism by sea lamprey is held to be one of the most important negative factors affecting stocks of lake trout and whitefish (Lawrie and Rahrer 1972, 1973; Lawrie 1978; Smith and Tibbles 1980).

The relative abundance (as defined by Margolis et al, 1982) of parasites is related to certain aspects of the environment as well as to host-specific factors. The complex of parasites when environmental factors change may tend to lower the chances of survival for fish. Parasites occurring in one or other species of fish, alone or in combination with other factors, cause losses of economic significance in fish stocks. The complex of parasites of fishes may be considered as a good indicator of water quality, especially in conjunction with benthic, plankton, and physico-chemical data. Infections of salmonid communities with such parasites as *Metechinorhynchus salmonis, Cyathocephalus truncatus, Cystidicola farionis, C. cristivomeri* (intermediate *hosts - Pontoporeia affinis, Mysis relicta),* are evidence of oligotrophy of the lake (Cook and Johnson 1974).

Cystidicola cristivomeri develops and matures only in lake trout, brook trout, and Arctic char *(Salvelinus alpinus)* of North America (Lankester and Smith 1980, Black 1983a). This parasite develops to the infective stage only in an intermediate host, *Mysis relicta* (Smith and Lankester 1979; Black and Lankester 1980). Carpenter et al. (1974) reported that the highest concentrations of *Mysis relicta* in the Great Lakes were found in Lake Superior and appeared to be concentrated at depths of 125-200 m. In lake trout from the west part of the lake (Thunder Bay, Black Bay), and the north shore east of Thunder Bay to Wawa, *C. cristivomeri* was not found (Lankester and Smith 1980). However, it occurs in lake trout from several inland lakes of the Lake Superior watershed and the Northwest Territories (Margolis and Arthur 1979, Black 1983b). These authors were of the opinion that this nematode may have been present in Lake Superior after the finding by Leidy (1886) prior to the decline of lake trout populations in the Great Lakes after 1940.

As noted earlier, we found *C. cristivomeri* in lake trout in the eastern part of the lake near Michipicoten Island. According to Lawrie and Rahrer (1973) several variants of lake trout exist in the lake, two of them clearly distinct- *Salvelinus namaycush namaycush* and *S.n. siscowet.* Further investigation should clarify which sub-species is more susceptible to infection by C. *cristivomeri.* We suspect that *S.n. namaycush* is a less suitable or even unsuitable host for *C. cristivomeri.*

Because parasites may be stressors (physical and/or chemical) on fishes, studies of fish parasites and diseases in Lake Superior may help us to understand their ecological role and may pave the way for an increased awareness of the biology of fishes and improvements in the control of fish populations in the lake.

ACKNOWLEDGMENTS

We thank Dr. W.H. Kwain and staff members of the Lake Superior Fisheries Research Unit and particularly Mr. C. Parker, for their kindness in supplying fish specimens. K.H. Loftus provided encouragement to undertake this study. Dr. D.K. Cone, St. Mary's University, Halifax, N.S. provided a valuable review of the manuscript. We especially thank Dr. Mary Beverley-Burton, University of Guelph, Guelph, Ontario and Dr. John D. Smith, Ontario Ministry of Health, Ottawa, Ontario for their exhaustive and extremely helpful reviews.

Survey of the Parasite Fauna of Lake Huron Fishes, 1961 to 1971[1]

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ABSTRACT

This study of the parasite fauna of Lake Huron fish was the first extensive survey since 1951 (Bangham 1955). During 1961-71, a total of 2783 fish representing 57 species was examined and 221 parasite species were recorded. Of the fish examined 94% of all individuals carried at least one species of parasite. While none was considered dangerous to man a number of pathogenic forms which have been reported elsewhere as contributing to fish mortalities were recorded. Overall, the observed parasite fauna of salmonids increased only slightly from 1951 to 1971 but that of warmwater fishes increased considerably; particularly the monogeneans, digeneans (Trematoda) with metacercariae occuring in fishes and crustaceans of the genera Ergasilus and Argulus. Although Lake Huron proper is oligotrophic, these parasite taxa are characteristic of fishes inhabiting its more eutrophic bays and estuaries.

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INTRODUCTION

An extensive survey of the parasite fauna of Lake Huron fishes was conducted during 1961-1971, the first major work since a study in 1951 by Bangham (1955) recorded 98 parasite species in 53 species of fish. In other investigations, Cooper (1919) reported *Proteocephalus ambloplitis,* Ryerson (19 15) reported two species of leeches, *Piscicola milneri* for lake trout and *P. punctata* for rock bass, and Mavor (1915, 1916) reported *Myxidium lieberkuhni* for northern pike (in the urinary bladder), *Cryptobia borreli,* for white sucker (blood) and *Myxobolus notatus* for bluntnose minnow (muscles). More recently, Monaco and Mizelle (1955) reported *Dactylogyrus banghami* in common shiner from the Manitou River. DeGiuisti and Budd (1959) reported larval stages of two fish parasites *(Metechinorhynchus salmonis* and *Cyathocephalus truncatus)* in their intermediate host, *Pontoporeia affinis.* Based on all these prior studies and those of Uhazy (1976), Bower and Woo (1977), Bell and Beverley-Burton (1980), a total of 120 species had been reported previously.

In the current study, 2783 fish representing 57 species were examined and 221 species of parasites were encountered. The ecological significance of the observations is considered.

MATERIALS AND METHODS

Fishes were collected from several sites in Lake Huron and some of its tributaries including the Goderich area, South Bay, Rogers Creek, the Manitou River, and in Georgian Bay, the Nottawasaga River and Silver Creek. Most specimens were captured in experimental gear (gillnets, impounding nets, seines, and trawls) fished by he Lake Huron Fisheries Research Unit, Ontario Ministry of Natural Resources (OMNR) Tehkummah. However, some fish were supplied by A. Wainio, for-me District Biologist, OMNR, Maple, Ontario, and by anglers. About 60% of the specimens were examined as fresh material while 20% had been frozen, and 20 o preserved in formalin. Each fish was subjected to standard examination procedures for external and internal parasites (Dechtiar 1972b). For a survey of parasits of fishes, the usual size of the sample is 15 fish. The parasites from this study e temporarily housed under the care of Dr. M. Beverley-Burton, College of Biological Sciences, University of Guelph, Guelph, Ontario pending their final destination at the National Museum of Natural Sciences, Ottawa, Ontario.

RESULTS

Results are arranged in a host-parasite checklist, and summarized in Tables 1 and 2. The host fish specie are arranged in order according to Robins et al. (1980). For each host species, the number of fish examined, the prevalence (%) of infection, and the site an intensity of infection are given. Intensity of

TABLE I. Numbers of major parasitic taxa in selected species of fish taken in Lake Huron during 1951 and during this study in 1961-1971 (in parenthesis).

Host species	No. fish examined		Protozoa	Trematoda	Monogenea	Cestoidea	Nematoda	Acantho-cephala	Mollusca	Arthro-poda	Other'
Lake herring	75	(101)	(1)	1(3)		5(5)	1(1)	1(1)		2(1)	
Lake whitefish	71	(90)		1(3)	(1)	5(4)	3(3)	1(3)		1(1)	(1)
Bloater	47	(55)		1(3)	1(1)	4(3)	1	2(3)			
Burbot	19	(36)	(1)	1(2)		3(1)	2(3)	5(3)	(1)	(1)	
Round whitefish	22	(43)		2(3)	1(1)	1(3)	2(1)	2(3)		2(1)	
Rainbow trout	15	(82)		1(3)		3	1(2)	2(2)			
Lake trout	15	(25)		1(1)		1		2(2)			(1)
Brook trout	12	(22)		2(3)		1		(1)		(1)	(1)
Rainbow smelt	50	(328)		1(1)		(2)	2(1)	2(3)		(1)	
Northern pike	62	(38)		2(4)	(2)	2(3)	1(2)	5(2)		(1)	(1)
Spottail shiner	100	(119)	(3)	7(7)	(3)	2	2(1)	4(1)			
White sucker	73	(147)	1(4)	3(5)	1(5)	2(3)	1(1)	(5)	(1)	1(1)	1(2)
Brown bullhead	15	(27)	(1)	6(6)	(3)	1(2)	2	1(2)		1(1)	
Trout perch	19	(75)	(1)	4(6)	(2)	1(1)	3(1)	3(1)		2(1)	(1)
Rock bass	48	(46)	(1)	8(6)	(5)	2(2)	5(1)	4(2)	(1)	2(1)	1(2)
Smallmouth bass	95	(72)		9(8)	(6)	1(3)	5(3)	5(4)		2(2)	1(2)
Yellow perch	65	(134)	(3)	2(9)	(2)	(3)	(4)	(4)	1(1)	1(2)	1(3)

'Viruses, Saprolegnia sp., sea lamprey scars.

infection is indicated as: L(light, l-9 parasites/host); M(medium, 10-49 parasites/host); H(heavy, ⩾50 parasites/host). Parasites are listed in decreasing order of prevalence, and taxonomy is according to Margolis and Arthur (1979) and Beverley-Burton (1984) except where noted. An asterisk before a parasite name indicates its presence in a larval or immature stage.

TABLE 2. Checklist of parasites of Lake Huron fishes, 1961-71.

Virus
- Pox virus (Lymphocystis disease)

Fungus
- *Saprolegnia* sp.

Protozoa
- *Glugea anomala* (Moniez, 1884), Gurley, 1893
- *Henneguya doori* Guilford, 1963
- *Henneguya exilis* Kudo, 1929
- *Henneguya zschokkei* (Gurley, 1893) Doflein, 1901
- *Ichthyophthirius multifiliis* Fouquet, 1876
- *Myxobolus conspicuus* Kudo, 1929
- *Myxobolus grandis* Fantham, Porter and Richardson, 1939
- *Myxobolus* sp.
- *Myxosoma bibullatum* Kudo, 1934
- *Myxosoma pendula* Guilford, 1967
- *Myxosoma procerum* Kudo, 1934
- *Myxosoma rotundum* Meglitsch, 1937
- *Myxosoma scleroperca* Guilford, 1963
- *Pleistophora cepedianae* Putz, Hoffman and Dunbar, 1965
- *Thelohanellus notatus* (Mavor, 1961) Kudo, 1933
- *Trichodina urinaria* Dogiel, 1940
- *Trichodina* sp.
- *Trichophrya* sp.

Trematoda: Digenea
- *Acetodextra amiuri* (Stafford, 1900) Pearse, 1924
- *Allacanthochasmus artus* Mueller and Van Cleave, 1932
- *Allacanthochasmus varius* Van Cleave, 1922
- *Allocreadium lobatum* Wallin, 1909
- *Alloglossidium corti* (Lamont, 1921) Van Cleave and Mueller, 1934
- **Apophallus brevis* Ransom, 1920
- *Azygia angusticauda* (Stafford, 1904) Manter, 1926
- *Azygia longa* (Leidy, 1851) Manter, 1926
- **Bucephalus* sp.
- *Bucephalus* sp.
- *Bunoderina eucaliae* Miller, 1936
- *Bunoderina sacculata* (Van Cleave and Mueller, 1932) Yamaguti, 1958
- **Centrovarium lobotes* (MacCallum, 1895) Stafford, 1904
- *Centrovarium lobotes* (MacCallum, 1895) Stafford, 1904
- **Clinostomum marginatum* (Rudolphi, 1819) Brown, 1899
- **Crassiphiala* bulboglossa Haitsma, 1925
- *Crepidostumum cooperi* Hopkins, 193 1
- *Crepidostomum cornutum* (Osborn, 1903) Stafford, 1904
- *Crepidostomum farionis* (Muller 1780) Luhe, 1909
- *Crepidostomum isostomum* Hopkins, 193 1
- *Crepidostomum lintoni* (Pratt and Linton, 1901) Hopkins, 1933
- *Creptotrema funduli* Mueller, 1934

Cryptogonimus chili Osborn, 1903
**Diplostomulum baeri eucaliae* Hoffman and Hundley, 1957
**Diplostomulum* sp.
**Diplostomum scheuringi* Hughes, 1929
**Diplostomum spathaceum* (Rudolphi, 1819) Olsson, 1876
Lissorchis attenuatum (Mueller and Van Cleave, 1932) Krygier and Macy, 1969
Megalogonia ictaluri Surber, 1928
Microphallus opacus (Ward, 1894) Ward, 1901
Neascus sp.
Phyllodistomum brevicecum Steen, 1938
Phyllodistomum coregoni Dechtiar, 1966
Phyllodistomum lachancei Choquette, 1947
Phyllodistomum lohrenzi (Loewen, 1935)
Phyllodistomum lysteri Miller, 1940
Phyllodistomum staffordi Pearse, 1924
Phyllodistomum superbum Stafford, 1904
Phyllodistomum undulans Steen, 1938
Phyllodistomum sp.
Plagioporus cooperi (Hunter and Bangham, 1932) Price, 1934
**Posthodiplostomum minimum* (MacCallum, 1921) Dubois, 1936
Proterometra macrostoma (Faust, 1918) Horsfall, 1933
Prosorhynchoides pusilla (Stafford, 1904)
Sanguinicola occidentalis Van Cleave and Mueller, 1932
Sanguinicola sp.
Skrjabinopsolus manteri (Cable, 1952) Cable, 1955
**Tetracotyle intermedia* Hughes, 1928
**Tetracotyle* sp.
**Uvulifer ambloplitis* (Hughes, 1927) Dubois, 1938

Monogenea
Acolpenteron catostomi Fischthal and Allison, 1942
Acolpenteron ureteroecetes Fischthal and Allison, 1940
Actinocleidus recurvatus Mizelle and Donahue, 1944
Aethycteron malleus (Mueller, 1938) Suriano and Beverley-Burton, 1982
Anonchohaptor anomalum Mueller, 1938
Cleidodiscus brachus Mueller, 1938
Cleidodiscus robustus Mueller, 1934
Clavunculus bursatus (Mueller, 1936) Mizelle et al., 1956
Dactylogyrus anchoratus (Dujardin, 1845) Wagener, 1857
Dactylogyrus attenuatus Mizelle and Klucka, 1953
Dactylogyrus aureus Seamster, 1948
Dactylogyrus banghami Mizelle and Donahue, 1944
Dactylogyrus bifurcatus Mizelle, 1937
Dactylogyrus buddi Dechtiar, 1974
Dactylogyrus chrosomi Hanek, Molnar and Fernando, 1975
Dactylogyrus cornutus Mueller, 1938
Dactylogyrus duquesni (Mueller, 1938) Price, 1938
Dactylogyrus eucalius Mizelle and Regensberger, 1945
Dactylogyrus extensus Mueller and Van Cleave, 1932
Dactylogyrus heterolepis Hanek, Molnar and Fernando, 1975
Dactylogyrus lineatus Mizelle and Klucka, 1953
Dactylogyrus pollen Mizelle and Donahue, 1944
Dactylogyrus sp.
Diclybothrium armatum Leuckart, 1835
Discocotyle sagittata (Leuckart, 1842) Diesing, 1850

continued

Gyrodactylus atratuli Putz and Hoffman, 1963
Gyrodactylus bairdi Wood and Mizelle, 1957
Gyrodactylus couesius Wood and Mizelle, 1957
Gyrodactylus dechtiari Hanek and Fernando, 1971
Gyrodactylus eucaliae Ikezaki and Hoffman, 1957
Gyrodactylus etheostomae Wellborn and Rogers, 1967
Gyrodactylus funduli Hargis, 1955
Gyrodactylus freemani Hanek and Fernando, 1971
Gyrodactylus goerani Hanel and Fernando, 1971
Gyrodactylus medius Kathariner, 1895
Gyrodactylus nebulosus Kritsky and Mizelle, 1968
Gyrodactylus spathulatus Mueller, 1936
Gyrodactylus stunkardi Kritsky and Mizelle, 1968
Gyrodactylus sp.
Haplocleidus dispar[1] (Mueller, 1936) Mueller, 1937
Leptocleidus megalonchus Mueller, 1936
Ligictaluridus floridanus (Mueller, 1936) Beverley-Burton, 1984
Ligictaluridus monticellii (Cognetti de Martiis, 1924) Klassen and Beverley-Burton, 1985
Ligictaluridus pricei (Muller, 1936) Beverley-Burton, 1984
Lyrodiscus minimus Kritsky and Hathaway, 1969
Lyrodiscus rupestris Dechtiar, 1973
Mazocraeoides olentangiensis Sroule, 1959
Octomacrum lanceatum Mueller, 1934
Octomacrum microconfibula Hargis, 1952
Octomacrum semotili Dechtiar, 1966
Onchocleidus chautauquaensis (Mueller, 1938) Murith and Beverley-Burton, 1984
Onchocleidus chrysops (Mizelle and Klucka, 1953) Beverley-Burton, 1984
Onchocleidus ferox (Mueller, 1934) Mueller, 1936
Pellucidhaptor catostomi Dechtiar, 1969
Pellucidhaptor nasalis Dechtiar, 1969
Pellucidhaptor sp.
Pseudacolpenteron pavlovskii Bychowsky and Gussev, 1955
Pseudomurraytrema copulatum (Mueller, 1938) Bychowsky, 1957
Salsuginus fundulus (Mizelle, 1940) Beverley-Burton, 1984
Syncleithrium fusiformis (Mueller, 1934) Price, 1967
Tetracleidus banghami Mueller, 1936
Tetracleidus capax (Mizelle, 1936) Beverley-Burton, 1984
Tetracleidus longus (Mizelle, 1936) Beverley-Burton, 1984
Tetraonchus monenteron (Wagener, 1857) Diesing, 1858
Tetraonchus variabilis Mizelle and Webb, 1953
Urocleidus aculeatus (Van Cleave and Mueller, 1932) Mueller, 1934
Urocleidus adspectus Mueller, 1936
"Urocleidus" alatus (Mueller, 1938) Price, 1968
Urocleidus baldwini (Dechtiar, 1974) Beverley-Burton, 1984

Cestoidea

Bothriocephalus claviceps (Goeze, 1782) Rudolphi, 1810
Bothriocephalus cuspidatus Cooper, 19 17
Bothriocephalus formosus Mueller and Van Cleave, 1932
Corallobothrium fimbriatum Essex, 1927
Corallotaenia minutia (Fritts, 1959) Befus and Freeman, 1973
Cyathocephalus truncatus (Pallas, 1781) Kessler, 1868
**Diphyllobothrium ditremum* (Creplin, 1825) Luhe, 1910
**Diphyllobothrium* sp.
Eubothrium rugosum (Batsch, 1786) Nybelin, 1922
**Eubothrium salvelini* (Schrank, 1790) Nybelin, 1922

Glaridacris catostomi Cooper, 1920
Haplobothrium globuliforme Cooper, 1914
**Ligula intestinalis* (Linnaeus, 1758) Gmelin, 1790
Megathylacoides giganteum (Essex, 1928) Freze, 1965
**Proteocephalus ambloplitis* (Leidy, 1887) Benedict, 1900
Proteocephalus ambloplitis (Leidy, 1887) Benedict, 1900
Proteocephalus exiguus LaRue, 1911
Proteocephalus fluviatilis Bangham, 1925
Proteocephalus laruei Faust, 1920
Proteocephalus pearsei LaRue, 1914
Proteocephalus perplexus LaRue, 1911
Proteocephalus pinguis LaRue, 1911
Proteocephalus stizostedionis Miller, 1945
**Proteocephalus* sp.
**Schistocephalus solidus* (Muller, 1776) Steenstrup, 1857
**Triaenophorus crassus* Forel, 1868
Triaenophorus crassus Forel, 1868
**Triaenophorus nodulosus* (Pallas, 1760) Rudolphi, 1819
Triaenophorus nodulosus (Pallas, 1760) Rudolphi, 1819

Nematoda
Agamospirura sp.
Camallanus oxycephalus Ward and Magath, 1917
Cucullanelus cotylophora (Ward and Magath, 1917) Petter, 1974
Cystidicola farionis Fischer, 1798
Cystidicoloides tenuissima (Zeder, 1800) Rasheed, 1965
**Eustrongylides tubifex* (Nitzsch, 1819) Jagerskiold, 1909
Haplonema hamulatum Moulton, 1931
**Hysterothylacium brachyurum* Ward and Magath, 1917
Hysterothylacium brachyurum Ward and Magath, 1917
**Hysterothylacium brachyurum* sp.
Philometra cylindracea (Ward and Magath, 1917) Van Cleave and Mueller, 1934
**Philometra* sp.
Philometroides huronensis Uhazy, 1976
Philometroides nodulosa (Thomas, 1929) Dailey, 1967
**Raphidascaris* acus (Bloch, 1779) Ralliet and Henry, 1915
Raphidascaris acus (Bloch, 1779) Ralliet and Henry, 1915
Rhabdochona canadensis Moravec and Arai, 1971
Rhabdochona cascadilla Wigdor, 19 18
Rhabdochona cotti Gustafson, 1949
Rhabdochona decaturensis Gustafson, 1949
Rhabdochona sp.
Spinitectus carolini Holl, 1928
Spinitectus gracilis Ward and Magath, 1917
**Spiroxys* sp.
Thominx catenata (Van Cleave and Mueller, 1932) Skrjabin and Schikghobalova, 1954

Acanthocephala
Acanthocephalus jacksoni Bullock, 1962
**Leptorhynchoides thecatus* (Linton, 1891) Kostylew, 1924
Leptorhynchoides thecatus (Linton, 1891) Kostylew, 1924
Metechinorhynchus lateralis (Lerdy, 1851) Golvan, 1969
Metechinorhynchus leidyi (Van Cleave, 1924) Golvan, 1969
Metechinorhynchus salmonis (Muller, 1784) Petrochenko, 1956
Neoechinorhynchus crassus Van Cleave, 1919
Neoechinorhynchus cristatus Lynch, 1936

continued

Neoechinorhynchus cylindratus (Van Cleave, 1913) Van Cleave, 1919
Neoechinorhynchus notemigoni Dechtiar, 1967
Neoechinorhynchus pungitius Dechtiar, 197 1
Neoechinorhynchus rutili (Muller, 1780) Hamann, 1892
Neoechinorhynchus strigosus Van Cleave, 1949
Neoechinorhynchus tenellus (Van Cleave, 1913) Van Cleave, 1919
Neoechinorhynchus tumidus Van Cleave and Bangham, 1949
Neoechinorhynchus sp.
Octospinifer macilentus Van Cleave, 1919
Pomphorhynchus bulbocolli Linkins in Van Cleave, 1919

Annelida: Hirudinea
Actinobdella inequiannulata Moore, 1901
Myzobdella moorei (Meyer, 1940) Meyer and Moore, 1954
Myzobdella sp.
Piscicola punctata (Verrill, 1871) Moore, 1912

Mollusca: Pelecypoda
*Glochidia

Arthropoda: Crustacea
Archtheres ambloplitis Kellicott, 1880
Achteres corpulentus Kellicott, 1880
Achtheres micropteri Wright, 1882
Argulus catostomi Dana and Herrick, 1837
Argulus sp.
Ergasilus caeruleus Wilson, 1911
Ergasilus celestis Mueller, 1936
Ergasilus luciopercarum Henderson, 1926
Ergasilus versicolor Wilson, 1911
Ergasilus sp.
Hydrachna sp.
Lernaea cyprinacea Linnaeus, 1758
Salmincola edwardsii (Olsson, 1869) Wilson, 1915
Salmincola extumescens (Gadd, 1901) Wilson, 1915

Pisces Agnatha: Petromyzontidae
Petromyzon marinus Linnaeus

[1]Beverley-Burton and Suriano (1980, 1981) resurrected and redescribed the genera *Haplocleidus (Mueller, 1936); Pterocleidus* (Mueller, 1936) and Onchocleidus (Mueller, 1934).
[2]Sprinkle Fastzkie and Crites (1977) redescribed *Eustrongylides* tubifex (Nitzsch, 1819) Jagerskiold, 1909.

Acipenser fulvescens Rafinesque - lake sturgeon
Examined 8 : Prevalence 100%

Diclybothrium armatum	5%	L	gills
Skrjabinopsolus manteri	3%	L	intestine
Spinitectus gracilis	2%	L	intestine
Metechinorhynchus salmonis[1]	2%	H	intestine
Crepidostomum lintoni	2%	H	intestine

1 Nomenclature according to Amin (1985)

Amia calva Linnaeus - bowfin
Examined 13 : Prevalence 92%

Ergasilus sp.	39%	L	gills
Proteocephalus perplexus	39%	M	intestine
Spinitectus carolini	31%	L	intestine
**Diplostomum spathaceum*	31%	L	eye
Crepidostomum cornutum	31%	L	intestine
Leptorhynchoides thecatus	31%	L	intestine
**Triaenophorus nodulosus*	15%	L	liver

Alosa pseudoharengus (Wilson)-alewife
Examined 93 : Prevalence 65%

**Diplostomum spathaceum*	65%	L	eye
Acanthocephalus jacksoni	22%	L	intestine
Saprolegnia sp.	11%	H	skin
**Tetracotyle* sp.	5%	L	mesenteries

Dorosoma cepedianum (Lesueur) - gizzard shad
Examined 13 : Prevalence 77%

Mazocraeoides olentangiensis	46%	M	gills
**Diplostomum spathaceum*	39%	L	eye
Pleistophora cepedianae	8%	H	mesenteries

Coregonus artedii (Lesueur) - lake herring
Examined 101 : Prevalence 97%

Phyllodistomum sp.	49%	L	ureters
**Diphyllobothrium ditremum*	47%	L	stomach wall
**Triaenophorus crassus*	47%	L	muscles
Cystidicola farionis	44%	M	swim bladder
Proteocephalus laruei	44%	M	intestine
Cyathocephalus truncatus	44%	M	intestine
Proteocephalus exiguus	12%	M	intestine
**Tetracotyle intermedia*	10%	L	heart
Metechinorhynchus salmonis	9%	M	intestine
Salmincola extumescens[2]	3%	L	gills
Henneguya zschokkei	2%	H	muscle
**Diplostomum spathaceum*	2%	L	eye

Phyllodistomum sp. is an apparently undescribed species which seems to be the same as the species found in lake herring from Lake of the Woods by Dechtiar (1972a).

[2]Nomenclature according to Kabata (1969)

Coregonus clupeaformis (Mitchill)-lake whitefish
Examined 90 : Prevalence 99%

Phyllodistomum coregoni	39%	L	ureters
Cystidicoloides tenuissima	31%	L	intestine
**Diplostomum spathaceum*	20%	L	eye
**Raphidascaris acus*	19%	M	liver, spleen (encysted)
**Tetracotyle intermedia*	19%	L	heart
Cyathocephalus truncatus	17%	M	pyloric caeca
Metechinorhynchus salmonis	17%	M-H	intestine
Discocotyle sagittata	17%	L	gills
Neoechinorhynchus tumidus	13%	L	intestine
Achtheres corpulentus	11%	L	gills
Lamprey scars (marks)	9%	L	skin
**Triaenophorus crassus*	8%	L	muscle
Cystidicola farionis	8%	L	swim bladder
Proteocephalus laruei	6%	M	intestine
Pomphorhynchus bulbocolli	2%	L	intestine
**Diphyllobothrium* sp.	2%	M	intestinal wall

Bangham's recording of the parasite *Lymphocystis* sp. is erroneus, but the disease lymphocystis does occur in marine and freshwater fishes. The causative agent of lymphocystis disease is a pox virus. Although Bangham (1955) recorded "Lymphocystis tumor-cells" in whitefish (from Mindemoya Lake), the occurrence of this viral disease has not been subsequently confirmed for salmonids.

Coregonus hoyi (Gill)-bloater
Examined 55 : Prevalence 95%

**Triaenophorus crassus*	47%	L	muscles
Phyllodistomum sp.	45%	L	ureters
**Diphyllobothrium* sp.	36%	L	stomach wall
Neoechinorhynchus rutili	29%	L	intestine
**Tetracoryle intermedia*	27%	L	heart
Discocotyle sagittata	18%	L	gills
Cyathocephalus truncatus	9%	L	intestine
Metechinorhynchus salmonis	9%	M	intestine
Neoechinorhynchus tumidus	5%	L	intestine
**Diplostomum spathaceum*	4%	L	eye

Phyllodistomum sp. may be a new species.

Prosopium cylindraceum (Pallas)-round whitefish
Examined 43 : Prevalence 98%

Tetraonchus variabilis	70%	L	gills
Salmincola extumescens	23%	L	gills
**Diplostomum spathaceum*	21%	L	eye
**Tetracotyle sp.*	14%	L	heart

Cyathocephalus truncatus	14%	L	intestine
**Triaenophorus nodulosus*	9%	L	liver cysts
Phyllodistomum sp.	7%	L	ureters
Cystidicola farionis	7%	L	swim bladder
Pomphorhynchus bulbocolli	7%	L	intestine
Metechinorhynchus salmonis	7%	M	intestine
**Triaenophorus crassus*	7%	L	muscles
Neoechinorhynchus tumidus	7%	L	intestine

Preliminary examination suggests that *Phyllodistomum* sp. may be an apparently undescribed species.

Oncorhynchus kisutch (Walbaum) - coho salmon
Examined 4 : Prevalence 100%

Metechinorhynchus salmonis	100%	M	intestine
Cystidicola farionis	50%	M	swim bladder
**Diplostomum spathaceum*	50%	L	eye
Cystidicoloides tenuissima	50%	L	intestine

Oncorhynchus nerka (Walbaum) - kokanee
Examined 223 : Prevalence 79%

Metechinorhynchus salmonis	55%	M	intestine
Cystidicola farionis	43%	M	swim bladder
**Tetracotyle intermedia*	11%	L	mesentaries
Acanthocephalus jacksoni	11%	M	intestine
Ergasilus caeruleus	7%	L	gills
Crepidostomum farionis	5%	M	intestine
Cystidicoloides tenuissima	4%	L	intestine
Spinitectus gracilis	3%	L	intestine
Rhabdochona cascadilla	3%	L	intestine
Neoechinorhynchus rutili	3%	L	intestine
**Diplostomum spathaceum*	2%	L	eye
Neoechinorhynchus pungitius	2%	L	intestine
Neoechinorhynchus tumidus	1%	L	intestine
Thominx catenata	1%	L	intestine
Pomphorhynchus bulbocolli	1%	L	intestine
Hydrachna sp.	1%	L	gills
**Triaenophorus nodulosus*	0.5%	L	liver
Leptorhynchoides thecatus	0.5%	L	intestine
Saprolegnia sp.	0.5%	L	skin
Lamprey scars (marks)	0.5%	L	skin

Cystidicoloides tenuissima was found since the publication of the previous parasite list for kokanee (Collins and Dechtiar 1974).

Salmo gairdneri Richardson-rainbow trout
Examined 82 : Prevalence 89%

Phyllodistomum lachancei	32%	L	ureters
Pomphorhynchus bulbocolli	18%	L	intestine
**Diplostomum spathaceum*	18%	L	eye

**Tetracotyle sp.*	18%	L	mesenteries
Cystidicola farionis	17%	L	swim bladder
Cystidicoloides tenuissima	4%	L	intestine
Metechinorhynchus salmonis	4%	L	intestine

Salmo trutta Linnaeus - brown trout
Examined 3 : Prevalence 100%

Metechinorhynchus salmonis	100%	H	intestine
Cystidicoloides tenuissima	100%	L	intestine
Acanthocephalus jacksoni	100%	L	intestine

Salvelinus fontinalis (Mitchill) - brook trout
Examined 22 : Prevalence 86%

Phyllodistomum lachancei	82%	L	ureters
**Diplostomum spathaceum*	14%	L	eye
Salmincola edwardsii [3]	14%	L	gills
Crepidostomum farionis	14%	M	intestine
Piscicola punctata	5%	L	skin
Metechinorhynchus lateralis	5%	M	intestine

Salvelinus namaycush (Walbaum) - lake trout
Examined 25 : Prevalence 100%

Metechinorhynchus salmonis	100%	M	intestine
Metechinorhynchus leidyi	60%	L-M	intestine
Lamprey scars (marks)	20%	L	skin
**Diplostomum spathaceum*	12%	L	eyes

Salvelinus namaycush x Salvelinus fontinalis-splake (hybrid)
Examined 61 : Prevalence 93%

Metechinorhynchus salmonis	82%	M	intestine
Acanthocephalus jacksoni	41%	M	intestine
Pomphorhynchus bulbocolli	39%	L	intestine
**Tetracotyle intermedia*	16%	L	heart
**Eubothrium salvelini*	11%	L	intestine
Neoechinorhynchus tumidus	11%	L	intestine
Hysterothylacium brachyurum[4]	8%	L	intestine
Cystidicola farionis	8%	L	swim bladder
**Diplostomum spathaceum*	8%	L	eye
**Proteocephalus sp.*	8%	L	intestine
Lamprey scars (marks)	5%	L	skin

[3]Nomenclature according to Kabata (1969)
[4]Nomenclature according to Deardorff and Overstreet (1980)

**Triaenophorus nodulosus*	2%	L	liver
Discocotyle sagittata	2%	L	gills
Spinitectus gracilis	2%	L	intestine
Cyathocephalus truncatus	2%	L	intestine

A total of 21 parasite species are now known to occur in splake with the inclusion by Dechtiar and Berst (1978) of the following species: *Saprolegnia* sp., *Crepidostomum farionis, *Diphyllobothrium* sp., *Rhabdochona* sp., *Capillaria salvelini,* and *Ergasilus caeruleus.*

Osmerus mordax (Mitchill)-rainbow smelt
Examined 328 : Prevalence 95%

**Proteocephalus* sp.	76%	L	intestine
Neoechinorhynchus rutili	38%	L	intestine
**Diplostomum spathaceum*	15%	L-M	eye
Neoechinorhynchus sp.	6%	L	intestine
Metechinorhynchus salmonis	5%	L	intestine
Cyathocephalus truncatus	1%	L	intestine
Piscicola punctata	1%	L	skin
Cystidicola farionis	1%	L	swim bladder

Umbra limi (Kirtland)-central mudminnow
Examined 14 : Prevalence 93%

Phyllodistomum brevicecum	93%	L	ureters
Creptotrema funduli	36%	L	intestine
Bunoderina eucaliae	14%	L	intestine
Trichodina sp.	14%	M	gills
**Tetracotyle* sp.	14%	L	mesenteries
**Spiroxys* sp.	14%	L	mesenteries
**Diplostomum spathaceum*	7%	L	eye

Esox lucius Linnaeus - northern pike
Examined 38 : Prevalence 100%

Proteocephalus pinguis	95%	M	intestine
Tetraonchus monenteron	92%	M	gills
Hysterothylacium brachyurum	42%	M	intestine
Triaenophorus nodulosus	39%	L	intestine
Triaenophorus crassus	39%	M	intestine
Metechinorhynchus salmonis	37%	M	intestine
**Tetracotyle* sp.	32%	L	mesenteries
Neoechinorhynchus tenellus	26%	M	intestine
**Diplostomum spathaceum*	18%	L	eye
Gyrodactylus sp.	5%	L	fins
Azygia longa	5%	L	stomach
**Uvulifer ambloplitis*	5%	M	fins

Myzobdella sp.	5%	L	fins
Argulus sp.	5%	L	body surface
Raphidascaris acus	5%	L-M	intestine

Couesius *plumbeus* (Agassiz) - lake chub
Examined 83 : Prevalence 96%

Dactylogyrus banghami	39%	L	gills
Octomacrum semotili	18%	L	gills
Plagioporus cooperi	12%	L	intestine
Ergasilus sp.	8%	L	gills
Neoechinorhynchus rutili	8%	L	intestine
**Diplostomum spathaceum*	7%	L	eye
Rhabdochona canadensis	7%	L	intestine
**Posthodiplostomum minimum*	6%	M	mesenteries
*Glochidia	6%	L	gills
Metechinorhynchus salmonis	5%	L	intestine
**Proteocephalus* sp.	5%	L	intestine
Gyrodactylus couesius	5%	L	fins, gills

Cyprinus carpio Linnaeus - carp
Examined 17 : Prevalence 100%

Pomphorhynchus bulbocolli	35%	M	intestine
Pseudacolpenteron pavlovskii	29%	L	fins
Dactylogyrus anchoratus	29%	L	gills
Dactylogyrus extensus	29%	M	gills
Gyrodactylus medius [5]	24%	L	gills
Spinitectus gracilis	12%	L	intestine
Lernaea cyprinacea	12%	L	muscles
**Diplostomum spathaceum*	12%	L	eye

Notemigonus crysoleucas (Mitchill) - golden shiner
Examined 10 : Prevalence 100%

Dactylogyrus aureus	60%	M	gills
Neoechinorhynchus rutili	40%	L	intestine
Neoechinorhynchus notemigoni	20%	L	intestine
**Crassiphiala bulboglossa*	20%	L	fins, skin

Notropis cornutus (Mitchill)-common shiner
Examined 60 : Prevalence 97%

Dactylogyrus cornutus	45%	L	gills
Gyrodactylus sp.	43%	L	gills

[5]According to Ergens (1974) Gyrodactylus carpio (Kritsky and Mizelle, 1968) is a synonym of G. *medius.*

Rhabdochona decaturensis	25%	L	intestine
lchthyophthirius multifiliis	1 3 %	M	skin, gills
Allocreadium lobatum	12%	L	intestine
Ergasilus sp.	12%	L	gills
Plagioporus cooperi	10%	L	intestine
Octomacrum microconfibula	8%	L	gills
Thelohanellus notatus	8%	H	skin, muscle
**Posthodiplostomum minimum*	8%	M	mesenteries, liver
**Crassiphiala bulboglossa*	8%	M	skin
Dactylogyrus pollex	3%	L	gills
Rhabdochona cascadilla	3%	L	intestine

Notropis atherinoides Rafinesque - emerald shiner
Examined 16 : Prevalence 100%

**Posthodiplostomum minimum*	8 1 %	M	mesenteries
Dactylogyrus sp.	8 1 %	L	gills
**Diplostomum spathaceum*	38%	L	eye
Gyrodactylus sp.	19%	L	fins
Plagioporus cooperi	13%	L	intestine

Notropis heterolepis Eigenmann and Eigenmann - blacknose shiner
Examined 5 : Prevalence 100%

**Posthodiplostomum minimum*	100%	M	mesenteries
Dactylogyrus heterolepis	60%	L	gills
**Ligula intestinalis*	40%	L	body cavity
**Proteocephalus* sp.	40%	L	eye
**Diplostomum spathaceum*	40%	L	eye
**Uvulifer ambloplitis*	40%	M	skin, fins
**Clinostomum marginatum*	40%	L	muscles
**Spiroxys* sp.	40%	L	mesenteries

Notropis hudsonius (Clinton)-spottail shiner
Examined 119 : Prevalence 100%

Dactylogyrus sp.	67%	L	gills
Neoechinorhynchus rutili	23%	L	intestine
**Centrovarium lobotes*	21%	L	muscles
Rhabdochona decaturensis	17%	L	intestine
**Tetracotyle* sp.	1 3 %	M	mesenteries
Gyrodactylus sp.	1 3 %	M	fins
Plagioporus cooperi	8%	L	intestines, gall bladder
Trichodina sp.	4%	H	gills
**Bucephalus* sp.	4%	L	gills
Myxobolus grandis	4%	H	liver
**Posthodiplostomum minimum*	4%	M	liver, mesenteries
Octomacrum semotili	3%	L	gills
**Diplostomum spathaceum*	3%	L	eye

Myxobolus sp.	2%	L	intestine
**Uvulifer ambloplitis*	2%	M	skin, fins

Notropis rubellus (Agassiz) - rosyface shiner
Examined 10 : Prevalence 100%

**Diplostomum spathaceum*	60%	L	eye
**Posthodiplostomum minimum*	50%	L	liver

Phoxinus neogaeus Cope-finescale dace
Examined 49 : Prevalence 92%

Dactylogyrus chrosomi	51%	L	gills
Gyrodactylus sp.	49%	L	gills
**Posthodiplostomum minimum*	31%	M	mesenteries, liver
Trichodina sp.	10%	H	ureters, gills
**Diplostomum spathaceum*	8%	L	eye
Argulus catostomi	6%	L	skin
*Glochidia	6%	L	gills
Myxobolus conspicuus	6%	L	skin
Neoechinorhynchus rutili	6%	L	intestine
**Clinostomum marginatum*	6%	M	mesenteries, muscles

Pimephales notatus (Rafinesque) - bluntnose minnow
Examined 38 : Prevalence 89%

Dactylogyrus bifurcatus	39%	L	gills
Neoechinorhynchus rutili	32%	M	intestine
**Posthodiplostomum minimum*	32%	M	mesenteries, liver
Thelohanellus notatus	32%	M	muscle
Ichthyophthirius multifiliis	29%	M	skin, gills, fins
**Diplostomum spathaceum*	26%	L	eye
**Proteocephalus* sp.	16%	L	intestine
**Ligula intestinalis*	16%	L	body cavity
**Centrovarium lobotes*	13%	M	muscles
Gyrodactylus sp.	13%	L	fins

Pimephales promelas Rafinesque - fathead minnow
Examined 10 : Prevalence 90%

Dactylogyrus bifurcatus	70%	L	gills
Gyrodactylus sp.	50%	L	fins
*Neascus sp.	20%	L	fins

Gyrodactylus sp. may be a new species.

Rhinichthys atratulus (Hermann)-blacknose dace
Examined 26 : Prevalence 96%

Gyrodactylus dechtiari	46%	L	gills
Dactylogyrus banghami	46%	L	gills
**Clinostomum marginatum*	19%	L	muscles
**Tetracotyle* sp.	12%	L	mesenteries

Rhinichthys cataractae (Valenciennes) - longnose dace
Examined 26 : Prevalence 89%

Dactylogyrus banghami	62%	L	gills
Allocreadium lobatum	39%	L	intestine
**Diplostomum spathaceum*	23%	L	eye
**Crassiphiala bulboglossa*	19%	L	skin
Gyrodactylus atratuli	19%	L	fins
Rhabdochona canadensis	19%	L	intestine
**Posthodiplostomum minimum*	15%	M	mesenteries
Gyrodactylus dechtiari	12%	L	fins
Ergasilus caeruleus	8%	M	gills

Semotilus atromaculatus (Mitchill)-creek chub
Examined 18 : Prevalence 100%

Cleidodiscus brachus	61%	L	gills
**Diplostomum spathaceum*	56%	L	eye
Dactylogyrus lineatus	56%	L	gills
**Posthodiplostomum minimum*	50%	M	mesenteries, liver
Dactylogyrus attenuatus	44%	L	gills
Allocreadium lobatum	44%	L	intestine
**Crassiphiala bulboglossa*	44%	L	skin
*Glochidia	22%	L	gills
**Bucephalus* sp.	22%	L	intestine
Myxosoma pendula	22%	M	gills
Rhabdochona canadensis	22%	L	intestine
**Ligula intestinalis*	11%	L	body cavity
Rhabdochona cascadilla	11%	L	intestine

Semotilus margarita (Cope)-pearl dace
Examined 5 : Prevalence 100%

Dactylogyrus banghami	60%	L	gills
Gyrodactylus margaritae	60%	L	fins

Carpiodes cyprinus (Lesueur) - quillback
Examined 1 : Prevalence 100%

**Diplostomum spathaceum*	100%	L	eye
Ergasilus sp.	100%	L	gills
Pomphorhynchus bulbocolli	100%	M	intestine
Myxosoma rotundum	100%	L	gills

Catostomus Catostomus (Forster) - longnose sucker
Examined 62 : Prevalence 89%

**Diplostomum spathaceum*	40%	L-M	eye
Octomacrum lanceatum	25%	L	gills
Pellucidhaptor catostomi	24%	L	gills, nasal cavity
Anonchohaptor anomalum	24%	L	gills
Myxosoma bibullatum	24%	M	gills
Acolpenteron catostomi	24%	M	ureters
Glaridacris catostomi	16%	M	intestine
Phyllodistomum lysteri	16%	L	ureters
Ergasilus caeruleus	16%	L	gilts
**Ligula intestinalis*	8%	L	body cavity
Metechinorhynchus salmonis	8%	M	intestine
Neoechinorhynchus cristatus	8%	M	intestine
Leptorhynchoides thecatus	8%	L	intestine
Philometroides nodulosa	8%	L	subcutaneous tissue of head
*Glochidia	8%	L	fins
Sanguinicola sp.	5%	M	blood
Actinobdella inequiannulata[6]	5%	L	gill chambers
Argulus catostomi	5%	L	skin
Neoechinorhynchus crassus	5%	L	intestine
**Triaenophorus nodulosus*	5%	L	liver

Catostomus commersoni (LacCpbdej - white sucker
Examined 147 : Prevalence 99%

**Diplostomum spathaceum*	21%	L-M	eye
Neochinorhynchus cristatus	17%	L	intestine
Glaridacris catostomi	14%	L-M	intestine
Pellucidhaptor nasalis	14%	L	nasal cavity
Neoechinorhynchus crassus	12%	L	intestine
Octomacrum lanceatum	12%	L	gills
Octospinifer macilentus	11%	L	intestine
Sanguinicola sp.	10%	L	blood vessels
*Glochidia	10%	L	fins
Anonchohaptor anomalum	10%	L	gills, mesenteries
Neochinorhynchus strigossus	10%	L	intestine
Gyrodactylus spathulatus	10%	L	fins
Pomphorhynchus bulbocolli	10%	M	intestine
**Neascus* sp.	8%	M	body surface
Gyrodactylus sp.	7%	H	gills
**Ligula intestinalis*	5%	L	body cavity
Lamprey scars	4%	L	body surface
Phyllodistomum lysteri	4%	L	ureters
Actinobdella inequiannulata	3%	L	gill chambers
Ergasilus caeruleus	3%	M	gills
Philometroides nodulosa	3%	L	head tissue
Lissorchis attenuatum	3%	M	intestine
lchthyophthirius multifiliis	3%	H	fins, gills
Myxosoma bibullatum	3%	H	gills

'Nomenclature according to Daniels and Freeman (1976).

Acolpenteron catostomi	*3%*	M	ureters
Trichodina sp.	1%	H	gills
**Triaenophorus nodulosus*	1%	L	liver

Moxostoma macrolepidotum (Lesueur) - shorthead redhorse
Examined 6 : Prevalence 100%

Dactylogyrus duquesni	*50%*	L	gills
Pseudomurraytrema copulatum	*50%*	L	gills
Ergasilus caeruleus	*50%*	L	gills
Phyllodistomum lysteri	*33%*	L	ureters
Pellucidhaptor sp.	*33%*	L	fins, skin
Myxobolus sp.	*33%*	M	gills
**Triaenophorus nodulosus*	17%	L	liver
Argulus catostomi	17%	L	skin

Ictalurus nebulosus (Lesueur) - brown bullhead
Examined 27 : Prevalence 100%

Ligictaluridus pricei	74%	M	gills
Megalogonia ictaluri	44%	L	intestine
**Diplostomum spathaceum*	37%	L-M	eye
Henneguya exilis	37%	M	gills
Acetodextra amiuri	22%	L	swim bladder
Leptorhynchoides thecatus	19%	L	intestine
Gyrodactylus nebulosus	19%	L	fins
Phyllodistomum staffordi	19%	L	ureters
Corallobothrium fimbriatum	19%	M	intestine
Ergasilus versicolor	19%	L	gills
Corallotaenia minutia	19%	L	intestine
Pomphorhynchus bulbocolli	15%	L	intestine
Ligictaluridus monticellii	7%	L	nasal cavity
Microphalus opacus	7%	M	intestine
**Clinostomum marginatum*	7%	M	muscles, mesenteries

Ictalurus punctatus (Rafinesque) - channel catfish
Examined 3 : Prevalence 100%

Ligictaluridus floridanus	100%	M	gills
**Diplostomum spathaceum*	100%	L	eye
Ergasilus versicolor	67%	L	gills
Megalogonia ictaluri	67%	L	intestine
Megathylacoides giganteum	67%	L	intestine
Alloglossidium corti	67%	M	intestine

Noturus flavus Rafinesque - stonecat
Examined 4 : Prevalence 100%

Ligictaluridus pricei	100%	M	gills
Corallobothrium fimbriatum	100%	M	intestine
**Hysterothylacium brachyurum*	*75%*	M	liver

Leptorhynchoides thecatus	75%	L	intestine
Ergasilus versicolor	50%	L	gills

Percopsis omiscomaycus (Walbaum) - trout perch
Examined 75 : Prevalence 100%

Urocleidus baldwini	43%	L	gills
**Diplostomum spathaceum*	27%	L	eye
*Centrovarium *lobotes*	27%	L-M	intestine, muscles
**Tetracotyle intermedia*	20%	L	mesenteries
Crepidostomum isostomum	16%	M	intestine
Myxosoma procerum	16%	M	skin, muscle
Pomphorhynchus bulbocolli	13%	L	intestine
Piscicola punctata	11%	L	fins
Hysterothylacium brachyurum	8%	L	intestine
Ergasilus caeruleus	7%	M	gills
Bothriocephalus formosus	7%	L	intestine
Gyrodactylus sp.	4%	L	fins
**Posthodiplostomum minimum*	4%	M	mesenteries

Lota lota (Linnaeus) - burbot
Examined 36 : Prevalence 100%

Ergasilus celestis	42%	L	gills
**Hysterothylacium brachyurum*	33%	M	liver
*Glochidia	33%	L	gills
Haplonema hamulatum	31%	L	intestine
Leptorhynchoides thecatus	31%	L	intestine
**Diplostomum spathaceum*	28%	L-M	eyes
**Tetracotyle* sp.	28%	L	mesentery
Metechinorhynchus salmonis	22%	M	intestine
Eubothrium rugosum	17%	M	intestine
Myxobolus sp.	14%	M	gills
Acanthocephalus jacksoni	8%	L	intestine
Spinitectus gracilis	8%	L	intestine

Fundulus diaphanus (Lesueur) - banded killifish
Examined 13 : Prevalence 100%

**Diplostomum spathaceum*	54%	L	eye
**Posthodiplostomum minimum*	54%	M	liver, mesentery
Gyrodactylus funduli	38%	L	fins
Salsuginus fundulus	31%	L	gills
**Eustrongylides tubifex*	23%	L	muscles
Ichthyophthirius multifilliis	23%	L	fins
**Leptorhynchoides thecatus*	23%	L	intestine
**Diplostomum scheuringi*	15%	L	eye

Culaea inconstans (Kirtland&--brook stickleback
Examined 76 : Prevalence 96%

Dactylogyrus eucalius	62%	L	gills
Gyrodactylus eucaliae	59%	L	fins
**Tetracotyle* sp.	42%	L	kidney
Neoechinorhynchus pungitius	29%	M	intestine
Ergasilus versicolor	20%	L	gills
**Hysterothylacium* sp.	8%	L	liver
Rhabdochona cascadilla	8%	L	liver
Bunoderina eucaliae	7%	L	intestine
**Diplostomum spathaceum*	7%	L	eyes
Glugea anomala	4%	L	skin, muscle
**Agamospirura* sp.	4%	M	mesenteries
Acanthocephalus jacksoni	4%	L	intestine
**Posthodiplostomum minimum*	4%	M	liver, mesenteries
**Diplostomulum baeri eucaliae*	3%	H	brain
Neoechinorhynchus rutili	3%	L	intestine

Pungitius pungitius (Linnaeus) - ninespine stickleback
Examined 145 : Prevalence 100%

Neoechinorhynchus pungitius	31%	L	intestine
Ergasilus sp.	31%	L	gills
**Diplostomum spathaceum*	19%	L	eye
**Schistocephalus solidus*	15%	L	body cavity
Glugea anomala	7%	L	skin, muscles
Gyrodactylus eucaliae	7%	L	fins
Neoechinorhynchus rutili	4%	L	intestine
Acanthocephalus jacksoni	3%	L	intestine

Morone chrysops (Rafinesque) - white bass
Examined 3 : Prevalence 100%

**Proteocephalus ambloplitis*	100%	L	liver
Onchocleidus chrysops	100%	M	gills
Allacanthochasmus artus	100%	M	intestine
Allacanthochasmus varius	100%	L	intestine
**Triaenophorus nodulosus*	100%	L	liver
**Diplostomum spathaceum*	100%	L	eyes
*Glochidia	100%	L	gills
Bucephalus sp.	100%	L	intestine
Trichophyra sp.	33%	H	gills
Spinitectus carolini	33%	L	intestine

Ambloplites rupestris (Rafinesque) - rock bass
Examined 46 : Prevalence 98%

"Urocleidus" alatus	46%	L	gills
**Diplostomum spathaceum*	43%	L	eyes
Onchocleidus chautauquaensis	43%	L	gills

Cryptogonimus chili	43%	M	intestine
**Clinostomum marginatum*	37%	L-M	mesenteries, muscles
Lyrodiscus rupestris	33%	L	fins
Neoechinorhynchus cylindratus	22%	L	intestine
**Posthodiplostomum minimum*	22%	M	liver, mesenteries
Myxobolus sp.	11%	L	gills
Spinitectus gracilis	11%	L	intestine
**Proteocephalus ambloplitis*	11%	L	intestine
Gyrodactylus goerani	11%	L	fins
Pomphorhynchus bulbocolli	11%	L	intestine
Achtheres ambloplitis	11%	L	gills
Bothriocephalus claviceps	11%	L	gills
*Glochidia	9%	L	gills
**Uvulifer ambloplitis*	9%	L	Skin
Saprolegnia sp.	9%	H	skin
Ergasilus caeruleus	9%	L	gills
Lyrodiscus minimus	1%	L	fins
Myzobdella moorei	4%	L	fins, body surface
Crepidostomum cooperi	4%	L	intestine

Lepomis gibbosus (Linnaeus) - pumpkinseed
Examined 34 : Prevalence 100%

Onchocleidus ferox[7]	44%	L	gills
**Tetracotyle sp.*	44%	M	mesenteries
Haplocleidus dispar [8]	41%	L	gills
**Posthodiplostomum minimum*	32%	M-H	liver, mesenteries
Actinocleidus recurvatus	29%	L	skin, gills
**Diplostomum spathaceum*	29%	L	eyes
**Clinostomum marginatum*	15%	L	muscles
**Proteocephalus ambloplitis*	15%	L	liver
Neoechinorhynchus cylindratus	15%	L	intestine
**Uvulifer ambloplitis*	15%	L	skin
Crepidostomum cornutum	15%	L	intestine
Crepidostomum cooperi	15%	L	intestine
Cleidodiscus robustus	15%	L	gills
Proterometra macrostoma	12%	L	intestine
Leptorhynchoides thecatus	9%	L	intestine

Micropterus dolomieui Lacépède - smallmouth bass
Examined 72 : Prevalence 100%

Syncleithrium fusiformis	38%	L	gills
Leptorhynchoides thecatus	38%	L-M	intestine
Neoechinorhynchus cylindratus	36%	L	intestine
Tetracleidus banghami	35%	L	gills
**Proteocephalus ambloplitis*	33%	H	liver, mesenteries
Haplocleidus dispar	21%	L	gills

7 Nomenclature according to Beverley-Burton and Suriano (1980)
8 Nomenclature according to Beverley-Burton and Suriano (1981)

Proteocephalus ambloplitis	19%	L-M	intestine
Leptocleidus megalonchus [9]	18%	L	gills
Cryptogonimus chili	18%	M	intestine
Hysterothylacium brachyurum	17%	L	intestine
**Clinostomum marginatum*	17%	L-M	muscles
Ergasilus caeruleus	17%	M	gills
Phyllodistomum lohrenzi	4%	L	ureters
Proteocephalus fluviatilis	4%	M	intestine
**Posthodiplostomum minimum*	4%	M	mesenteries
**Eustrongylides tubifex*	4%	L	mesentery
**Diplostomum spathaceum*	4%	L	eyes
Myzobedella moorei	4%	L	fins
Acolpenteron ureteroecetes	3%	L	ureters
**Uvulifer ambloplitis*	3%	M	skin
Metechinorhynchus salmonis	3%	L	intestine
Clavunculus bursatus	3%	L	gills
Pomphorhynchus bulbocolli	3%	L	intestine
Saprolegnia sp.	3%	H	body surface
Achtheres micropteri	3%	L	gills
Azygia angusticauda	3%	L	intestine
Camallanus oxycephalus	3%	L	intestine
Crepidostomum cooperi	1%	M	intestine

Of the parasites found in smallmouth bass, **Proteocephalus ambloplitis*, *Leptorhynchoides thecatus* and the monogeneans are considered to be the most pathogenic.

Pomoxis nigromaculatus (Lesueur) - black crappie
Examined 4 : Prevalence 100%

Tetracleidus capax	100%	L	gills
**Diplostomum spathaceum*	75%	L	eyes
Tetracleidus longus	75%	L	gills
Neoechinorhynchus cylindratus	75%	L	intestine
**Posthodiplostomum minimum*	75%	M	liver
Spinitectus gracilis	50%	L	intestine

Perca flavescens (Mitchill)-yellow perch
Examined 134 : Prevalence 100%

Urocleidus adspectus	56%	L	gills
**Apophallus brevis*	49%	L	muscles
Crepidostomum cooperi	22%	L	intestine
Trichodina urinaria	11%	H	ureters
Ergasilus caeruleus	11%	L	gills
Ergasilus luciopercarum	11%	M	gills
**Crassiphiala bulboglossa*	11%	L	skin
Metechinorhynchus salmonis	11%	L	intestine

[9]Nomenclature according to Sullivan et al. (1978)

Bunoderina sacculata	*8%*	L	intestine
Henneguya doori	*8%*	M	gills
**Diplostomum spathaceum*	*8%*	L	eyes
Ichthyophthirius multifiliis	*4%*	M	skin, gills
Leptorhynchoides thecatus	*4%*	L	intestine
Azygia angusticauda	*4%*	L	intestine
Philometra cylindracea	*4%*	L	intestine
**Triaenophorus nodulosus*	*4%*	L	liver
*Glochidia	*4 %*	L - M	fins, gills
**Ligula intestinalis*	*4%*	L	body cavity
Cyathocephalus truncatus	*4%*	L	intestine
Phyllodistomum superbum	*2%*	L	ureters
**Raphidascaris acus*	*2 %*	L - M	liver, spleen (encysted)
Virus (Lymphocystis)	*2%*	L	Skin
**Eustrongylides tubifex*	*2%*	L	mesentery
Gyrodactylus freemani	*2%*	L	fins
Neoechinorhynchus pungitius	*2%*	L	intestine
Myzobdella moorei	*2%*	L	fins
**Clinostomum marginatum*	*2%*	M	muscles, mesenteries
Centrovarium lobotes	*2%*	L	intestine
Cucullanellus cotylophora	*2%*	L	intestine
Lamprey scars	1%	L	skin, muscle
Neoechinorhynchus rutili	1%	L	intestine

Stizostedion vitreum vitreum (Mitchill)-walleye
Examined 26 : Prevalence 100%

Urocleidus aculeatus[10]	88%	L	gills
Bothriocephalus cuspidatus	*58%*	M	intestine
Ergasilus luciopercarum	*58%*	L	gills
Virus (Lymphocystis)	19%	M	skin
Ergasilus caeruleus	19%	L	gills
Proteocephalus stizostethi	19%	L	intestine
Prosorhynchoides pusilla	19%	L	intestine
**Crassiphiala bulboglossa*	19%	L	skin
**Diplostomum spathaceum*	19%	L	eye
Sanguinicola occidentalis	19%	L	blood
Hysterothylacium brachyurum	19%	M	intestine

Etheostoma exile (Girard) - Iowa darter
Examined 5 : Prevalence 100%

Dactylogyrus sp.	*60%*	L	gills
Gyrodactylus sp.	*40%*	L	fins
Rhabdochona sp.	*40%*	L	intestine

Etheostoma nigrum Rafinesque - johnny darter
Examined 41 : Prevalence 100%

Bothriocephalus formosus	*56%*	L	intestine
Gyrodactylus etheostomae	51%	L	fins
Pomphorhynchus bulbocolli	*46%*	L	intestine

[10]Nomenclature according to Suriano and Beverley-Burton (198 1)

**Tetracotyle sp.*	24%	L	mesenteries
**Ligula intestinalis*	12%	L	body cavity
**Postodiplostomum minimum*	12%	M	mesenteries
Crepidostomum isostomum	10%	L	intestine
Gyrodactylus stunkardi	7%	L	fins
Leptorhynchoides thecatus	5%	L	intestine

Percina caprodes (Rafinesque) - logperch
Examined 6 : Prevalence 100%

Aethycteron malleus	83%	L	gills
Proteocephalus pearsei	50%	L	intestine
**Pomphorhynchus bulbocolli*	50%	L	intestine
Myxosoma scleroperca	33%	M	fins
Gyrodactylus sp.	33%	L	fins

Cottus *ricei* (Nelson)-spoonhead sculpin
Examined 21 : Prevalence 100%

Dactylogyrus buddi	71%	L	gills
**Diplostomum spathaceum*	48%	L	eye
Ergasilus sp.	43%	L	gills
**Tetracotyle sp.*	38%	L	mesentery
Proteocephalus pearsei	38%	L	intestine
Cyathocephalus truncatus	14%	L	intestine
Neoechinorhynchus rutili	14%	L	intestine
Ichthyophthirius multifiliis	14%	M	skin
*Glochidia	14%	L	fins
**Diplostomulum sp.*	10%	M	brain
Acanthocephalus jacksoni	10%	L	intestine

Cottus *bairdi* Girard - mottled sculpin
Examined 80 : Prevalence 94%

Dactylogyrus buddi	40%	L	gills
Neoechinorhynchus rutili	38%	L	intestine
Gyrodactylus bairdi	38%	L	fins
Metechinorhynchus salmonis	19%	L	intestine
**Tetracotyle sp.*	13%	L	mesenteries
**Schistocephalus solidus*	9%	L	body cavity
**Diplostomum spathaceum*	9%	L	eyes
Proteocephalus pearsei	9%	L	intestine
**Raphidascaris acus*	9%	L	spleen (encysted)
Pomphorhynchus bulbocolli	6%	M	intestine
Cyathocephalus truncatus	6%	L	intestine
Piscicola punctata	4%	L	fins
Phyllodistomum undulans	4%	L	ureters
Rhabdochona cotti	4%	L	intestine
Acanthocephalus jacksoni	4%	L	intestine

During this study 221 species of parasites were recorded for 57 fish species from Lake Huron. The following major taxa of parasites were represented: viruses and fungi-l species each; Protozoa-18; Trematoda-48; Monogenea-69; Cestoidea-26; Nematoda-21; Acanthocephala-17; Annelida (Hirudinea) 4; Arthropoda (Crustacea)-14; Mollusca-1 .

With the exception of mortality induced by sea lamprey parasitism, no mortalities attributed to parasite infections were observed during this study.

VIRUS

Lymphocystis, a virus-caused disease has occurred in yellow perch and walleye of Lake Huron and has been reported in a variety of freshwater and marine fishes (Nigrelli 1954; Hile 1954; Ryder 1961). The dermal warts of lymphocystis tumors are sometimes massive and infectious but not usually fatal.

Major die-offs of rainbow smelt in Lake Huron during the winter of 1942-1943 may have been caused by an infectious disease of viral or bacterial origin (Van Oosten 1947).

FUNGI

The most common fungi infesting fishes and their eggs after deposition are the "water molds", *Saprolegnia* sp. which are considered to be secondary pathogens (Hoffman 1969).

PROTOZOA

Ichthyophthirius multifiliis, Pleistophora cepedianae, Thelohanellus sp., and *Glugea anomala* may cause mortality in fish. *Ichthyophthirius multifiliis,* which was detected on 8 species of fish including yellow perch, can cause weight loss and mortalities among its hosts (Davis 1944; Elser 1955; Bauer et al. 1959; Allison and Kelly 1963). Hines and Spira (1974) reported that this parasite invades the skin causing severe hyperplasia and mucous cell depletion. *Glugea anomala* and *Pleistophora cepedianae* are reported to have caused mortalities when infections were intense (Bangham 1941; Putz et al. 1965). The myxosporidan parasites, *Thelohanellus* sp., *Myxobolus* sp. and *Henneguya exilis* were found on the gills, muscles, internal organs and the skin of over 11 species of fish. Dogiel et al. 1958, Reichenbach-Klinke and Elkan (1965), Reichenback-Klinke (1973) and McCraren et al. (1975) found that sporozoan parasites in gills and muscle tissue cause extensive damage to the host. Microsporidan invasion (Sindermann 1970) particularly by the genus *Glugea* causes hypertrophy of connective tissue cells and often *G. anomala* causes mass mortalities in ninespine sticklebacks. Heavy infection with *Trichodina* sp. causes severe hyperplasia on the gill lamellae and inflammation of the ureters which may result in death of the fish. This trichodinid parasite may cause disease of fish in hatcheries and in nature (Richardson 1938; Davis 1947; Hoffman and Lom 1967).

TREMATODA: DIGENEA

The adult trematodes and particularly metacercariae (larvae) affecting the muscles, brain, internal organs, eyes, and skin are dangerous to fish. Pathogenic forms detected in this study are: *Sanguinicola occidentalis* and **Diplostomum spathaceum* (infecting walleye), *Sanguinicola sp., Crepidostomum* spp., *Phyllodistomum* spp., **Tetracotyle* spp., **Clinostomum marginatum, *Apophallus brevis* (infecting perch) (Sinclair 1972), **Posthodiplostomum* spp., and **Centrovarium lobotes.* Mortalities of adult fish and particularly of the young, caused by trematodes (adult and larval stages) have been reported by several researchers (Meyer 1958; Wales 1958; Kozicka 1958; Bychovskaya-Pavloskaya and Petrushevski 1963).

MONOGENEA

Among the monogeneans, *Discocotyle sagittata* and species of the genera *Dactylogyrus* (14 spp.), *Gyrodactylus* (15 spp.), and 15 ancyrocephalid species are considered pathogens for adults and more particularly, for young fishes (Mizelle 1938; Tripathi 1959; Prost 1963; Lester and Adams 1974).

CESTOIDEA

Of the tapeworms recorded, nine species are considered pathogenic. Smith and Margolis (1970) reported that *Eubothrium salvelini* causes damage to young salmonid fishes. Boyce (1979) reported that *E. salvelini* had reduced the growth, survival, and swimming performance of sockeye salmon. *Cyathocephalus truncatus* causes serious damage to salmonid fishes and may cause mortality in nature (Vik 1954, 1958). A few worms caused severe inflammation and rupture of the gut wall, leading to the death of the host. This parasite occurred in nine fish species examined in this study.

The larval stage (plerocercoid) of *Triaenophorus nodulosus* occurs in cysts in the liver and mesenteries of splake, yellow perch, kokanee and others. This parasite can cause serious tissue damage (Lawler 1969) and Matthey (1963) reported a yellow perch mortality that was caused by this parasite. Plerocercoids of *Proteocephalus ambloplitis, Ligula intestinalis* and *Schistocephalus solidus,* which were found in several species of fish, may cause mass mortalities of cyprinid, catostomid and percid hosts. The plerocercoids invade the liver, mesenteries and gonads of smallmouth bass and other species resulting in heavy damage (Dechtiar 1972a, 1972b).

Miller (1945, 1952) reported that the occurrence of plerocercoids of *Triaenophorus crassus* in the muscles of coregonines can reduce their market value. This parasite was found in round whitefish, lake herring, bloater and lake whitefish. *Diphyllobothrium* sp. (larval stage) occurred in lake herring, bloater and lake whitefish. Duguid and Sheppard-(1944) reported an epizootic among trout in Wales, and Hoffman and Dunbar (1961) reported a mortality of *Salvelinus fontinalis* in the U.S.A. caused by *Diphyllobothrium* sp. Vik (1965)

considered that, in Norway, larvae of this parasite had caused a major decline of *Salmo trutta* and *Salvelinus alpinus.*

NEMATODA

Adults and larval stages of 20 species were encountered during this study. The most dangerous parasites *are: Hysterothylacium brachyurum, Raphidascaris* acus, and *Philometroides* sp., for which fish are the intermediate or final hosts. When fish are the intermediate host, larvae are found in the mesenteries, internal organs and muscles. Massive infection with larval stages of nematodes causes inflammation of the fish organs and a susceptibility to secondary infection by fungi, viruses or bacteria (Williams 1967).

ACANTHOCEPHALA

Sixteen species of acanthocephalans were recorded from Lake Huron fishes. Heavy infections of *Metechinorhynchus* (up to 500 parasites per fish) were detected in some splake and kokanee. Intense infections can reduce the nutrient uptake of the hosts (Petrushevski and Kogteva 1954).

ANNELIDA: HIRUDINEA

Four species of leeches were found on the body, fins and mouth cavity of fishes from Lake Huron. They may occasionally cause piscine mortality (Rupp and Meyer 1954) and can transmit blood protozoans, *e.g. Cryptobia* sp. (Mavor 1915; Becker and Katz 1965). Leeches extract their food by powerful suction from the host causing open wounds, scars, and inflammation of muscle tissue. These injuries would increase the opportunities for secondary invasions by viruses, bacteria and fungi.

MOLLUSCA: PELECYPODA

Only larval stages of the pelecypod molluscs (glochidia) are parasitic on fishes. Glochidia were found on 9 species of fishes. They are temporary parasites on the gills, fins, and surface of the body and when present in large numbers, can cause mechanical damage, interfere with respiration and provide access to viruses, bacteria and fungi (Davis 1961; Karna and Millemann 1978).

ARTHROPODA: CRUSTACEA

Several species of the crustacean parasites found are pathogenic and have caused fish mortalities (Schumacher 1952; Allum and Hugghins 1959). *Salmincola edwardsii* is particularly dangerous to brook trout where it may cause necrosis of the gill epithelium. Species of the genera *Argulus, Achtheres, Ergasilus* and *Lernaea* are not presently a serious problem for fishes in Lake Huron.

Sea lamprey *(Petromyzon marinus* Linnaeus) parasitism has had a profound effect on the fish communities of the Upper Great Lakes (Smith and Tibbles 1980). Berst and Spangler (1973) summed up the effect of lamprey by stating, "if any factor can be singled out as having played a leading role in the impairment of the Lake Huron fisheries, it must have been the sea lamprey".

DISCUSSION

The increase in parasites from a previously known 120 species is due to a number of factors including the expansion of parasitology as a frontier science. New parasite species have been described and of the 57 fish species examined, 16 were hosts which had not been necropsied by Bangham in 1951, and which represented 19 new parasite records. Further, there has been a substantial change in the fish community and thus of potential hosts, since the first major study (Bangham, 1955). There have been major changes in the abundance of deep-water coregonines, shallow-water cisco, lake whitefish and alewife (the latter was not present in 1951) and the introduction of other exotics such as Pacific salmon (kokanee, coho, chinook) as well as the hybrid trout (splake) (Berst and Spangler, 1973). In view of these changes and because samples used in this study were taken opportunistically, a direct quantitative comparison between the 1951 survey and the present one cannot be made.

Parasite fauna is determined by ecological conditions of the lake and the degree of host specificity of certain parasites. In particular the monogeneans have a narrow host specificity and are adapted to one or few related fish species (Dechtiar and Berst, 1978). Although Lake Huron is oligotrophic, there has been a slight overall trend toward eutrophication with a major change in Saginaw Bay (Beeton 1965) and to a lesser extent in other harbours and estuaries in the lake.

In this study more new parasites were recorded for warm-water fish species (average 8.4 per species) like yellow perch, walleye, northern pike than for colder water fish species (average 5.8) like lake whitefish, rainbow smelt, lake trout, suggesting indirectly that there may be a trend toward eutrophication in the warm-water habitats.

Warm-water fishes are known to harbour about 200 species of parasites. Of these, 30 may be regarded as characteristic of eutrophic waters e.g., *Tetraonchus monenteron, Pseudacolpenteron pavlovskii, Dactylogyrus extensus,* D. *anchoratus, D. dechtiari, Gyrodactylus medius, G. atratuli, *Posthodiplostomum minimum, *Clinostomum marginatum, *Diplostomum spathaceum, *Ligula intestinalis, *Triaenophorus nodulosus, *Eustrongylides tubifex, Philometroides nodulosa, Lernaea cyprinacea,* and *Ergasilus* sp. (Wisniewski 1958; Kozicka 1958; Chubb 1963).

If the species composition of the parasite fauna changes in response to eutrophication, one would expect a trend toward predominance of monogeneans, crustaceans, e.g., *Ergasilus* and *Argulus,* and digenetic trematodes which are

most characteristic of eutrophic habitats. This trend is confiied in the present study as the number of species of monogeneans and trematodes has increased almost fourfold since the early 1950's. It is interesting to note that Glugea hertwigi has not yet been detected in Lake Huron. This protozoan is specific to rainbow smelt and is the most abundant parasite in smelt of Lake Erie (Dechtiar 1972b; Nepszy and Dechtiar 1972) and to a lesser degree in Lake Ontario smelt (Chen and Power 1972).

The richest parasite fauna was found in yellow perch (30 species), smallmouth bass (28 species), white sucker (27 species) and rock bass (22 species). In the fish hosts of the families Acipenseridae, Salmonidae, Umbridae, Centrarchidae and Cottidae, the number of parasite species ranged from 5 to 21 per family.

The records of parasites in salmonids of Lake Huron, particularly *Metechinorhynchus salmonis, Cystidicola farionis* and *Cyathocephalus truncatus* which use the amphipods, *Pontoporeia affinis* and *Gammarus faciatus* as intermediate hosts (Smith and Lankester 1979) are evidence of oligotrophy (Bousfield 1958; Beeton 1965). The parasitological data also indicates indirectly that Lake Huron has populations of *Cyclops bicuspidatus* and *C. vernalis, Diaptomus* sp. and *Hexagenia limbata* which suggests that the lake environment is still suitable for the introduction of salmonids, the main thrust of the fisheries rehabilitation program.

ACKNOWLEDGMENTS

We extend our grateful thanks to Dr. G.R. Spangler and the staff at the Lake Huron Fisheries Research Station for their enthusiastic support in the collection of fish specimens. K.H. Loftus provided encouragement to undertake the study and A.H. Lawrie supported its continuation and critically reviewed the manuscript. Dr. D.K. Cone, St. Mary's University, Halifax, N.S. provided a valuable review. We sincerely thank Dr. Mary Beverley-Burton, University of Guelph, Guelph, Ontario and Dr. John D. Smith, Ontario Ministry of Health, Ottawa, Ontario for their exhaustive and extremely helpful reviews.

Survey of the Parasite Fauna of Selected Fish Species From Lake Erie, 1970-1975 [1]

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ABSTRACT

This study was initiated to determine the prevalence and intensity of infections by parasites in commercially important and associated fish species of Lake Erie. Emphasis is placed on parasitism as one of the important factors of the lake ecosystem and particularly its relationship with fish communities which cannot be ignored in future fisheries management. During the six year study period (1970-1975), 1522 fish representing 10 species (2 commercial and 8 associated species) were examined with 126 species of parasites recorded. Every species of fish contained parasites and 97% of all fish examined carried at least one species of parasite. No parasites considered dangerous to man were found. Forty-nine pathogenic parasites reported elsewhere as contributors to fish mortalities were encountered. Twenty-five of these pathogenic parasites were considered to be of potential economic importance. Comparisons to previous studies on the same fish species in Lake Erie are made.

INTRODUCTION

Three extensive studies of the parasite fauna of Lake Erie fishes have been conducted. The first covered the 1927-29 period in which 2156 fish representing

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[2]Deceased

79 species were examined and 112 species of parasites were recorded (Bangham and Hunter 1939). Bangham (1972) subsequently examined 1687 fish belonging to 66 species from western Lake Erie. Dechtiar (1972b) examined 1112 fish representing 46 species and recorded 96 species of parasites, including several new species. Several studies of particular species of parasites of Lake Erie fish have also been conducted (Ward 1920; Hunter and Hunter 1929; Herrick 1936, 1941; Davis 1944; Stromberg and Crites 1974a, 1974b, 1975).

The present study was initiated to further examine the prevalence and intensity of infection of selected fish species and to consider parasitism as a relevant factor in future fisheries management.

The relative abundance (as defined by Margolis et al 1982) of parasites is undoubtedly related to certain aspects of the aquatic environment as well as to host specific factors. Changes in the aquatic environment and the fish fauna (Carr and Hiltunen 1965; Beeton, 1969; Hartman 1973, Smith 1972, Leach and Nepszy 1976) have resulted in major and relatively rapid changes in the parasite fauna and these changes are examined here.

MATERIALS AND METHODS

Fishes were obtained mainly from commercial catches in the eastern basin and in the western area of Lake Erie. Additional specimens came from commercial catch samples from the central basin. Some samples also came from experimental gillnets and trawls fished by staff of the Fisheries Research Station, OMNR, Wheatley, Ontario.

Commercially important fish like rainbow smelt and yellow perch were obtained monthly when available on a year round basis. Standard procedures for examination of external and internal parasites were followed (Dechtiar 1972b). For closer examination and/or description, specimens were stained with Gomori's trichrome, routinely dehydrated, cleared in beechwood creosote and mounted in Picolyte. Histological sections were made for special identification problems. The usual sample size per species was fifteen fish and increased to forty-five or more for special parasitological problems. The parasites from this study are temporarily housed under the care of Dr. M. Beverley-Burton, College of Biological Sciences, University of Guelph, Guelph, Ontario pending their final destination at the National Museum of Natural Sciences, Ottawa, Ontario.

RESULTS

Findings are arranged in a host-parasite checklist and summarized in Tables 1, 2 and 3. The host fish species are arranged in order according to Robins et al (1980). For each host species, the number of fish examined, the prevalence (%) of infection, and the site and intensity of infection are given. Intensity of infection is indicated as: L (light, l-9 parasites/host); M (medium, 10–49 parasites/host); H (heavy, $\geqslant$50 parasites/host). Parasites are listed in decreasing

TABLE I. prevalence (%) and intensity of infection (number of species) of parasites of selected fish species in Lake Erie from 1927-29 to 1970-75.

Fish Species	1927-29[a] No. fish	Prevalence	SPP.	1957[b] No. fish	prevalence	SPP.	1961-69[c] No. fish	prevalence	SPP.	1970-75[d] No. fish	Prevalence	SPP
Rainbow smelt	0	0	0	61	71%	7	114	70%	5	327	97%	7
Northern Pike	8	88%	2	0	0	0	7	100%	9	24	100%	10
Quillback	16	50%	2	8	100%	8	81	86%	20	113	97%	30
White sucker	8	100%	7	15	100%	8	39	100%	16	115	94%	29
Channel cattish	36	86%	16	39	100%	22	3.5	100%	22	71	97%	22
White bass	34	88%	12	53	100%	17	63	95%	17	133	99%	19
Smallmouth bass	121	88%	29	51	100%	23	10	100%	32	96	97%	28
Yellow perch	128	77%	20	93	97%	24	150	100%	32	408	96%	29
Walleye	73	93%	19	33	100%	15	27	100%	23	75	97%	22
Freshwater drum	48	92%	19	88	100%	23	79	100%	25	160	97%	20

[a]From Bangham and Hunter (1930)
[b]From Bangham (1972)
[c]From Dechtiar (1972b)
[d]Present study

TABLE 2. Total number of parasite species by major taxa and fish species from Lake Erie from 1927-29 to 1970-75.

PARASITE GROUP	YEAR	Rainbow smelt	Northern pike	Quillback	White sucker	Channel catfish	White bass	Smallmouth bass	Yellow perch	Walleye	Freshwater drum	Total parasite species by taxon and year
		FISH SPECIES										
PROTOZOA	1927-29					1		2			1	3
	1957	1		1	1	2	1	2	1			2
	1961-69	1	1	2	1	2	3	2	5		1	11
	1970-75	1		2	1	2	3	1	5		1	11
DIGENEA	1927-29					5	3	9	8	5	5	26
	1957	4		3	3	7	6	8	7	5	7	30
	1961-69	2	3	3	2	6	3	9	11	6	8	37
	1970-75	2	3	6	7	6	5	8	7	7	5	30
MONOGENEA	1927-29					1	1	1			2	3
	1957			1		1	1	1	1	1	2	4
	1961-69		1	5	5	3	2	4	2	1	4	22
	1970-75		1	10	5	3	1	3	1	1	4	27
CESTODA	1927-29		1	1	3	2	3	5	5	4	3	14
	1957			1		3	3	4	4	5	3	11
	1961-69	1	2	2	3	3	4	5	4	4	3	17
	1970-75	1	2	3	4	4	3	3	3	3	3	17
NEMATODA	1927-29			1	1	3	4	4	4	4	5	8
	1957	1			1	4	3	2	4	1	6	10
	1961-69			3	1	3	4	4	5	4	6	11
	1970-75		1	4	3	1	4	6	6	2	3	14
ACANTHO-	1927-29		1		3	2		2	1	2	1	7
CEPHALA	1957	1		1	1	1		2	2		1	5
	1961-69	1	2	3	4	2		2	3	3	2	12
	1970-75	3	3	2	5	1	1	3	2	3	2	11
CRUSTACEA	1927-29					2		4		2		7
	1957				2	2	2	3	2	1	2	8
	1961-69			1	4	2		4		2		7
	1970-75			2	2	3	1	2	2	2		10
MOLLUSCA	1927-29						1				1	1
	1957					1	1	1	1	1	1	1
	1961-69			1			1				1	1
	1970-75			1	1	1	1	1	1	1	1	1
OTHER	1927-29							2	2	2	1	3
	1957			1		1			2	1	1	3
	1961-69					1		2	2	3	1	5
	1970-75				1	1		1	2	3	1	5
Total Parasite species by fish species and year	1927-29		2	2	7	16	12	29	20	19	19	
	1957	7		8	8	22	17	23	24	15	23	
	1961-69	5	9	20	16	20	16	26	29	21	24	
	1970-75	7	10	30	29	22	19	28	29	22	20	

order of prevalence and taxonomy is according to Margolis and Arthur (1979) and Beverly-Burton (1984) except where noted. An asterisk before a parasite name indicates its presence in a larval or immature stage.

TABLE 3. Checklist of parasites of Lake Erie fishes, 1970-75.

VIRUS
Pox virus (Lymphocystis disease)
FUNGUS
Saprolegnia sp.
PROTOZOA
Glugea hertwigi Weissenberg, 1911
Henneguya doori Guilford, 1963
Henneguya exilis Kudo, 1929
Ichthyophthirius multifiliis Fouquet, 1876
Myxobolus inornatus Fish, 1939
Myxosoma bibullatum Kudo, 1934
Myxosoma rotundum Meglitsch, 1937
Myxosoma scleroperca Guilford, 1963
Trichodina urinaria Dogiel, 1940
Trichodina sp.
Trichophrya piscium Butschli, 1889
TREMATODA : DIGENEA
Acetodextra amiuri (Stafford, 1900) Pearse, 1924
Allacanthochasmus artus Mueller and Van Cleave, 1932
Allacanthochasmus varius Van Cleave, 1922
Alloglossidium corti (Lamont, 1921) Van Cleave and Mueller, 1934
Anallocreadium pearsei Hunter and Bangham, 1932
Apophallus brevis Ransom, 1920
Azygia angusticauda (Stafford, 1904) Manter, 1926
**Bucephalus* sp.
Bucephalus sp.
Bunodera sacculata (Van Cleave and Mueller, 1932)
Centrovarium lobotes (MacCallum, 1895) Stafford, 1904
**Clinostomum marginatum* (Rudolphi, 1819) Braun, 1899
**Crassiphiala bulboglossa* Haitsma, 1925
Crepidostomum cooperi Hopkins, 1931
Crepidostomum cornutum (Osborn, 1903) Stafford, 1904
Cryptogonimus chyli Osborn, 1903
**Diplostomum spathaceum* (Rudolphi, 1819) Olsson, 1876
Leuceruthrus micropteri Marshall and Gilbert, 1905
Lissorchis attenuatum (Mueller and Van Cleave, 1932) Krygier and Macy, *1969*
Megalogonia ictaluri Surber, 1928
Neochasmus umbellus Van Cleave and Mueller, 1932
Phyllodistomum fausti Pearse, 1924
Phyllodistomum lacustri (Loewen, 1929) Lewis, 1935
Phyllodistomum lysteri Miller, 1940
**Posthodiplostomum minimum* (MacCallum, 1921) Dubois, 1936
Sanguinicola occidentalis Van Cleave and Mueller, 1932
**Sanguinicola* sp.
Sanguinicola sp.
**Tetracotyle diminuta* Hughes, 1928
**Tetracotyle intermedia* Hughes, 1928
**Tetracotyle* sp.
**Uvulifer ambloplitis* (Hughes, 1927) Dubois, 1938
TREMATODA : ASPIDOCOTYLEA
Cotylogaster occidentalis Nickerson, 1902
MONOGENEA
Acolpenteron catostomi Fischthal and Allison, 1942

continued

Anonchohaptor anomalus Mueller, 1938
Anonchohaptor muelleri Kritsky, Leiby and Shelton, 1972
Gyrodactylus macrochiri Hoffman and Putz, 1964
Gyrodactylus spathulatus Mueller, 1936
Gyrodactylus sp.
Icelanonchohaptor fyviei Dechtiar and Dillon, 1974
Icelanonchohaptor microcotyle Kritsky, Leiby and Shelton, 1972
Ligictaluridus floridanus (Mueller, 1936) Beverley-Burton, 1984
Ligictaluridus pricei (Mueller, 1936) Beverley-Burton, 1984
Lintaxine cokeri (Linton, 1940) Sproston, 1946
Microcotyle eriensis Bangham and Hunter, 1936
Microcotyle spinicirrus MacCallum, 1918
Neodiscocotyle carpioditis Dechtiar, 1967
Octomacrum lanceatum Mueller, 1934
Onchocleidus chrysops (Mizelle and Klucka, 1953) Beverley-Burton, 1984
Pellucidhaptor angularis Kritsky and Hathaway, 1969
Pellucidhaptor eremitus Rogers, 1967
Pellucidhaptor microcanthus Kritsky, Leiby and Shelton, 1972
Pseudomurraytrema copulatum (Mueller, 1938) Bychowsky, 1957
Syncleithrium fusiformis (Mueller, 1934) Price, 1967
Tetracleidus banghami Mueller, 1936
Tetraonchus monenteron (Wagener, 1857) Diesing, 1858
Urocleidus aculeatus (Van Cleave and Mueller, 1932) Mueller, 1934
Urocleidus adspectus Mueller, 1936

CESTOIDEA
Biacetabulum sp
**Bothriocephalus cuspidatus* Cooper, 1917
**Bothriocephalus* sp.
Bothriocephalus claviceps (Goeze, 1782) Rudolphi, 1810
Bothriocephalus cuspidatus Cooper, 1917
Corallobothrium fimbriatum Essex, 1927
Corallobothrium giganteum Essex, 1927
Glaridacris catostomi Cooper, 1920
**Ligula intestinalis* (Linnaeus, 1759) Gmelin, 1790
**Proteocephalus ambloplitis* (Leidy, 1887) Benedict, 1900
Proteocephalus ambloplitis (Leidy, 1887) Benedict, 1900
Proteocephalus fluviatilis Bangham, 1925
**Proteocephalus pearsei* LaRue, 1919
Proteocephalus pearsei LaRue, 1919
Proteocephalus pinguis LaRue, 1911
Proteocephalus stizostethi Hunter and Bangham, 1933
**Proteocephalus* sp.
Spartoides wardi Hunter, 1929
**Triaenophorus nodulosus* (Pallas, 1760) Rudolphi, 1819
Triaenophorus nodulosus (Pallas, 1760) Rudolphi, 1819
Triaenophorus stizostedionis Miller, 1945

NEMATODA
Camallanus ancylodirus Ward and Magath, 1916
Camallanus oxycephalus Ward and Magath, 1917
Cucullanellus cotylophora (Ward and Magath, 1916) Petter, 1974
**Eustrongylides tubifex* (Nitzsch, 1819) Jagerskiold, 1909
**Hysterothylacium brachyurum* Ward and Magath, 1917
Hysterothylacium brachyurum Ward and Magath, 1917
Philometra cylindracea (Ward and Magath, 1917) Van Cleave and Mueller, 1934
Philometra nodulosa Thomas. 1929

Philometra sp.
**Raphidascaris canadensis* Smedley, 1933
Rhabdochona milleri Choquette, 1951
Rhabdochona ovifilamenta Weller, 1938
Spinitectus carolini Holl, 1928
Spinitectus gracilis Ward and Magath, 1917
**Spiroxys sp.*

ACANTHOCEPHALA
**Acanthocephalus jacksoni* Bullock, 1962
Acanthocephalus jacksoni Bullock, 1962
Leptorhynchoides thecatus (Linton, 1891) Kostylew, 1924
Metechinorhynchus salmonis (Muller, 1784) Petrochenko, 1954
Neoechinorhynchus carpiodi Dechtiar, 1968
Neoechinorhynchus crassus Van Cleave, 1919
Neoechinorhynchus cristatus Lynch, 1936
Neoechinorhynchus cylindratus (Van Cleave, 1913) Van Cleave, 1919
Neoechinorhynchus rutili (Muller, 1780) Hamann, 1892
Neoechinorhynchus tenellus (Van Cleave, 1913) Van Cleave, 1919
Octospinifer macilentus Van Cleave, 1919
**Pomphorhynchus bulbocolli* Linkins in Van Cleave, 1919
Pomphorhynchus bulbocolli Linkins in Van Cleave, 1919

HIRUDINEA
Macrobdella decora (Say, 1824) Verrill, 1872
Myzobdella moorei (Meyer, 1940) Meyer and Moore, 1954
Myzobdella sp.

MOLLUSCA
*Glochidia

ARTHROPODA
Achtheres ambloplitis Kellicott, 1880
Achtheres micropteri Wright, 1882
Achtheres pimelodi Krøyer, 1863
Argulus biramosus Bere, 1931
Argulus catostomi Dana and Herrick, 1837
Ergasilus caeruleus Wilson, 1911
Ergasilus centrarchidarum Wright, 1882
Ergasilus luciopercarum Henderson, 1926
Ergasilus versicolor Wilson, 1911
Ergasilus sp.

Osmerus mordax (Mitchill)-rainbow smelt
Examined 327 : Prevalence 97%

Glugea hertwigi	55%	H	intestinal wall, gonads, fins, muscles
Metechinorhynchus salmonis[1]	29%	M	intestine
Acanthocephalus jacksoni	27%	M	intestine
**Diplostomum spathaceum*	21%	L	eye
**Tetracotyle intermedia*	8%	M	heart, kidneys
Neoechinorhynchus rutili	5%	L	intestine
**Proteocephalus sp.*	3%	L	intestine

1 Nomenclature according to Amin (1985)

The microsporidan parasite, *Glugea hertwigi,* has been the most abundant parasite in Lake Erie rainbow smelt, with high prevalence and intensity of infection in all age groups including young-of-the-year.

Chen and Power (1972) in their study of rainbow smelt in Lake Ontario and Lake Erie did not observe any mortality as a consequence of infection by G. *hertwigi.* However, we observed and investigated mass mortalities of young-of-the-year smelt in Lake Erie in 1969 (Nepszy et al. 1978) and severe mortalities of adult rainbow smelt in 1971 (Nepszy and Dechtiar 1972) as well as a similar mortality of adult smelt in Lake Ontario in 1967 (A.O. Dechtiar unpublished data). We believe that the major contributing factor to these mortalities was the high prevalence of G. *hertwigi.*

Since the first record of G. *hertwigi* cysts in rainbow smelt in 1960 (Dechtiar 1965), prevalence increased steadily until 1971. From 1964 to 1971 prevalence in eastern basin smelt increased from 4.6 to 87.0%, while in central basin smelt prevalence rose from 11.7 to 87.2% (Nepszy and Dechtiar 1972). Although the prevalence observed in 1972 was similar to that in 1971, it began to decline in 1973 and continued to 58 and 63.8% in 1975 and further to 6.5% and 10% prevalence in 1982 in eastern and central basin smelt respectively (S.J. Nepszy unpublished data). Observations indicated that infection was seasonal, usually with a peak of infection occurring in the fall but fluctuations did occur monthly (S . J. Nepszy unpublished data).

Four other parasites, *Metechinorhynchus salmonis, Acanthocephalus jacksoni, *Diplostomum spathaceum* and **Tetracotyle intermedia* are pathogenic to rainbow smelt. *Metechinorhynchus salmonis* and **D. spathaceum are* known to contribute to mortality of rainbow smelt elsewhere (Meyer 1958, Wales 1958; Bychovskaya-Pavlovskaya and Petrushevski 1963; Nmann 1972). The amphipod, *Pontoporeia affinis,* is known to be the intermediate host of *M. salmonis* (Brownell 1970) and since rainbow smelt feed largely on amphipods (Ferguson 1965), the high prevalence of this parasite in smelt is understandable.

Esox lucius Linnaeus-northern pike
Examined 24 : Prevalence 100%

Tetraonchus monenteron	58%	L	gills
Proteocephalus pinguis	54%	M	intestine
Triaenophorus nodulosus	50%	M	intestine
Neoechinorhynchus tenellus	33%	M	intestine
**Acanthocephalus jacksoni*	21%	L	intestine
Hysterothylacium brachyurum[z]	21%	M	intestine
Centrovarium lobotes	21%	M	intestine
Metechinorhynchus salmonis	17%	L	intestine
**Uvulifer ambloplitis*	13%	M	skin
Azygia angusticauda	8%	L	intestine, stomach

[2]Nomenclature according to Deardorff and Overstreet (1980)

Carpiodes cyprinus (Lesueur) - quillback
Examined 113 : Prevalence 97%

Spartoides wardi	4 5 %	M	intestine
Neodiscocotyle carpioditis	3 8 %	M	intestine
Myxosoma rotundum	3 5 %	M	gills
Icelanonchohaptor fyviei	21%	L	skin, fins
Camallanus ancylodirus	21%	L	intestine
Camallanus oxycephalus	2 1 %	M	intestine
Biacetabulum sp.	21%	L	intestine
Sanguinicola sp.	10%	L	blood
**Triaenophorus nodulosus*	10%	L	liver
Anonchohaptor anomalus	9%	L	gills
Pellucidhaptor angularis	8%	L	fins, skin
Philometra nodulosa	7%	L	fins
Lissorchis attenuatum	7%	L	intestine
Pomphorhynchus bulbocolli	7%	L	intestine
Neoechinorhynchus carpiodi	6%	M	intestine
**Posthodiplostomum minimum*	6%	M	mesentery
Trichodina sp.	6%	H	g i l l s
Acolpenteron catostomi	5%	L	ureters
Ergasilus caeruleus	5%	L	gills
Pellucidhaptor eremitus	4%	L	fins
**Diplostomum spathaceum*	4%	L	eye
Anonchohaptor muelleri	4%	L	fins
Icelanonchohaptor microcotyle	4%	L	skin, fins
Pellucidhaptor microcanthus	4%	L	fins
Argulus catostomi	4%	L	skin
Rhabdochona milleri	4%	L	intestine
**Tetracotyle* sp.	4%	L	heart
*Glochidia	4%	L	gills
Phyllodistomum lysteri	3%	L	ureters
Gyrodactylus sp.	3%	L	tins

Catostomus commersoni (La&p&de)-white sucker
Examined 115 : Prevalence 94%

Glaridacris catostomi	4 8 %	M	intestine
Myxosoma bibullatum	4 4 %	M	gills
Octospinifer macilentus	4 3 %	L	intestine
Gyrodactylus spathulatus	27%	L	fins
Biacetabulum sp.	23%	L	intestine
Pseudomurraytrema copulatum	20%	L	gills
Octomacrum lanceatum	20%	L	gills
Lissorchis attenuatum	15%	L	gills
Ergasilus caeruleus	13%	L	gills
Pomphorhynchus bulbocolli	13%	L	intestine
Neoechinorhynchus crassus	13%	L	intestine
**Diplostomum spathaceum*	10%	L	eye
Anonchohaptor anomalus	10%	L	fins, skin, nasal cavity
Acolpenteron catostomi	10%	L	ureters
Acanthocephalus jacksoni	9%	L	intestine
**Ligula intestinalis*	9%	L	body cavity

**Triaenophorus nodulosus*	7%	L	liver
**Sanguinicola* sp.	7%	L	blood
*Glochidia	7%	L	gills, fins
Phyllodistomum lysteri	7%	L	ureters
Philometra nodulosa	7%	L	fins
Argulus catostomi	6%	L	skin
**Tetracotyle* sp.	6%	L	heart
**Eustrongylides tubifex3*	6%	L	mesentery
Bucephalus sp.	4%	L	gills
Neoechinorhynchus cristatus	3%	L	intestine
**Posthodiplostomum minimum*	3%	L	mesentery
Rhabdochona ovifilamenta	3%	L	intestine
Myzobdella sp.	3%	L	skin

Of the parasites encountered in this fish species the following are considered pathogenic: *Glaridacris catostomi, Octomacrum lanceatum, Pseudomurraytrema copulatum, *Diplostomum spathaceum, Gyrodactylus spathulatus, Argulus catostomi, *Triaenophorus nodulosus, Pomphorhynchus bulbocolli, Acanthocephalus jacksoni, *Ligula intestinalis, *Eustrongylides tubifex.*

Ictalurus punctatus (Rafinesque)----channel catfish
Examined 71 : Prevalence 97%

Ligictaluridus floridanus	54%	M	gills
Ergasilus versicolor	51%	L	gills
Megalogonia ictaluri	45%	M	intestine
Alloglossidium corti	45%	L	ureters
Phyllodistomum lacustris	44%	L	ureters
Corallobothrium fimbriatum	41%	L	intestine
Corallobothrium giganteum	30%	L	intestine
Ichthyophthirius multifiliis	30%	M	fins, skin
Acetodextra amiuri	21%	L	air bladder
**Diplostomum spathaceum*	17%	L	eye
Ligictaluridus pricei	14%	L	gills
Henneguya exilis	13%	M	gills
*Glochidia	11%	M	gills
Myzobdella moorei	10%	M	fins, skin
**Pomphorhynchus bulbocolli*	10%	L	intestine
Achtheres pimelodi	8%	L	gills
**Eustrongylides tubifex*	8%	L	mesentery
**Clinostomum marginatum*	8%	L	muscle
Argulus biramosus	7%	L	fins
**Proteocephalus ambloplitis*	7%	L	liver
Gyrodactylus sp.	7%	L	fins
**Bothriocephalus* sp.	6%	L	intestine

The following parasites are considered to be pathogens of potential economic importance: *Ligictaluridus floridanus, Ergasilus versicolor, Phyllodistomum lacustris, Corallobothrium giganteum, C. fimbriatum, Ichthyophthi-*

[3]Nomenclature according to Sprinkle Fastzkie and Crites (1977)

*rius multifiliis, Acetodextra amiuri, *Diplostomum spathaceum,* and *Henneguya exilis.*

Morone chrysops (Rafinesque) - white bass
Examined 133 : Prevalence 99%

Onchocleidus chrysops	64%	M	gills
**Triaenophorus nodulosus*	53%	L	liver, *mesentery*
Allacanthochasmus varius	50%	M	intestine
Allacanthochasmus artus	47%	M	intestine
Camallanus oxvcephalus	47%	M	intestine
Neochasmus umbellus	24%	L	intestine
**Diplostomum spathaceum*	13%	L	eye
**Raphidascaris canadensis*	11%	M	liver
Trichophrya piscium	9%	H	gills
**Proteocephalus pearsei*	8%	M	intestine
**Bothriocephalus cuspidatus*	8%	M	intestine
Ichthyophthirius multifiliis	8%	H	fins, gills
Ergasilus sp.	8%	L	gills
*Glochidia	8%	L	gills
Acanthocephalus jacksoni	7%	L	intestines
Trichodina sp.	5%	H	gills
**Spiroxys* sp.	4%	M	mesentery
Leuceruthrus micropteri	4%	L	intestine
**Eustrongylides tubifex*	4%	L	mesentery

Of the parasites listed for white bass, the following are considered to be pathogens and of potential economic importance: *Ichthyophthirius multifiliis, Trichophrya piscium, *Diplostomum spathaceum* and "*Triaenophorus nodulosus.* The first two were encountered as heavy infections. *Triaenophorus nodulosus* is a potentially serious pathogen (Stromberg and Crites, 1974a) and its plerocercoids cause triaenophoriasis which may contribute to fish mortality.

Micropterus dolomieui (LacCpbde) - smallmouth bass
Examined 96 : Prevalence 97%

Tetracleidus banghami	45%	M	gills
Leptorhynchoides thecatus	44%	M	intestine
Neoechinorhynchus cylindratus	36%	M	intestine
**Diplostomum spathaceum*	32%	L	eye
Crepidostomum cornutum	32%	L	intestine
Ergasilus centrarchidarum	31%	L	gills
Cucullanellus cotylophora	28%	L	intestine
Cryptogonimus chyli	23%	M	intestine
Syncleithrium fusiformis	19%	M	gills
**Posthodiplostomum minimum*	19%	M	liver
**Proteocephalus ambloplitis*	18%	L	liver
Azygia angusticauda	14%	L	intestine
*Spiroxys sp.	13%	L	mesentery
Hysterothylacium brachyurum	13%	M	intestine

*Uvulifer ambloplitis	10%	M	skin, fins
Proteocephalus ambloplitis	10%	L	intestine
*Glochidia	10%	L	fins, gills
Camallanus oxycephalus	10%	L	intestine
Spinitectus carolini	8%	L	intestine
Achtheres micropteri	8%	L	gills
Leuceruthrus micropteri	7%	L	intestine
**Pomphorhynchus bulbocolli*	5%	L	intestine
**Eustrongylides tubifex*	5%	L	mesentery
Myxobolus inornatus	5%	H	muscle
Proteocephalus fluviatilis	5%	L	intestine
Myzobdella moorei	5%	L	fins
**Bucephalus* sp.	4%	L	gills
**Triaenophorus nodulosus*	4%	L	liver
Gyrodacytlus macrochiri	3%	M	fins

The following parasites are considered to be pathogens to smallmouth bass: *Tetracleidus banghami, Syncleithrium fusiformis, Leptorhynchoides thecatus, "Triaenophorus nodulosus, *Proteocephalus ambloplitis, *Diplostomum spathaceum, *Posthodiplostomum minimum, Hysterothylacium brachyurum* and *Ergasilus centrarchidarum.* About half were encountered as medium infections, the remainder as light.

Perca *flavescens* (Mitchill) - yellow perch
Examined 408 : Prevalence 96%

Urocleidus adspectus	56%	M	gills
**Eustrongylides tubifex*	50%	L	mesentery
**Tetracotyle diminuta*	36%	L	kidney
Apophallus brevis	32%	M	muscle
Ergasilus luciopercarum	22%	L	gills
**Diplostomum spathaceum*	20%	L	eyes
Crepidostomum cooperi	15%	L	intestine
Philometra cylindracea	10%	L	body cavity
Bunodera sacculata	10%	L	intestine
Myxosoma scleroperca	10%	L	eye
Proteocephalus pearsei	9%	L	intestine
**Raphidascaris canadensis*	8%	M	liver
Henneguya doori	8%	M	gills
Trichodina urinaria **4**	7%	H	ureters
Camallanus oxycephalus	7%	L	intestine
Trichodina sp.	7%	M	gills
Ichthyophthirius multifiliis	7%	H	gills, fins
Cucullanellus cotylophora	6%	L	intestine
*Glochidia	6%	L	gills, fins
**Triaenophorus nodulosus*	5%	L	liver
**Proteocephalus ambloplitis*	5%	L	liver
Sanguinicola occidentalis	4%	L	blood
**Hysterothylacium brachyurum*	4%	M	liver

[4]Identification confirmed by Dr. J. Lom (Institute of Parasitology, Czechoslovak Academy of Sciences, Prague, Czechoslovakia)

**Crassiphiala bulboglossa*	*4%*	M	skin
Leptorhynchoides thecatus	*3%*	L	intestine
Achtheres ambloplitis	*2%*	L	gills
Saprolegnia sp.	*2%*	H	skin, fins
Neochinorhynchus rutili	*2%*	L	intestine
Virus (Lymphocystis)	1%	M	fins

Of the parasites listed for yellow perch the following are considered pathogens and of potential economic importance: *Ichthyophthirius multifiliis, Trichodina* spp., *Myxosoma scleroperca, *Tetracotyle diminuta, Apophallus brevis, Sanguinicola occidentalis, *Diplostomum spathaceum,* *Triaenophorus *nodulosus, Proteocephalus ambloplitis, Raphidascaris canadensis, *Hysterothylacium brachyurum, *Eustrongylides tubifex, Philometra cylindracea.* About half were present only as light infections, the remainder medium to heavy.

A large mortality of yearling yellow perch in June 1963 was attributed mainly to the parasites, *Ichthyophthirius multifiliis* and *Trichodina* spp. (Dechtiar 1972b). Such a mass mortality had not been reported previously for Lake Erie. Further mortalities are possible if degradation of the lake through enrichment continues. Nümann (1972) reported that the causative agent in a mass mortality of the European perch, *Perca fluviatilis,* in the Bodensee was **Diplostomum spathaceum (D. volvens).* Such large mortalities were not known before eutrophication in the Bodensee.

Apophallus brevis was not recorded for yellow perch during 1927-57 (Bangham and Hunter 1939, Bangham 1972) but in the early 1960s prevalence was 10% (Dechtiar 1972b) and now has increased to 31%. The first intermediate host for this digenean is the mollusc, *Amnicola limosa* (Sinclair 1972) while the second is yellow perch, with herring gulls as the final host.

Stizostedion vitreum vitreum (Mitchill)-walleye
Examined 75 : Prevalence 97%

Urocleidus aculeatus	*57%*	M	gills
Bothriocephalus cuspidatus	*53%*	M	intestine
Ergasilus luciopercarum	*53%*	M	gills
**Tetracotyle* sp.	*40%*	M	mesentery, kidney
Neoechinorhynchus tenellus	*33%*	M	intestine
Myzobdella moorei	*20%*	L	skin
**Diplostomum spathaceum*	*20%*	L	eye
Centrovarium lobotes	*20%*	L	intestine
Proteocephalus stizostethi	*20%*	L	intestine
Ergasilus caeruleus	*20%*	L	gills
Neoechinorhynchus cylindratus	*20%*	M	intestine
Spinitectus gracilis	*20%*	L	intestine
Camallanus oxycephalus	16%	L	intestine
*Glochidia	16%	L	fins, gills
Leptorhynchoides thecatus	16%	L	intestine
Sanguinicola occidentalis	13%	L	blood
**Bucephalus sp.*	11%	M	gills
Azygia angusticauda	11%	L	intestine

**Crassiphiala bulboglossa*	11%	L	skin
Triaenophorus stizostedionis	11%	L	intestine
Saprolegnia sp.	1%	H	fins
Virus (Lymphocystis)	7%	H	fins

Those parasites considered pathogenic and of potential economic importance are: *Sanguinicola occidentalis, Myzobdella moorei, *Tetracotyle* sp., **Diplostomum spathaceum, Ergasilus luciopercarum* and glochidia. Most were encountered as light infections.

Aplodinotus grunniens (Rafinesque) - freshwater drum
Examined 160 : Prevalence 97%

Microcotyle spinicirrus	53%	M	gills
Anallocreadium pearsei	19%	M	intestine
Camallanus oxycephalus	14%	L	intestine
Sanguinicola sp.	11%	M	blood
lchthyophthirius multifiliis	11%	H	fins, gills
**Diplostomum spathaceum*	10%	L	eye
*Glochidia	10%	M	fins, gills
**Pomphorhynchus bulbocolli*	10%	L	intestine
Lintaxine cokeri	9%	L	gills
**Bothriocephalus* sp.	9%	L	intestine
**Tetracotyle* sp.	9%	M	mesentery
Philometra sp.	6%	L	eye
Microcotyle eriensis	6%	L	gills
**Eustrongylides tubifex*	6%	L	mesentery
**Proteocephalus pearsei*	6%	L	intestine
Leptorhynchoides thecatus	5%	L	intestine
Phyllodistomum fausti	4%	L	ureters
Cotylogaster occidentalis	3%	L	intestine
Bothriocephalus claviceps	3%	L	intestine
Macrobdella decora	3%	L	operculum

The freshwater drum is one of the most abundant species in Lake Erie at the present time. Changes in environmental conditions appear to have favoured a vigorous increase in population (Hartman 1973, Leach and Nepszy 1976). Increasing prevalence of parasites in this species coincided with increases in the population in the 1960s. A mortality of yearling freshwater drum in 1963 is believed to have been due primarily to the prevalence and intensity of infections of *Ichthyophthirius multifiliis* and *Trichodina* sp. (A.O. Dechtiar unpublished data). The former was encountered at a heavy infection rate in this study while the latter was not found. Other parasites such as Microcotyle *spinicirrus, Lintaxine cokeri, Philometra* sp., **Tetracotyle* sp., **Diplostomum spathaceum,* glochidia sp. and *Sanguinicola* sp. which are potentially dangerous to freshwater drum, were encountered as light or medium infections.

A total of 126 species of parasites was detected and the following major taxa were found: viruses and fungi-l species each: Protozoa-l 1; Trematoda-31; Monogenea-25; Cestoidea-17; Nematoda-14; Acanthocephala-1 1; Arthropoda (Crustacean)-10; Annelida (Hirudinea)-3; Mollusca-1.

DISCUSSION

There are several reasons for studying the parasites of Lake Erie: parasites are part of the ecosystem of the lake; they may cause fish mortalities; they may cause fish to be unfit for human consumption and, if present in large numbers in particular fish hosts, may provide an extremely sensitive "biological tag" in the study of the different aspects of the life history of the fish (Polyanski 1957; Margolis 1960; Pippy 1969; Hoffman and Bauer 1971).

The known parasite fauna of the fish species examined has steadily increased with regard to number of species occuring, prevalence and intensity of infection (Tables 1 and 2). It must be noted again that the data from Bangham (1972) is from *fish* of *the* western *basin* only while the other three studies involved fish from all of Lake Erie.

A total number of recorded species of parasites of Lake Erie fishes increased from 72 in 1927-29 to 126 in 1970-75 (Table 2). Although the parasite fauna for rainbow smelt (not recorded from the lake in 1927-29) only increased by two species for the period of record, note the marked increase in occurrence in the other nine species of warm-water fish; namely, 2 to 10 species in northern pike, 2 to 30 species in quillback, 7 to 29 species in white sucker, and 20 to 29 species in yellow perch. Increases were also evident to a lesser degree in the other species (Table 2). Although the total number of parasite species in smallmouth bass did not change significantly, there was however a shift to Monogenea. The fish species examined in this study hosted 49 species of pathogenic parasites.

Progressive changes in the physico-chemical characteristics of Lake Erie (Beeton 1969; Beeton and Edmondson 1972) have brought about changes in the species composition and abundance of phytoplankton, benthos, zooplankton and fish populations (Leach and Nepszy 1976). These changes are in turn reflected in the species composition and abundance of certain groups of parasites (Digenea, Cestoidea, Acanthocephala and Nematoda) which use various zooplankters and benthic organisms as intermediate hosts for completion of their life cycles.

Wilson (1929) found that cladocerans were more abundant than copepods, with *Daphnia pulex* and *Epischura lucustris* being the dominant species of the respective groups. However, both the amount and composition of zooplankton have changed over the intervening years. Zooplankton production in the island area of the western basin increased markedly from 1939 to 1959 (Hartman 1973). The copepod, *Diaptomus siciloides,* which is usually found in eutrophic waters was very rare in Lake Erie in 1929-30 but was later found to be very abundant in the western basin (Davis 1966). Stromberg and Crites (1974a, 1974b, 1975) found that during the 1970-73 period the dominant summer plankton species were *Cyclops bicuspidatus* and *Cyclops vernalis.* This agrees with Watson (1976) who found that during much of 1970, cyclopoids were the most numerous crustacean zooplankton with offshore centers of abundance. Increased prevalence and intensity of parasites such as *Triaenophorus nodulosus* and *Camallanus oxycepyhalus* are almost certainly related to the changes in abundance of the planktonic copepods, *Cyclops bicuspidatus* and C. *vernalis* since the latter are suitable intermediate hosts.

Significant increases in the oxygen demand of lake sediments has led to a serious disruption of the benthic communities. Oxygen depletion in 1953 drastically reduced the nymph population of the dominant mayfly, *Hexagenia* (Britt 1955) and this insect has been virtually eliminated from the western part of the lake. In contrast, Carr and Hiltunen (1965) observed a ninefold increase in Oligochaeta, a fourfold increase in Tendipedidae, a sixfold increase in Gastropoda and a twofold increase in Sphaeriidae during the period from 1930-1961.

The reduction of *Hexagenia* nymphs to less than 1% of their former abundance (Carr and Hiltunen (1965) is reflected in the decrease in number, prevalence and intensity of infections of parasites of the genera *Rhabdochona* and *Spinitectus* for which *Hexagenia* nymphs are intermediate hosts. The nine-fold increase in Oligochaeta is reflected in the increase in number, prevalence and intensity of infection of parasites of the genera *Glaridacris, Spartoides, Biacetabulum* and *Eustrongylides.* Increases in Sphaeriidae and Gastropoda have resulted in a twofold increase in digenetic trematodes with life histories involving snail, fish and bird hosts and which are more characteristic of eutrophic than oligotrophic conditions (Wisniewski 1958; Chubb 1963; Grimaldi and Nümann 1972).

Protozoans pathogenic to seven fish species including yellow perch, rainbow smelt and channel catfish were: *Glugea hertwigi, Ichthyophthirius multifiliis, Trichodina urinaria, Trichodina* sp., *Myxosoma bibullatum, M. scleroperca, Henneguya exilis, Myxobolus inornatus.* These parasites can cause weight loss, extensive damage to fish tissues and organs and possible fish mortalities (Davis 1944; Elser 1955; Dogiel et al. 1958; Allison and Kelly 1963; Reichenbach-Klinke and Elkan 1965; Nepszy and Dechtiar 1972; Nepszy et al. 1978).

Digeneans, characteristic of eutrophic lakes, were the most abundant group of parasites found in all ten species of fish examined. The larval and adult stages of several digeneans are considered pathogenic and of potential economic importance. Mortalities of young fish caused by digeneans have been reported by Meyer (1958), Wales (1958) and Bychovskaya-Pavlovskaya and Petrushevski (1963). The monogeneans found on nine species of fish are considered dangerous to fish populations (Mizelle 1938; Tripathi 1959; Dogiel et al. 1958; Prost 1963, 1973).

Tapeworms, both larval and adult stages of which may cause serious damage to fish tissue and mortality in some cases (Lawler and Scott 1954; Matthey 1963; Lawler 1969; Dechtiar 1972b; Harris and Wheeler 1974), were found in all species of fish examined.

Nematodes were found in nine species of fish while glochidia were taken from six species including yellow perch, walleye and smallmouth bass.

Acanthocephalans are known to interfere with the state of nutrition of the host by causing hemmorhaging and inflammation in the mucosa of the intestine (Petrushevski and Kogteva 1954; Bullock 1963; Schmidt et al. 1974).

The crustacean parasites, *Ergasilus* spp. and *Argulus catostomi,* found on seven species of fish could be detrimental to their hosts and even cause mortalities (Schumacher 1952; Allum and Hugghins 1959).

When eutrophication is accelerated, the prevalence of parasitism is higher (Nümann 1972; Grimaldi and Nümann 1972; Colby et al. 1972). The prevalence of infectious diseases in fish is believed to be related to increased stress caused by eutrophication, domestic and industrial pollution, contaminants and temperature (Snieszko 1974). Leach et al. (1977) reviewed the information on increased parasitism and prevalence of diseases in percids as a consequence of eutrophication. Studies of diseases, particularly those of parasitic origin, may help to answer the question as to what degree parasites are a negative biological influence in the Lake Erie environment which contains vanishing salmonid species and increasing warm-water fish species (Hartman 1973; Leach and Nepszy 1976). The processes by which cultural eutrophication causes the decline or disappearance of oligotrophic fish in the Great Lakes are poorly understood (Smith 1972).

Qualitative and quantitative changes have occurred in the parasite fauna of fishes in Lake Erie since 1927-29. These are related to changes in the host fauna and ultimately to changes in abiotic conditions brought about by eutrophication. If a host species is typical for its environment then the parasite fauna is also typical for the same environment (Wisniewski 1958; Chubb 1963). Thus, parasites of salmonid species are the oligotrophic elements of the parasite fauna while those of warm-water fish species are the eutrophic elements.

ACKNOWLEDGMENTS

We thank the staff of the Fisheries Research Station, Wheatley for their assistance, particularly Messrs J. Murphy and J. Kippax for their assistance in obtaining and handling fish specimens. We are also grateful to fisherman Rudy Krause of Krause Bros. Fisheries, Leamington for his continuing assistance in providing fish specimens. Omstead Foods Ltd., (Wheatley) and Henry H. Misner Ltd. (Port Dover) also provided some fish for examination. K.H. Loftus provided encouragement to undertake the study. A.H. Lawrie and A.M. McCombie and J.H. Leach, of the Fisheries Research Section, Ontario Ministry of Natural Resources, critically reviewed the manuscript. Dr. Glenn Hoffman, U.S. Fish and Wildlife Service, Stuttgart, Arkansas, Carlos Fetterolf, Jr., Great Lakes Fishery Commission, AM Arbor, Michigan and Dr. D.K. Cone, St. Mary's University, Halifax, N. S. provided valuable reviews. We especially thank Dr. Mary Beverley-Burton, University of Guelph, Guelph, Ontario and Dr. John D. Smith, Ontario Ministry of Health, Ottawa, Ontario for their exhaustive and extremely helpful reviews.

Survey of the Parasite Fauna of Lake Ontario Fishes, 1961 to 1971[1]

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ABSTRACT

This was the first extensive survey of the parasites of fishes from Lake Ontario. A total of 1965 fish representing 56 species were examined and 212 species of parasites were recorded. Every species of fish and 94% of the individuals examined carried at least one parasite species. No parasites considered dangerous to humans were found. A number of pathogenic parasites reported elsewhere as contributors to fish mortalities were recorded.

INTRODUCTION

A survey of the parasites of fishes from Lake Ontario was undertaken in the period 1961-1971. This study was the first extensive survey of parasites of fishes in this water body although limited studies had been carried out by Wright (1879)) Hart (1931)) Pritchard (1931), and Mueller (1940) earlier and more recently by Tedla and Fernando (1969a, 1969b, 1969c, 1969d, 1969e, 1970a, 1970b, 1970c, 1970d), Hanek and Fernando (1971a, 1971b, 1972a, 1972b, 1973), Molnar and Fernando (1974) and Lester and Huizinga (1977). In aggregate, 32 fish parasites were previously recorded for Lake Ontario and its tributaries. In the current study,

1 Contribution No. 86-14 of the Ontario Ministry of Natural Resources, Research Section, Fisheries Branch, Box 50, Maple, Ontario LOJ 1EO
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1965 fish representing 56 species were examined and 212 species of parasites were found. The ecological significance of the observations is considered.

MATERIALS AND METHODS

Fishes were collected from a variety of locations in the Canadian waters of Lake Ontario from Grimsby to the Thousand Islands area. The Bay of Quinte and some Lake Ontario tributaries (Credit River, Shelter Valley Creek and the Trent River) were included. Most of the specimens were collected by experimental gear operated by the staff of the Lake Ontario Fisheries Research Unit, Ontario Ministry of Natural Resources (OMNR), Picton. Staff of the OMNR Brockville District collected fish samples from the Thousand Islands area and staff of the OMNR Lake Simcoe District provided samples from the Credit River. Additional fish specimens came from anglers and other interested persons. Most of the fish were examined as fresh material, and the rest as frozen or preserved in formalin solution. Each fish was subjected to standard examination procedures used for external and internal parasites (Dechtiar 1972b). The parasites from this study are temporarily housed under the care of Dr. M. Beverley-Burton, College of Biological Sciences, University of Guelph, Guelph, Ontario, pending their final destination at the National Museum of Natural Sciences, Ottawa, Ontario.

RESULTS

Findings are arranged in a host-parasite checklist and summarized in Tables 1 and 2. The host fish species are arranged in order according to Robins et al. (1980). For each host species, the number of fish examined, the prevalence (%) of infection, and the site and intensity of infection are given. Intensity of infection is indicated as: L (light, l-9 parasites/host); M (medium, 10-49 parasites/host); H (heavy, $\geqslant$50 parasites/host). Parasites are listed in decreasing order of prevalence and taxonomy is according to Margolis and Arthur (1979) and Beverley-Burton (1984) except where noted. An asterisk before a parasite name indicates its presence in a larval or immature stage.

Acipenser fulvescens Rafinesque - lake sturgeon
Examined 2: Prevalence 100%

Crepidostomum lintoni	100%	M	intestine
Diclybothrium armatum	100%	L	gills
Metechinorhynchus salmonis[1]	100%	M	intestine
Cucullanus clitellarius	50%	L	intestine
Neoechinorhynchus rutili	50%	L	intestine
**Diplostomum spathaceum*	50%	L	eye
Scrjabinopsolus manteri	50%	L	intestine
Spinitectus gracilis	50%	L	intestine
**Triaenophorus nodulosus*	50%	L	liver

1 Nomenclature according to Amin (1985).

TABLE I. Numbers of major parasitic taxa in species of fish from Lake Ontario examined during 1961-65 and 1966-71 (in parenthesis).

Host species	No. fish examined	Protozoa	Trematoda	Monogenea	Cestoidea	Nematoda	Acanthocephala	Mollusca	Arthropoda	Other[1]
American eel	8(13)	1(3)	3(2)		1(2)	1(3)	1(3)	1(1)	1(1)	
Alewife	3(4)		1(2)				1(1)			1(1)
Lake herring	5(6)		3(2)		1(3)		1(1)			
Lake whitefish	7(13)		2(3)		2(4)	1(2)	1(3)		1(1)	
Rainbow smelt	4(8)	(1)	2(2)			1(2)	1(2)	(1)		
Northern pike	7(14)		3(5)	1(1)	1(2)	1(2)	1(3)		(1)	
Golden shiner	6(17)	1(2)	2(5)	2(3)	(1)	(2)	1(2)	(2)		
White sucker	8(24)	1(1)	1(3)	1(6)	1(4)	1(2)	1(4)	(1)	1(2)	1(1)
Brown bullhead	8(16)	1(1)	4(5)	1(3)	1(1)	1(2)	(1)	(1)	(1)	(1)
White perch	9(16)	3(2)	2(4)	1(2)	2(2)	(4)	(2)	1		
Rock bass	11(30)	1(2)	6(7)	(7)	1(1)	(6)	1(3)		2(2)	(1)
Smallmouth bass	18(26)	(1)	6(6)	2(5)	2(3)	2(4)	3(1)	1 (1)	2(2)	(2)
Yellow perch	16(29)	1(4)	7(7)	1(2)	2(4)	2(6)	1(3)	1(1)	1(1)	(1)
Walleye	1 1(22)	(1)	3(6)	1(1)	1(2)	2(3)	2(4)	1(1)	1(2)	(1)
Freshwater drum	8(12)		4(5)	2(2)	1(1)	(2)	1(1)			(1)

1 Viruses, fungi, sea lamprey.

TABLE 2. Classification of parasites of Lake Ontario fishes, 1961-71.

Virus
- Pox virus (Lymphocystis disease)

Fungus
- *Saprolegnia* sp.

Protozoa
- *Glugea hertwigi* Weissenberg, 1911
- *Henneguya acuta* Bond, 1939
- *Henneguya doori* Guilford, 1963
- *Henneguya exilis* Kudo, 1929
- *Henneguya* sp.
- *Ichthyophthirius multifiliis* Fouquet, 1876
- *Myxidium illinoisense* Meglitsch, 1937
- *Myxobolus* dentium Fantham, Porter and Richardson, 1939
- *Myxobolus* sp.
- *Myxosoma bibullatum* Kudo, 1934
- *Myxosoma pendula* Guilford, 1967
- *Myxosoma procerum* Kudo, 1934
- *Nosema pimephalus* Fantham, Porter and Richardson, 1941
- *Pleistophora cepedianae* Hoffman and Dunbar, 1965
- *Scyphidia micropteri* Surber, 1940
- *Scyphidia* sp.
- *Trichodina uriniaria* Dogiel, 1940
- *Trichodina* sp.
- *Trichophyra piscium* Butschli, 1889
- *Trichophyra* sp.

Trematoda: Digenea
- *Acetodextra amiuri* (Stafford, 1900) Pearse, 1924
- *Allacanthochasmus artus* Mueller and Van Cleave, 1932
- *Allacanthochasmus varius* Van Cleave, 1922

Alloglossidium geminus (Mueller, 1930) Van Cleave and Mueller, 1934
Alloglossidium corti (Lamont, 1921) Van Cleave and Mueller, 1934
**Apophallas brevis* Ransom, 1920
Azygia angusticauda (Stafford, 1904) Manter, 1926
Azygia longa (Leidy, 1851) Manter, 1926
**Bucephalus* sp.
Bunoderina eucaliae Miller, 1936
Bunoderina sacculata (Van Cleave and Mueller, 1932) Yamaguti, 1958
**Centrovarium lobotes* (MacCallu, 1895) Stafford, 1904
**Clinostomum marginatum* (Rudolphi, 1819) Braun, 1899
**Crassiphiala bulboglossa* Haitsma, 1925
Crepidostomum cooperi Hopkins, 193 1
Crepidostomum cornutum (Osborn, 1903) Stafford, 1904
Crepidostomum isostomum Hopkins, 1931
Crepidostomum lintoni (Pratt and Linton, 1901) Hopkins, 1933
Creptotrema funduli Mueller, 1934
**Diplostomulum scheuringi* Hughes, 1929
**Diplostomulum* sp.
**Diplostomum adamsi* Lester and Huizinga, 1977
**Diplostomum spathaceum* (Rudolphi, 1819) Olsson, 1876
**Diplostomum spathaceum huronense* (LaRue, 1927) Hughes, 1929
Homalometron armatum (MacCallum, 1895) Manter, 1947
Leuceruthrus micropteri Marshall and Gilbert, 1905
Lissorchis attenuatum (Mueller and Van Cleave, 1932) Krygier and Macy, 1969
Macroderoides typicus (Winfield, 1929) Van Cleave and Mueller, 1932
Megalogonia ictaluri Surber, 1928
Microphallus opacus (Ward, 1894) Ward, 1901
Neochasmus umbellus Van Cleave and Mueller, 1932
Phyllodistomum coregoni Dechtiar, 1966
Phyllodistomum lohrenzi (Loewen, 1935)
Phyllodistomum lysteri Miller, 1940
Phyllodistomum staffordi Pearse, 1924
Phyllodistomum sp.
Plagiocirrus primus Van Cleave and Mueller, 1932
Plagioporus sinitsini Mueller, 1934
**Posthodiplostomum minimum* (MacCallum, 1921) Dubois, 1936
**Posthodiplostomum minimum centrarchi* Hoffman, 1958
Prosorhynchoides pusilla (Stafford, 1904) Margolis and Arthur, 1979
Proterometra macrostoma (Faust, 1918) Horsfall, 1933
Prototransversotrema sp.
Sanguinicola occidentalis Van Cleave and Mueller, 1932
Scrjabinopsolus manteri (Cable, 1952) Cable, 1955
**Tetracotyle diminuta* Hughes, 1928
**Tetracotyle intermedia* Hughes, 1928
**Tetracotyle* sp.
**Uvulifer ambloplitis* (Hughes, 1927) Dubois, 1938

Trematoda: Aspidocotylea
Cotylogaster occidentalis Nickerson, 1902

Monogenea
Acolpenteron catostomi Fischthal and Allison, 1942
Actinocleidus brevicirrus Mizelle and Jaskoski, 1942
Actinocleidus recurvatus Mizelle and Donahue, 1944
Actinocleidus sp.[1]
Aethycteron hargisi (Hanek and Fernando, 1972) Suriano and Beverley-Burton, 1982
Aethycteron malleus (Mueller, 1938) Suriano and Beverley-Burton, 1982

continued

Aethycteron sp.
Anchorodiscus triangularis (Summers, 1937) Mizelle, 1941
Anonchohaptor anomalus Mueller, 1938
Cleidodiscus robustus Mueller, 1934
Cleidodiscus venardi Mizelle and Jaskoski, 1942
Dactylogyrus aureus Seamster, 1948
Dactylogyrus banghami Mizelle and Donahue, 1944
Dactylogyrus buddi Dechtiar, 1974
Dactylogyrus bulbus Mueller, 1938
Dactylogyrus cornutus Mueller, 1938
Dactylogyrus eucalius Mizelle and Regensberger, 1945
Dactylogyrus extensus Mueller and Van Cleave, 1932
Dactylogyrus luxili Rogers, 1967
Dactylogyrus urus Mueller, 1938
Dactylogyrus sp.
Diclybothrium armatum Leuckart, 1835
Gyrodactylus avalonia Hanek and Threlfall, 1969
Gyrodactylus dechtiari Hanek and Fernando, 1971
Gyrodactylus etheostomae Wellborn and Rogers, 1967
Gyrodactylus eucaliae Ikezaki and Hoffman, 1957
Gyrodactylus freemani Hanek and Fernando, 197 1
Gyrodactylus georani Hanek and Fernando, 1971
Gyrodactylus limi Wood and Mizelle, 1957
Gyrodactylus macrochiri Hoffman and Putz, 1964
Gyrodactylus medius Kathariner, 1895
Gyrodactylus nebulosus Kritsky and Mizelle, 1968
Gyrodactylus prolongus Hargis, 1955
Gyrodactylus spathulatus Mueller, 1936
Gyrodactylus stableri Hathaway and Herlevich, 1973
Gyrodactylus stunkardi Kritsky and Mizelle, 1968
Gyrodactylus sp.
Haplocleidus dispar (Mueller, 1936) Mueller, 1937
Haplocleidus furcatus Mueller, 1937
Ligictaluridus floridanus (Mueller, 1936) Beverley-Burton, 1984
Ligictaluridus monticelli (Cognetti de Martiis, 1924) Klassen and Beverley-Burton, 1985
Ligictaluridus pricei (Mueller, 1936) Beverley-Burton, 1984
Lintaxine cokeri (Linton, 1946) Sproston, 1946
Lyrodiscus longibasus Rogers, 1967
Lyrodiscus minimus Kritsky and Hathway, 1969
Lyrodiscus rupestris Dechtiar, 1973
Lyrodiscus seminolensis Rogers, 1967
Mazocraeoides olentangiensis Sroufe, 1959
Microcotyle spinicirrus MacCallum, 1918
Octomacrum lanceatum Mueller, 1934
Octomacrum microconfibula Hargis, 1952
Octomacrum semotili Dechtiar, 1966
Onchocleidus chautauquaensis (Mueller, 1938) Murith and Beverley-Burton. 1984
Onchocleidus chrysops (Mizelle and Klucka, 1952) Beverley-Burton, 1984
Onchocleidus ferox (Mueller, 1934) Mueller, 1937
Onchocleidus helicis Mueller, 1936
Onchocleidus principalis Mizelle, 1936
Onchocleidus rogersi (Hanek and Fernando, 1972) Beverley-Burton, 1984
Pseudacolpenteron pavlovskii Bychowsky and Gussev, 1955
Pseudomazocraeoides ontariensis Hanek and Fernando, 1971
Pseudomurraytrema copulatum (Mueller, 1939) Bychowsky, 1957
Pterocleidus acer (Mueller, 1936) Mueller, 1937

Salsuginus fundulus (Mizelle, 1940) Beverley-Burton, 1984
Syncleithrium fusiformis (Mueller, 1934) Price, 1967
Tetracleidus banghami Mueller, 1936
Tetracleidus capax (Mizelle, 1936) Beverley-Burton, 1984
Tetrucleidus glenorensis (Hanek and Fernando, 1972) Beverley-Burton, 1984
Tetracleidus longus (Mizelle, 1936) Beverley-Burton, 1984
Tetracleidus stentor (Mueller, 1937) Beverley-Burton, 1984
Tetraonchus monenteron (Wagener, 1857) Diesing, 1858
Urocleidus aculeatus (Van Cleave and Mueller, 1932) Mueller, 1934
Urocleidus adspectus Mueller, 1936
"Urocleidus" alatus (Mueller, 1938) Price, 1968[2]
Urocleidus baldwini (Dechtiar, 1974) Beverley-Burton, 1984
Urocleidus brachus (Mueller, 1938) Price, 1968

Cestoidea
Bothriocephalus claviceps (Goeze, 1782) Rudolphi, 1810
Bothriocephalus cuspidatus Cooper, 1917
**Bothriocephalus cuspidatus* Cooper, 1917
Corallobothrium fimbriatum Essex, 1928
Cyathocephalus truncatus (Pallas, 1781) Kessler, 1868
**Dilepis sp.*
**Diphyllobothrium ditremum* (Creplin, 1825) Luhe, 1910
**Diphyllobothrium* sp.
Eubothrium salvelini (Schrank, 1790) Nybelin, 1922
Glaridacris catostomi Cooper, 1920
Glaridacris sp.
Haplobothrium globuliforme Cooper, 1914
Hunterella nodulosa Mackiewicz and McCrae, 1962
**Ligula intestinalis* (Linnaeus, 1758) Gmelin, 1790
Megathylacoides giganteum (Essex, 1928) Freze, 1963
Pliovitelluria wisconsinensis Fischthal, 1951
Proteocephalus ambloplitis (Leidy, 1887) Benedict, 1900
**Proteocephalus ambloplitis* (Leidy, 1887) Benedict, 1900
Proteocephalus exiguus LaRue, 1911
Proteocephalus fluviatilis Bangham, 1925
Proteocephalus laruei Faust, 1920
Proteocephalus macrocephalus (Creplin, 1825) Nufer, 1905
Proteocephalus pearsei LaRue, 1919
Proteocephalus perplexus LaRue, 1911
Proteocephalus pinguis LaRue, 1911
Proteocephalus pugetensis Hoff and Hoff, 1929
**Proteocephalus* sp.
Triaenophorus crassus Forel 1868
Triaenophorus nodulosus (Pallas, 1760) Rudolphi, 18 19
**Triaenophorus nodulosus* (Pallas, 1760) Rudolphi, 18 19
Triaenophorus stizostedionis Miller, 1945

Nematoda
**Agamospirura* sp.
Camallanus oxycephalus Ward and Magath, 1917
**Camallanus oxycephalus* Ward and Magath, 1917
Capillaria salvelini Polyansky, 1952
Cucullanellus cotylophora (Ward and Magath, 1917) Petter, 1974
Cucullanus clitellarius (Ward and Magath, 1917) Petter, 1974
Cystidicola farionis Fisher, 1798
Cystidicoloides tenuissima (Zeder, 1800) Rasheed, 1965
**Eustrongylides tubifex* (Nitzsch, 1819) Jagerskiold, 1909

continued

Hysterothylacium brachyurum Ward and Magath, 1917
**Hysterothylacium brachyurum* Ward and Magath, 1917
**Hysterothylacium* sp.
Philometra cylindracea (Ward and Magath, 1917) Van Cleave and Mueller, 1934
Philometra sp.
Philometroides nodulosa (Thomas, 1929) Dailey, 1967
Raphidascaris acus (Bloch, 1779) Ralliet and Henry, 1915
Rhabdochona canadensis Moravec and Arai, 1971
Rhabdochona decaturensis Gustafson, 1949
Rhabdochona milleri Choquette, 195 1
Rhabdochona ovifilamenta Weller, 1938
Rhabdochona sp.
Spinitectus carolini Holl, 1928
Spinitectus gracilis Ward and Magath, 1917
Spinitectus sp.
**Spiroxys* sp.

Acanthocephala
Acanthocephalus jacksoni Ballock, 1962
Leptorhynchoides thecatus (Linton, 1891) Kostylew, 1924
**Leptorhynchoides thecatus* (Linton, 1891) Kostylew, 1924
Metechinorhynchus salmonis (Muller, 1784) Petrochenko, 1954
Neoechinorhynchus crassus Van Cleave, 1919
Neoechinorhynchus cristatus Lynch, 1936
Neoechinorhynchus cylindratus (Van Cleave, 1913) Van Cleave, 1919
Neoechinorhynchus notemigoni Dechtiar, 1967
Neoechinorhynchus rutili (Muller, 1780) Hamann, 1892
Neoechinorhynchus saginatus Van Cleave and Bangham, 1949
Neoechinorhynchus tenellus (Van Cleave, 1913) Van Cleave, 1919
Neoechinorhynchus tumidus Van Cleave and Bangham, 1941
Neoechinorhynchus sp.
Octospinifer macilentus Van Cleave, 1919
Pomphorhynchus bulbocolli Linkins in Van Cleave, 1919

Annelida: Hirudinea
Actinobdella inequiannulata Moore, 1901
Myzobdella alba Meyer, 1940
Myzobdella moorei (Meyer, 1940) Meyer and Moore, 1954
Piscicola sp.

Mollusca- Pelecypoda
*Glochidia

Arthropoda: Crustacea
Achtheres ambloplitis Kellicot, 1880
Achtheres corpulentus Kellicot, 1880
Achtheres micropteri Wright, 1882
Argulus catostomi Dana and Herrick, 1837
Ergasilus caeruleus Wilson, 1911
Ergasilus centrarchidarum Wright, 1882
Ergasilus luciopercarum Henderson, 1926
Ergasilus versicolor Wilson, 1911
Ergasilus sp.

Pisces: Agnata: Petromyzontidae
Petromyzon marinus Linnaeus

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1 Considered by Beverley-Burton (1986) to be *species inquirendae.*
2 See Beverley-Burton (1984) with regard to generic designation.

Lake sturgeon from Lake Ontario have not been examined by earlier investigators. Both of the present specimens were from the upper St. Lawrence River and heads and internal organs were received from commercial fishermen. The first, a 79 kg specimen, was caught in 1962, and the second, weighing 18 kg, was caught in l-964.

Lepisosteus osseus (Linnaeus) - longnose gar
Examined 2: Prevalence 100%

Leptorhynchoides thecatus	100%	L	intestine
**Proteocephalus ambloplitis*	50%	L	mesentery
**Spiroxys sp.*	50%	L	mesentery
**Diplostomum spathaceum*	50%	L	eye

Amia calva Linnaeus - bowfin
Examined 4: Prevalence 75%

Proteocephalus perplexus	75%	M	intestine
Neoechinorhynchus rutili	50%	M	intestine
Haplobothrium globuliforme	50%	M	intestine
Azygia longa	50%	L	intestine
**Diplostomum spathaceum*	25%	L	eye
Macroderoides typicus	25%	L	intestine

Bowfin from Lake Ontario were not examined by earlier investigators.

Anguilla rostrata (Lesueur) - American eel
Examined 42: Prevalence 95%

**Diplostomum spathaceum*	33%	L	eye
Ergasilus versicolor	31%	L	gills
*Glochidia	14%	L	gills
Metechinorhynchus salmonis	12%	M	intestine
Proteocephalus macrocephalus	10%	L	intestine
Myxidium illinoisense	10%	L	gills, kidney
Azygia longa	10%	L	intestine
Spinitectus sp.	7%	L	intestine
Trichodina sp.	5%	H	gills
Ichthyophthirius multifiliis	5%	H	body surface, gills
Bothriocephalus claviceps	5%	L	intestine
**Diphyllobothrium* sp.	5%	L	stomach wall
Leptorhynchoides thecatus	5%	L	intestine

Alosa pseudoharengus (Wilson)-alewife
Examined 6 1: Prevalence 90%

**Diplostomum spathaceum*	66%	L	eye
Saprolegnia sp.	33%	L	body surface

Acanthocephalus jacksoni	13%	L	intestine
**Posthodiplostomum minimum*	3%	L	mesenteries

Dorosoma cepedianum (Lesueur) - gizzard shad
Examined 24: Prevalence 54%

Mazocraeoides olentangiensis	46%	L	gills
**Diplostomum spathaceum*	42%	L	eye
Pseudomazocraeoides ontariensis	21%	L	gills
Pleistophora cepedianae	8%	M	mesenteries

The sporozoan parasite *Pleistophora cepedianae* apparently can cause the death of numerous young fish (Bangham 1941; Putz et al. 1965).

Coregonus artedii LeSueur - lake herring
Examined 25: Prevalence 92%

Metechinorhynchus salmonis	92%	M	intestine
Proteocephalus laruei	80%	M	intestine
**Tetracotyle intermedia*	40%	L	heart
**Diphyllobothrium ditremum*	16%	L	stomach wall
**Diplostomum spathaceum*	12%	L	eye
Proteocephalus exiguus	12%	M	intestine

Coregonus clupeaformis (Mitchill) - lake whitefish
Examined 22: Prevalence 100%

Metechinorhynchus salmonis	100%	M	intestine
**Tetracotyle intermedia*	60%	L	heart
Cystidicoloides tenuissima (Syn. *Metabronema salvelini)*	56%	L	intestine
Cystidicola farionis	52%	M	air bladder
**Diphyllobothrium* sp.	28%	L	stomach wall
Acanthocephalus jacksoni	28%	L	intestine
Phyllodistomum coregoni	24%	L	ureters
Cyathocephalus truncatus	16%	M	intestine
Neoechinorhynchus tumidus	16%	L	intestine
Proteocephalus exiguus	12%	M	intestine
**Diplostomum spathaceum*	8%	L	eye
**Triaenophorus crassus*	8%	L	muscles
Achtheres corpulentus	8%	L	gill arches

Oncorhynchus kisutch (Walbaum) - coho salmon
Examined 14: Prevalence 100%

Metechinorhynchus salmonis	86%	M	intestine
Acanthocephalus jacksoni	43%	M	intestine

**Camallanus oxycephalus*	14%	L	intestine
Capillaria salvelini	14%	L	intestine

Salmo gairdneri Richardson-rainbow trout
Examined 14: Prevalence 100%

Metechinorhynchus salmonis	*86%*	M	intestine
**Diplostomum spathaceum*	71%	L	eye
Cystidicoloides tenuissima	*36%*	L	intestine

Salvelinus fontinalis (Mitchill) - brook trout
Examined 5: Prevalence 40%

Acanthocephalus jacksoni	*20%*	M	intestine
Metechinorhynchus salmonis	*20%*	L	intestine
**Tetracotyle* sp.	*20%*	L	heart, kidney
**Diplostomum spathaceum*	*20%*	L	eye
Cystidicoloides tenuissima (Syn. *Metabronema salvelini)*	*20%*	L	intestine

Three of the five fish were from the Credit River and two were from Shelter Valley Creek.

Salvelinus namaycush (Walbaum) - lake trout
Examined 10: Prevalence 100%

Metechinorhynchus salmonis	100%	M	intestine
Eubothrium salvelini	*50%*	L	intestine
**Diplostomum spathaceum*	10%	L	eye

Osmerus mordax (Mitchill)-rainbow smelt
Examined 631: Prevalence 95%

Metechinorhynchus salmonis	*46%*	L	intestine
Glugea hertwigi	*23%*	H	intestinal wall, ovaries and mesenteries
**Diplostomum spathaceum*	18%	L	eye
**Tetracoytle* sp.	18%	L	mesenteries
Acanthocephalus jacksoni	*8%*	L	intestine
Spinitectus gracilis	*2%*	L	intestine
Cystidicola farionis	*2%*	L	swim bladder
Saprolegnia sp.	*2%*	M	body surface

Glugea hertwigi was first noted in Lake Ontario rainbow smelt at Port Ontario (U.S. side of the lake) in 1966 by Ehlinger (1966). In 1967, we detected and identified this parasite in rainbow smelt from the Bay of Quinte.

Umbra limi (Kirtland)--central mudminnow
Examined 17: Prevalence 94%

**Tetracotyle sp.*	29%	L	mesenteries
Gyrodactylus limi	29%	M	body surface
**Spiroxys sp.*	18%	L	mesenteries
Creptotrema funduli	12%	L	intestine
**Proteocephalus sp.*	6%	L	intestine
**Diplostomum spathaceum*	6%	L	eye

Esox lucius Linnaeus - northern pike
Examined 25: Prevalence 88%

Tetraonchus monenteron	88%	M-H	gills
Proteocephalus pinguis	80%	M-H	intestine
Hysterothylacium brachyurum2	40%	M	intestine
Neoechinorhynchus tenellus	28%	M	liver, intestine
Phyllodistomum sp.	24%	L	urinary bladder
Azygia angusticauda	24%	L	intestine
Metechinorhynchus salmonis	16%	L	intestine
**Tetracotyle sp.*	24%	L	mesenteries
Leptorhynchoides thecatus	16%	L	intestine
**Uvulifer ambloplitis*	16%	M	skin, fins
**Camallanus oxycephalus*	8%	L	intestine
*Glochidia	8%	L	gills
**Diplostomum spathaceum*	8%	L	eye
Triaenophorus nodulosus	8%	L	intestine

Phyllodistomum sp. is thought to be new but this awaits a more detailed examination.

Esox masquinongy Mitchill-muskellunge
Examined 1: Prevalence 100%

Proteocephalus pinguis	100%	M	intestine
Triaenophorus nodulosus	100%	M	intestine
Azygia longa	100%	L	intestine
Hysterothylacium brachyurum	100%	L	intestine
Raphidascaris acus	100%	L	intestine
Henneguya acuta	100%	M	gills
Myxobolus dentium	100%	H	mouth tissue
Gyrodactylus sp.	100%	M	gills

Phoxinus neogaeus Cope-finescale dace
Examined 18: Prevalence 100%

Octomacrum semotili	67%	L	gills
Dactylogyrus sp.	67%	M	gills

[2]Nomenclature according to Deardorff and Overstreet (1980).

Gyrodactylus sp.	28% M	gills, fins
Trichodina sp.	28% H	gills

Trichodina sp., *Dactylogyrus* sp. and *Gyrodactylus* sp. are probably new species, but a final decision must be based on a more detailed examination.

Notropis atherinoides Rafinesque - emerald shiner
Examined 26: Prevalence 23%

**Diplostomum spathaceum*	23% L	eye
Dactylogyrus sp.	12% L	gills

Dactylogyrus sp. is thought to be a new species but requires further examination.

Cyprinus carpio Linnaeus- carp
Examined 12: Prevalence 92%

Dactylogyrus extensus	75% M	gills
Pseudocolpenteron pavlovskii	42% M	body surface, fins
Gyrodactylus medius (Syn. G. *carpio*[3])	25% L	body surface, fins
**Diplostomum spathaceum*	17% L	eye
Ergasilus caeruleus	17% L	gills

Notemigonus crysoleucas (Mitchill)-golden shiner
Examined 75: Prevalence 99%

**Crassiphiala bulboglossa*	43% M	skin, fins
Dactylogyrus aureus	25% L	gills
Gyrodactylus sp.	13% M	skin, fins
**Diplostomum spathaceum*	13% L	eye
**Posthodiplostomum minimum*	13% M	internal organs
Trichodina sp.	12% H	ureters
Rhabdochona sp.	11% L	intestine
Neoechinorhynchus notemigoni	11% M	intestine
Neoechinorhychus rutili	11% L	intestine
**Apophallus brevis*	11% L	muscles
Pliovitellaria wisconsinensis	8% L	intestine
Myxobolus sp.	8% L	gills
Saprolegnia sp.	3% L	body surface
**Camallanus oxycephalus*	3% L	intestine
Piscicola sp.	3% L	body surface
Plagiocirrus primus	3% L	intestine
Dactylogyrus luxili	3% L	gills

[3]According to Ergens (1974), *Gyrodactylus carpio* (Kritsky and Mizelle 1968) is a synonym of G. *medius.*

Dactylogyrus luxili is a new host record. This species was originally described by Rogers (1967) from *Notropis chrysocephalus isolepis.*

Notropis cornutus (Mitchill) - common shiner
Examined 15: Prevalence 80%

Gyrodactylus sp.	67%	M	body surface, fins
Dactylogyrus banghami	33%	M	gills
Dactylogyrus cornutus	33%	M	gills
**Clinostomum marginatum*	33%	L	muscles
Dactylogyrus bulbus	20%	M	gills
Octomacrum microconfibula	20%	L	gills
**Proteocephalus ambloplitis*	20%	L	liver
Henneguya sp.	20%	L	gills
Plagioporus sinitsini	13%	L	intestine, gall bladder
Prototransversotrema sp.	13%	L	under scales

Our finding of the trematode *Prototransversotrema* sp. beneath the scales of common shiner from the Credit River constitutes the first report of this parasite for North America. This parasite is thought to be a new species but this awaits further study. *Prototransversotrema steeri,* reported by Angel (1969) from South Australia, is closely related to our form.

Notropis hudsonius (Clinton)-spottail shiner
Examined 33: Prevalence 94%

**Diplostomum spathaceum*	76%	L	eye
Neoechinorhynchus rutili	61%	L	intestine
Dactylogyrus sp.	45%	M	gills
Plagioporus sinitsini	36%	L	intestine, gall bladder
Gyrodactylus sp.	30%	M	fins, skin
**Triaenophorus nodulosus*	24%	L	liver
Rhabdochona decaturensis	18%	L	intestine
Trichodina sp.	15%	M	ureters
**Tetracotyle sp.*	15%	L	mesenteries
Glaridacris sp.	6%	L	intestine

Glaridacris sp., *Dactylogyrus* sp. and *Gyrodactylus* sp. are thought to be new species but more detailed examination is required. The larval stage of *Triaenophorus nodulosus* is highly pathogenic to fish. Cysts of this parasite were found in the liver where they caused heavy damage.

Pimephales promelas Rafinesque - fathead minnow
Examined 11: Prevalence 82%

**Diplostomum spathaceum*	91%	L	eye
Dactylogyrus sp.	45%	M	gills

Gyrodactylus sp.	*45%*	M	fins, skin
**Diplostomulum* sp.	*36%*	M	brain
Nosema pimephalus	*27%*	L	muscles
**Crassiphiala bulboglossa*	*27%*	L	skin, fins

Pimephales notatus (Rafinesque) - bluntnose minnow
Examined 19: Prevalence 53%

**Diplostomulum* sp.	16%	L	eye
**Posthodiplostomum minimum*	16%	L	mesenteries
Neoechinorhynchus sp.	*5%*	L	intestine
**Crassiphiala bulboglossa*	*5%*	L	fins, skin
Dactylogyrus sp.	*5%*	L	gills
Nosema pimephalus	*5%*	H	internal organs

Rhinichthys atratulus (Hermann)- blacknose dace
Examined 9: Prevalence 78%

Gyrodactylus dechtiari	*78%*	L	fins
Dactylogyrus banghami	*67%*	M	gills

Rhinichthys cataractae (Valenciennes) - longnose dace
Examined 13: Prevalence 77%

Rhabdochona canadensis	*77%*	L	intestine
Gyrodactylus stunkardi	*38%*	L	fins
Dactylogyrus banghami	31%	M	gills
Myxobolus sp.	*8%*	L	caudal fin

Semotilus atromaculatus (Mitchill)-creek chub
Examined 10: Prevalence 100%

Urocleidus brachus	100%	L	gills
Neochinorhynchus saginatus	*90%*	L	intestine
Octomacrum semotili	*40%*	L	gills
**Diplostomum spathaceum*	*30%*	L	eye
Myxosoma pendula	*20%*	L	gills

The acanthocephalan *Neoechinorhynchus saginatus* is the first record for Canada.

Couesius plumbeus (Agassiz) - lake chub
Examined 4: Prevalence 100%

**Diplostomum spathaceum*	100%	L	eye
**Tetracotyle sp.*	100%	L	mesenteries
Octomacrum semotili	*50%*	L	gills

Catostomus commersoni (Lactp&deI - white sucker
Examined 54: Prevalence 100%

Myxosoma bibullatum	65%	M	gills
Gyrodactylus sp.	46%	M	fins, gills
Gyrodactylus spathulatus	37%	M	fins, gills
Glaridacris catostomi	26%	L	intestine
Octomacrum lanceatum	24%	L	gills
**Triaenophorus* nodulosus	22%	L	liver, mesenteries
Neoechinorhynchus crassus	22%	L	intestine
Neoechinorhynchus cristatus	22%	L	intestine
Ergasilus caeruleus	19%	L	gills
Pomphorhynchus bulbocolli	19%	M	intestine
Argulus catostomi	19%	L	body surface
Pseudomurraytrema copulatum	19%	L	gills
*Glochidia	15%	L	gills
Octospinifer macilentus	15%	L	intestine
Anonchohaptor anomalus	15%	L	gills
Rhabdochona ovifilamenta	13%	L	intestine
**Ligula intestinalis*	13%	L	body cavity
Lissorchis attenuatum	13%	L	intestine
**Diplostomum spathaceum*	11%	L	eye
Phyllodistomum lysteri	6%	L	meters
Actinobdella inequiannulata [4]	6%	L	gill cover
Philometroides nodulosa[5]	4%	L	under skin in the tins
Acolpenteron catostomi	4%	M	ureters
Hunterella nodulosa	4%	M	intestine

Moxostoma macrolepidotum (Lesueur) - shorthead redhorse
Examined 15: Prevalence 100%

Glaridacris catostomi	80%	M	intestine
Myxobolus sp.	33%	M	gills
Pseudomurraytrema copulatum	27%	M	gills
Neoechinorhynchus crassus	27%	L	intestine
Dactylogyrus urus	27%	M	gills
Anonchohaptor anomalus	20%	M	gills
Gyrodactylus sp.	13%	M	gills
Rhabdochona milleri	13%	L	intestine

Ictalurus nebulosus (Lesueur) - brown bullhead
Examined 34: Prevalence 100%

Ligictaluridus pricei	44%	M	gills
Megalogonia ictaluri	29%	M	intestine
Corallobothrium fimbriatum	29%	M	intestine
Phyllodistomum staffordi	24%	L	ureters
Acetodextra amiuri	24%	L	air bladder, ovaries

[4]Nomenclature according to Daniels and Freeman (1976).
[5]Nomenclature according to Uhazy (1976).

Ergasilus versicolor	21%	L	gills
**Spiroxys sp.*	21%	L	mesenteries
Ligictaluridus monticelli	21%	L	nares
*Glochidia	18%	L	gills
Alloglossidium geminus	15%	L	intestine
Henneguya exilis	12%	H	gills
**Eustrongylides tubifex*	9%	L	mesenteries
**Tetracotyle* sp.	9%	L	mesenteries
Leptorhynchoides thecatus	6%	H	intestine
Gyrodactylus nebulosus	6%	M	fins
Myzobdella moorei	6%	L	fins

Ictalurus punctatus (Rafinesque) -channel catfish
Examined 15: Prevalence 100%

Ergasilus versicolor	80%	M	gills
Ligictaluridus floridanus	67%	M	gills
Megathylacoides giganteum	40%	M	intestine
Myzobdella moorei	33%	L	fins
Henneguya exilis	20%	L	gills
Metechinorhynchus salmonis	20%	L	intestine
Microphallus opacus	13%	L	intestine
Alloglossidium corti	13%	L	intestine
Ichthyophthirius multifiliis	13%	M	fins, gills

Noturus gyrinus (Mitchill)-tadpole madtom
Examined 5: Prevalence 100%

**Diplostomum spathaceum*	100%	L	eye
Megalogonia ictaluri	60%	M	intestine
Alloglossidium corti	60%	M	intestine
Ligictaluridus pricei	40%	L	gills
Rhabdochona decaturensis	40%	L	intestine

Noturus flaws Rafinesque - stonecat
Examined 6: Prevalence 50%

Megalogonia ictaluri	50%	L	intestine
Ligictaluridus pricei	33%	L	gills
Alloglossidium corti	33%	L	intestine
Rhabdochona decaturensis	32%	L	intestine
Alloglossidium geminus	17%	L	intestine
**Proteocephalus sp.*	17%	L	intestine

Percopsis omiscomaycus (Walbaum) - trout perch
Examined 39: Prevalence 97%

Urocleidus baldwini	90%	L	gills
**Tetracotyle diminuta*	54%	L	mesenteries
Crepidostomum isostomum	46%	M	intestine

[6]Nomenclature according to Davies (1973).

*Glochidia	38%	L	gills
Myxosoma procerum	26%	M	Skin
Gyrodactylus sp.	18%	L	fins
Spinitectus gracilis	13%	L	intestine
**Diplostomum spathaceum*	13%	L	eye
Metechinorhynchus salmonis	13%	L	intestine
**Bucephalus sp.*	10%	L	intestine
**Centrovarium lobotes*	10%	M	muscles
*Triaenophorus stizostedionis	8%	L	liver

Fundulus diaphanus (Lesueur) - banded killifish
Examined 20: Prevalence 85%

Salsuginus fundulus	40%	L	gills
**Posthodiplostomum minimum*	40%	L	gills
Gyrodactylus stableri	20%	L	fins
Gyrodactylus prolongus	20%	L	fins
**Diplostomum spathaceum*	15%	L	eye
Gyrodactylus avalonia	15%	L	fins
**Camallanus oxycephalus*	10%	L	intestine
**Hysterothylacium sp.*	10%	L	mesenteries
**Leptorhynchoides thecatus*	10%	L	mesenteries
Trichodina sp.	10%	H	ureters
**Proteocephalus ambloplitis*	5%	L	liver

The monogenean *Gyrodactylus stableri* described by Hathway and Herlevich (1973) is recorded here for the first time in Canada. This parasite was originally described from the plains killifish, *Fundulus kansae.*

Labidesthes sicculus (Cope)-brook silverside
Examined 15: Prevalence 20%

**Diplostomum spathaceum*	20%	L	eye
**Posthodiplostomum minimum*	20%	M	mesenteries

Culaea inconstans (Kirtland)--brook stickleback
Examined 17: Prevalence 100%

Gyrodactylus eucaliae	88%	L	fms
Dactylogyrus eucalius	59%	L	gills
Bunoderina eucaliae	41%	L	intestine
Proteocephalus pugatensis	29%	L	intestine
Neoechinorhynchus rutili	18%	L	intestine

Gasterosteus aculeatus Linnaeus - threespine stickleback
Examined 23: Prevalence 87%

Metechinorhynchus salmonis	43%	L	intestine
**Diplostomum spathaceum*	39%	L	eye
*Glochidia	22%	L	fins

Gyrodactylus avalonia	17%	L	fins
Trichophyra sp.	17%	H	gills
Gyrodactylus sp.	17%	L	fins
Ergasilus sp.	17%	L	gills
Proteocephalus pugetensis	13%	L	intestine
**Hysterothylacium* sp.	13%	L	liver
Bunoderina eucaliae	13%	L	intestine

Morone americana (Gmelin) - white perch
Examined 67: Prevalence 96%

**Triaenophorus nodulosus*	39%	L	liver
Onchocleidus rogersi	37%	L	gills
Leptorhynchoides thecatus	30%	L	intestine
Cucullanellus cotylophora	30%	L	intestine
**Proteocephalus ambloplitis*	28%	L	liver
**Diplostomulum scheuringi*	24%	L	eye
**Diplostomum spathaceum huronense*	21%	L	eye
Neoechinorhynchus cylindratus	12%	L	intestine
Trichodina sp.	8%	H	gills
**Eustrongylides tubifex*	4%	L	mesenteries
**Tetracotyle* sp.	4%	L	kidney
Spinitectus carolini	4%	L	intestine
**Posthodiplostomum minimum*	3%	M	mesenteries
Scyphidia sp.	3%	M	gills
**Hysterothylacium* sp.	3%	L	liver
Gyrodactylus sp.	3%	M	fins

Tedla and Fernando (1969e) reported *Eubothrium crassum* from white perch in Lake Ontario. However, Kennedy (1978) has discussed the occurrence of *E. crassum* in North America. He concluded that it is found only in fish taken in the marine environment or from anadromous fish, especially *Salmo salar* and *Onchorhynchus* sp., returning from the sea. Reports of the parasite from hosts wholly confined to freshwater were attributed by Kennedy to the species *E. salvelini.* Accordingly, the report by Tedla and Fernando (1969e) of *E. crassum* from white perch in Lake Ontario should probably be *E. salvelini.*

Morone chrysops (Rafinesque) - white bass
Examined 15: Prevalence 100%

Allacanthochasmus artus	100%	M	intestine
Allacanthochasmus varius	100%	M	intestine
Onchocleidus chrysops	100%	L	gills
**Triaenophorus nodulosus*	67%	L	liver
Neoechinorhynchus sp.	67%	L	intestine
Leptorhynchoides thecatus	67%	L	intestine
Metechinorhynchus salmonis	53%	L	intestine
Acanthocephalus jacksoni	33%	L	intestine
Neochasmus umbellus	33%	M	intestine
**Bothriocephalus cuspidatus*	33%	M	intestine

**Diplostomum spathaceum*	33%	L	eye
Ergasilus centrarchidarum	20%	L	gills
**Tetracotyle sp.*	20%	L	mesenteries
Proteocephalus pearsei	13%	L	intestine
Trichophrya piscium	7%	H	gills

Ambloplites rupestris (Rafinesque) - rock bass
Examined 56: Prevalence 98%

"Urocleidus" alatus	57%	M	gills
Tetracleidus stentor	45%	L	gills
Onchocleidus chautauquaensis	44%	L	gills
Tetracleidus glenorensis	39%	L	gills
Crepidostomum cornutum	39%	M	intestine
Ergasilus centrarchidarum	25%	M	gills
**Posthodiplostomum minimum*	25%	M	mesenteries, liver
Hysterothylacium brachyurum	25%	L	intestine
**Hysterothylacium brachyurum*	21%	L	mesentery, liver
Neoechinorhynchus cylindratus	16%	L	intestine
Lyrodiscus rupestris	16%	L	fins, nares
Leptorhynchoides thecatus	16%	L	intestine
Metechinorhynchus salmonis	14%	L	intestine
**Diplostomum spathaceum*	14%	L	eye
Myzobdella moorei	14%	L	fins
**Proteocephalus ambloplitis*	13%	M	liver
**Uvulifer ambloplitis*	13%	L	fins
Proterometra macrostoma	13%	L	intestine
Gyrodactylus georani	11%	L	fins
**Camallanus oxycephalus*	9%	L	intestine
Rhabdochona sp.	9%	L	intestine
Spinitectus gracilis	9%	L	intestine
**Spiroxys* sp.	5%	L	mesenteries
Phyllodistomum lohrenzi	5%	L	ureters
Lyrodiscus minimus	5%	L	fins
**Eustrongylides tubifex*	5%	L	mesenteries
**Clinostomum marginatum*	5%	L	gill arches
Achtheres ambloplitis	4%	L	gill arches
Trichodina sp.	4%	H	gills
Myxobolus sp.	4%	H	muscles

Hanek and Fernando (1973) reported *Urocleidus chautauquaensis* as a new record for Canada. Apparently they were unaware that Dechtiar (1972b) had already reported this species from rock bass from Lake Erie. Species of the genus *Lyrodiscus* were reported for the first time from Canada by Dechtiar (1973).

Lepomis gibbosus (Linnaeus) - pumpkinseed
Examined 66: Prevalence 95%

Haplocleidus dispar[7]	38%	M	gills
Actinocleidus recurvatus	35%	L	gills

7 Nomenclature according to Beverley-Button and Suriano (1980)

Onchocleidus ferox[8]	35%	L	gills
**Posthodiplostomum minimum centrarchi*	35%	M	mesenteries, liver
**Proteocephalus ambloplitis*	35%	L	mesenteries, liver
Ergasilus caeruleus	27%	L	gills
*Glochidia	27%	L	gills
**Triaenophorus nodulosus*	27%	L	liver
**Diplostomum spathaceum*	24%	L	eye
Leptorhynchoides thecatus	23%	L	intestine
Metechinorhynchus salmonis	23%	L	intestine
**Clinostomum marginatum*	23%	L	muscles
**Tetracotyle* sp.	21%	L	mesenteries
Azygia angusticauda	18%	L	intestine
Gyrodactylus macrochiri	18%	M	tins
**Eustronglyides tubifex*	15%	L	mesenteries
Cucullanelus cotylophora	12%	L	intestine
Camallanus oxycephalus	12%	L	intestine
**Diplostomulum scheuringi*	12%	L	eye
Lyrodiscus seminolensis	12%	L	fins, skin
Myzobdella moorei	12%	L	fins
**Uvulifer ambloplitis*	9%	L	fins
Hysterothylacium brachyurum	8%	M	intestine
Spinitectus carolini	6%	L	intestine
**Dilepis* sp.	6%	L	mesenteries
Achtheres ambloplitis	6%	L	gill arches
Trichodina sp.	6%	H	gills
Myxobolus sp.	3%	H	heart
Argulus catostomi	3%	L	fins
Proterometra macrostoma	3%	L	intestine
Haplocleidus furcatus	3%	L	gills
Cleidodiscus robustus	3%	L	gills
Pterocleidus acer [9]	3%	L	gills

Lepomis macrochirus Rafinesque - bluegill
Examined 25: Prevalence 100%

Gyrodactylus macrochiri	72%	M	fins
Actinocleidus sp.	40%	L	gills
Lyrodiscus longibasus	40%	L	tins
Camallanus oxycephalus	40%	L	intestine
**Hysterothylacium* sp.	28%	L	liver
Cleidodiscus robustus	24%	M	gills
Onchocleidus ferox	24%	M	gills
Cleidodiscus venardi	24%	L	fins
Lyrodiscus seminolensis	24%	L	fins
Ergasilus caeruleus	24%	L	gills
**Posthodiplostomum minimum centrarchi*	24%	H	mesenteries
Metechinorhynchus salmonis	12%	L	intestine
*Glochidia	12%	L	gills
Spinitectus carolini	12%	L	intestine
Crepidostomum cornutum	12%	L	intestine

[8]Nomenclature according to Beverley-Burton and Suriano (1981).
9 Nomenclature according to Beverley-Burton and Suriano (1980).

Bunoderina sacculata	12%	L	intestine
**Triaenophorus nodulosus*	8%	L	liver
**Proteocephalus ambloplitis*	8%	L	liver
**Tetracotyle sp.*	4%	L	kidney
Anchorodiscus triangularis	4%	L	gills
Virus - (Lymphocystis)	4%	M	fins
Actinocleidus brevicirrus	4%	L	gills

Micropterus dolomieui Lacépède—smallmouth bass
Examined 36: Prevalence 100%

Tetracleidus banghami	64%	M	gills
**Camallanus oxycephalus*	56%	L	intestine
Leptorhynchoides thecatus	56%	M	intestine
**Uvulifer ambloplitis*	19%	L	skin, fins
Onchocleidus ferox	19%	M	gills
Cucullanelus cotylophora	19%	L	intestine
Ergasilus centrarchidarum	14%	L	gills
Onchocleidus principalis	14%	M	gills
Azygia angusticauda	14%	L	intestine
Syncleithrium fusiformis	14%	M	gills
*Glochidia	14%	L	gills
**Diplostomum spathaceum*	11%	L	eye
Scyphidia micropteri	6%	M	gills
Achtheres micropteri	6%	L	gill arches
Proteocephalus ambloplitis	6%	L	intestine
**Proteocephalus ambloplitis*	6%	L	liver, mesenteries
Proteocephalus fluviatilis	6%	L	intestine
Myzobdella moorei	6%	L	fins
Saprolegnia sp.	6%	L	skin
**Tetracotyle* sp.	6%	L	mesenteries
**Eustrongylides tubifex*	6%	L	mesenteries
Crepidostomum cornutum	6%	M	intestine
Hysterothylacium brachyurum	6%	M	intestine
Gyrodactylus macrochiri	3%	L	fins
**Posthodiplostomum minimum centrarchi*	3%	M	mesenteries
**Triaenophorus nodulosus*	3%	L	mesenteries

Micropterus salmoides (Lactpkde+ - largemouth bass
Examined 14: Prevalence 100%

Syncleithrium fusiformis	71%	M	gills
Onchocleidus helicis	71%	L	gills
Haplocleidus furcatus	64%	M	intestine
Leptorhynchoides thecatus	57%	M	intestine
Neoechinorhynchus cylindratus	57%	M	intestine
Actinocleidus sp.	50%	L	gills
Ergasilus centrarchidarum	43%	L	gills
Azygia angusticauda	43%	L	intestine
Crepidostomum cornutum	29%	M	intestine
Proteocephalus ambloplitis	21%	M	intestine
**Proteocephalus ambloplitis*	21%	L	ovaries

**Diplostomum spathaceum*	21%	L	eye
**Clinostomum marginatum*	21%	L	muscles
Achtheres micropteri	14%	L	gills
Proteocephalus fluviatilis	14%	L	intestine
Scyphidia micropteri	7%	H	gills
Gyrodactylus macrochiri	7%	L	fins
Myxobolus sp.	7%	M	fins
Philometra sp.	7%	M	gills, blood vessel
Leuceruthrus micropteri	7%	L	intestine

Pomoxis nigromaculatus (Lesueur) - black crappie
Examined 21: Prevalence 95%

Tetracleidus capax	57%	M	gills
Tetracleidus longus	57%	L	gills
Myzobdella alba	48%	L	fins
Camallanus oxycephalus	48%	L	intestine
Lyrodiscus longibasus	48%	L	fins
**Tetracotyle* sp.	29%	L	kidney
Gyrodactylus sp.	29%	L	fins
Leptorhynchoides thecatus	29%	L	intestine
Myxobolus sp.	24%	L	gills
Trichodina sp.	14%	H	gills
Ergasilus caeruleus	14%	L	gills
**Diplostomum spathaceum*	10%	L	eye
Tetracleidus stentor (accidental infection from rock bass?)	5%	L	gills

Perca flavescens (Mitchill) - yellow perch
Examined 150: Prevalence 100%

**Tetracotyle diminuta*	27%	L	kidney, mesenteries
Urocleidus adspectus	25%	L	gills
Metechinorhynchus salmonis	13%	L	intestine
Acanthocephalus jacksoni	13%	L	intestine
*Glochidia	13%	L	gills, fins
**Crassiphiala bulboglossa*	11%	M	skin
**Bothriocephalus cuspidatus*	7%	M	intestine
Trichodina sp.	5%	H	gills
**Apophallus brevis*	5%	M	muscles
Ergasilus luciopercarum	5%	M	gills
**Diplostomum spathaceum huronense*	5%	L	eye
**Hysterothylacium brachyurum*	5%	M	liver
Cucullanelus cotylophora	5%	L	intestine
Proteocephalus pearsei	5%	L	intestine
**Eustrongylides tubifex*	5%	L	mesenteries
Philometra cylindracea	5%	L	body cavity
Trichodina urinaria	5%	H	ureters
Crepidostomum cooperi	5%	L	intestine
Gyrodactylus freemani	5%	M	fins
**Clinostomum marginatum*	5%	L	muscle
Bunoderina sacculata	5%	L	intestine

Leptorhynchoides thecatus	3%	L	intestine
Henneguya doori	3%	H	gills
Ichthyophthirius multifiliis	2%	L	fins
Cyathocephalus truncatus	2%	L	intestine
Spinitectus gracilis	1%	L	intestine
**Agamospirura* sp.	1%	L	mesenteries
Virus (lymphocystis)	1%	L	fins
**Triaenophorous nodulosus*	1%	L	liver

Stizostedion vitreum vitreum (Mitchill) - walleye
Examined 37: Prevalance 97%

Ergasilus luciopercarum	95%	M	gills
Bothriocephalus cuspidatus	81%	M	intestine
Ergasilus caeruleus	73%	L	gills
Neoechinorhynchus tenellus	54%	M	intestine
**Tetracotyle* sp.	49%	L	heart
Urocleidus aculeatus	41%	M	gills
**Diplostomum spathaceum*	27%	L	eye
Azygia angusticauda	27%	L	intestine
Neoechinorhynchus rutili	24%	L	intestine
Myxobolus sp.	24%	M	heart
Prosorhynchoides pusilla	24%	L	intestine
Metechinorhynchus salmonis	24%	M	intestine
Cucullanelus cotylophora	14%	L	intestine
Leptorhynchoides thecatus	14%	L	intestine
*Glochidia	14%	L	gills
**Uvulifer ambloplitis*	14%	M	skin
Sanguinicola occidentalis	8%	M	blood
Triaenophorus stizostedionis	5%	M	intestine
**Eustrongylides tubifex*	5%	L	muscles
Virus (Lymphocystis)	5%	M	skin, fins
Hysterothylacium brachyurum	5%	M	intestine
**Hysterothylacium brachyurum*	5%	M	liver

Etheostoma caeruleum Storer-rainbow darter
Examined 5: Prevalence 60%

Aethycteron sp.	60%	L	gills
Rhabdochona sp.	40%	L	intestine
**Diplostomum spathaceum*	40%	L	eye

All specimens examined were from the Credit River.

Etheostoma exile (Girard) - Iowa darter
Examined 10: Prevalence 100%

Aethycteron sp.	50%	L	gills
**Tetracotyle* sp.	40%	L	mesenteries

**Apophallus brevis*	30%	L	muscles
**Diplostomum spathaceum*	20%	L	eye
**Camallanus oxycephalus*	20%	L	intestine

Etheostoma nigrum Rafinesque-johnny darter
Examined 45: Prevalence 98%

Gyrodactylus etheostomae	38%	L	fins
Aethycteron hargisi	33%	L	gills
**Apophallus brevis*	11%	L	muscles
Leptorhynchoides thecatus	11%	L	intestine
**Diplostomum spathaceum*	9%	L	eye

Percina caprodes (Rafinesque) - logperch
Examined 5: Prevalence 100%

Aethycteron malleus	100%	L	gills
**Diplostomulum scheuringi*	60%	L	eye
Crepidostomum isostomum	60%	L	intestine
**Camallanus oxycephalus*	40%	L	intestine

Aplodinotus grunniens Rafinesque - freshwater drum
Examined 24: Prevalence 100%

Microcotyle spinicirrus	96%	L	gills
Lintaxine cokeri	63%	L	gills
**Tetracotyle* sp.	46%	L	mesenteries
Homalometron armatum	42%	M	intestine
**Agamospirura* sp.	42%	M	mesenteries
Leptorhynchoides thecatus	29%	L	intestine
**Diplostomum spathaceum*	21%	L	eye
Proteocephalus pearsei	21%	L	intestine
**Eustrongylides tubifex*	21%	L	mesenteries
**Clinostomum marginatum*	13%	L	mesenteries
Cotylogaster occidentalis	8%	L	intestine

Cottus cognatus Richardson-slimy sculpin
Examined 12: Prevalence 100%

Dactylogyrus buddi	67%	L	gills
**Tetracotyle* sp.	50%	L	mesenteries
Acanthocephalus jacksoni	25%	L	intestine

Acanthocephalus jacksoni is pathogenic and may cause mortality to the host according to Schmidt et al. (1974).

Cottus bairdi Girard - mottled sculpin
Examined 10: Prevalence 100%

Dactylogyrus buddi	70%	L	gills
**Tetracotyle sp.*	70%	M	mesenteries
Metechinorhynchus salmonis	70%	L	intestine
Acanthocephalus jacksoni	50%	L	intestine

This survey included 56 of the 63 species of fish presently found in Lake Ontario. From a total of 1965 fish specimens examined, 212 parasite species were found. An additional 30 species have been found in the period 1879-1981 by other workers. Every species of fish and 97% of the individuals examined carried at least one parasite species (Table 1). The following major taxa were found: Protozoa-20 species; Trematoda-50; Monogenea-75; Cestoidea-28; Nematoda-23; Acanthocephala-14; Arthropoda (Crustacea) - 9; Annelida (Hirudinea)-4; Mollusca-1; Pisces-l.

PROTOZOA

The protozoans were found in over 25 different species of fish. *Ichthyophthirius multifiliis,* which is potentially dangerous, was detected on the skin and gills of eel, channel catfish and yellow perch. This parasite has caused weight loss and some mortality among fish (Davis 1944; Elser 1955; Allison and Kelly 1963). Microsporidans *(Glugea* and *Pleistophora)* and myxosporidans (Myxo*bolus, Henneguya, Myxosoma* and *Myxidium)* were found in the gills, muscle, eyes, internal organs and skin of over 17 species of fish. The most dangerous are *Glugea hertwigi* in rainbow smelt, *Pleistophora cepedianae* in gizzard shad, *Henneguya exilis* in channel catfish, *Myxidium illinoisense* in eel, and *Myxobolus dentium* in muskellunge (Edwards et al. 1977). Davis (1944), Dogiel et al. (1958), Reichenback-Klinke and Elkan (1965), and Nepszy et al. (1978) indicate that sporozoan parasites on gills and muscle tissue cause extensive damage to the host.

TREMATODA: DIGENEA

The larvae of several species of trematodes and several adults are considered as pathogens and include **Diplostomum* spp., *Neascus* spp., **Posthodiplostomum* spp., **Tetracotyle* spp., **Apophallus brevis, *Clinostomum marginatum, Crepidostomum* spp. and *Sanguinicola occidentalis.* Mortalities of young fish were associated with these parasites by Meyer (1958), Wales (1985), Bychovskya-Pavlovskaya and Petrushevski (1963), Freeman (1964), Lester (1977) and Lester and Huizinga (1977). Larval stages (metacercariae) of *Clinostomum marginatum, Neascus* spp. and *Apophallus brevis* which invade muscles and skin of numerous fish hosts are of economical importance as the fisherman is often obliged to discard the fish.

MONOGENEA

About 70 species of monogeneans were found on 50 species of fish, the most common belonging to the genera *Gyrodactylus, Dactylogyrus, Octomacrum, Acolpenteron, Anonchohaptor, Diclybothrium* and several ancyrocephalid species. The monogeneans, *Diclybothrium armatum, Gyrodactylus spp.* and *Dactylogyrus* spp. are considered dangerous to fish populations (Mizelle 1938; Tripathi 1959; Dogiel et al. 1958; Prost 1963; Lester and Adams 1974; Hoffman 1976).

CESTOIDEA

The larval stages (plerocercoids) and some adults of several species of cestodes are considered to be pathogenic. These include: **Triaenophorous nodulosus, *Proteocephalus ambloplitis, *Ligula intestinalis, Eubothrium salvelini, Cyathocephalus truncatus* and *"Diphyllobothrium* spp. The larval stage of *Triaenophorous nodulosus* occurs encysted in the liver and mesenteries of three major hosts: yellow perch, white perch and white bass. This parasite may cause serious tissue damage. Our study showed a higher prevalence of *T. nodulosus* (plercercoid) in white bass (39%) than in yellow perch (1%). The livers of white bass had moderate to heavy infection, suggesting that triaenophoriasis is a serious problem for this population. Lawler (1969) and Matthey (1963) reported a mortality of yellow perch that was caused by a plerocercoid of *T. nodulosus.*

Another pathogenic parasite found in several hosts is the larval stage of *Proteocephalus ambloplitis.* However, this parasite is not a serious threat for the populations of fish in Lake Ontario at the present time. The plerocercoids invade the liver, mesenteries and gonads of smallmouth bass and other fish species in other locations, resulting in heavy damage to the organs (Bangham 1972; Dechtiar 1972a, 1972b). *Ligula intestinalis,* which is pathogenic in the plerocercoid stage, has caused mass mortalities of cyprinid and catostomid fishes elsewhere (Dence 1958; Harris and Wheeler 1974), but is not a problem for Lake Ontario fishes at present. Vik (1954, 1958) reported that *Cyathocephalus truncatus* causes considerable damage to host salmonid fishes. *Diphyllobothrium* spp., which are pathogenic as plerocercoids, occurred in lake herring and lake whitefish in Lake Ontario. Duguid and Sheppard (1944) and Hoffman and Dunbar (1961) recorded an epizootic in brook trout and char caused by the plerocercoids of *Diphyllobothrium* sp. Vik (1965) considered that the plerocercoid stage of this parasite was responsible for a major decline of *Salmo trutta and Salvelinus alpinus* in Norway. The two new species, *Proteocephalus laruei* and *P. exiguus* may be responsible for the mortality of young-of-the-year and yearling coregonids (Nümann 1972).

NEMATODA

The larval stages of several species of nematodes and a few adult stages are considered as pathogenic to Lake Ontario fishes. These include: **Eustrongylides*

tubifex, Hysterothylacium brachyurum (adult and particularly larval stage) and *Philometra cylindracea* (adult). The large red roundworm, **E. tubifex*, was encountered in mesenteric cysts in yellow perch, white perch, rock bass, pumpkinseed, smallmouth bass and freshwater drum and in the muscle of walleye causing evident damage to the hosts. Adults of *Hysterothylacium brachyurum* parasitized the intestine of several fish species including smallmouth bass, northern pike, pumpkinseed and walleye. Encysted larvae parasitized the liver and mesenteries of yellow perch, killifish, threespine stickleback, bluegill and walleye and are considered particularly dangerous.

ACANTHOCEPHALA

In Lake Ontario, 13 species of acanthocephalans were recorded from the fishes examined. Only four of these are considered dangerous: *Pomphorhynchus bulbocolli* in Cyprinidae and Catostomidae, and *Leptorhynchoides thecatus, Acanthocephalus jacksoni* and *Metechinorhynchus salmonis* in salmonids. Acanthocephalans are potentially detrimental in heavily infected fish as nutrient uptake is impaired due to the hemorrhages and inflammatory processes caused by these parasites (Petrushevski and Kogteva 1954; Bullock 1963; Schmidt et al. 1974). In the lake herring and other species of salmonids, *Metechinorhynchus salmonis* causes damage to the mucosa of the posterior part of the intestine resulting in inflammation. These pathological changes interfere with the nutrition of the fish.

ANNELIDA: HIRUDINEA

The leeches are of minor importance and were detected on only five species of fish. Occasionally, leeches may cause mortalities of fish (Thompson 1927; Rupp and Meyer 1954).

ARTHROPODA: CRUSTACEA

The crustacean parasites, *Ergasilus* spp. and *Argulus* spp. are considered serious pathogens, particularly for the walleye. *Ergasilus* spp. feeds on the fill epithelium. Movements of these parasites on the gills cause serious destruction and hypotrophy of the gill filaments. *Ergasilus* spp. and *Argulus* spp. may cause mortalities (Schumacher 1952; Allum and Hugghins 1959; Kabata 1970).

MOLLUSCA: PELECYPODA

Glochidia are the larvae of bivalve molluscs and are parasites on the gills and fins of fish. Glochidia were taken from eight species of fish. These parasites may occasionally cause mortalities of hosts (Karna and Millemann 1978).

Sea lamprey *(Petromyzon marinus* Linnaeus) scars were present on several species of fishes. Parasitism of sea lamprey has had a profound effect on the fish communities of Lake Ontario (Christie 1972; Christie and Kolenosky 1980).

DISCUSSION

Salmonid or cold-water fish communities are characteristic of oligotrophic lakes in Europe and North America. Intermediate waters may contain mixed populations of salmonid and warm-water fish communities. All of the Great Lakes, except Lake Erie, may be placed in the oligotrophic category, although this classification is uncertain for Lake Ontario (Beeton 1965). Chemical content and changes in Lake Ontario have closely followed those in Lake Erie. Increases in calcium, sodium and potassium, chlorides and sulphates have been pronounced in lakes Erie and Ontario (Beeton and Edmondson 1972; Christie 1972). Such physico-chemical changes precipitate biotic changes in phytoplankton, littoral algae, zooplankton and benthos (Colby et al. 1972).

The presence of parasite species is determined by two main factors: ecological conditions which influence the possibility of infection (availability of fish hosts and intermediate hosts- crustaceans, molluscs, oligochaetes, ephemeropterans) and the level of host specificity of the parasites. Most monogeneans are adapted to one host or a few related host species, while digeneans, cestodes and nematodes do not appear to be so narrowly specific with regard to the fish host, as some can live in a fairly wide range of hosts.

From the checklist of parasite species, it can be seen that *Metechinorhynthus salmonis, Proteocephalus laruei, P. exiguus, *Diphyllobothrium* sp., **D. ditremum, Cystidicoloides tenuissima, Cystidicola farionis, Cyathocephalus truncatus, Capillaria salvelini, Eubothrium salvelini, Achtheres corpulentus, *Tetracotyle intermedia, Saprolegnia* sp., **Diplostomum spathaceum, Acanthocephalus jacksoni, Camallanus oxycephalus* and *Spinitectus gracilis* were found on salmonid fishes.

**Diplostomum spathaceum, Acanthocephalus jacksoni, Camallanus oxycephalus* and *Spinitectus gracilis* have been reported from both salmonid and warm-water fishes.

Warm-water fishes including the yellow perch (29 parasite species), northern pike (14), and golden shiner (17) had a combined total of 60 species of parasites. About 30 of these may be regarded as characteristic of eutrophic waters (Wisniewski 1958). The most typical for fish in eutrophic waters are: *Tetraonchus monenteron, Urocleidus adspectus, Henneguya doori, Dactylogyrus aureus, Bunoderina sacculata, Dactylogyrus luxili, Crassiphiala bulboglossa, Pliovitellaria wisconsinensis, Ergasilus luciopercarum, Camallanus oxycephalus,* *Glochidia, **Diplostomum spathaceum, *Triaenophorus nodulosus.*

Certain other parasites such as *Leptorhynchoides thecatus, Neoechinorhyn-*

*thus rutili, Spinitectus gracilis, Ichthyophthirius multifiliis, *Apophallus brevis, *Eustrongylides tubifex, Acanthocephalus jacksoni* may occur in all lake types. The parasites of lake sturgeon *(Crepidostomum lintoni, Diclybothrium armatum, Cucullanus clitellarius* and *Scrjabinopsolus manteri), the* bowfin *(Proteocephalus perplexus, Haplobothrium globuliforme),* the American eel *(Myxidium illinoisense, Bothriocephalus claviceps)* and the gizzard shad *(Mazocraeoides olentangiensis, Pleistophora cepedianae) are* associated with these fish wherever they occur.

Increases in the number of species in all taxa of parasites of Lake Ontario occurred in the late 1960s (Table 1). The increases were most marked among the protozoans, nematodes, monogeneans and the digeneans. These changes in parasite fauna may be related to accelerated eutrophication (Colby et al. 1972; Regier 1974). We suggest that the biotic conditions associated with this increased eutrophication created a more favourable environment for the survival of the free swimming larval Monogenea (oncomiracidia), Digenea (miracidiae and cercariae) and cestodes (coracidia).

Increases in the number of species of parasites, prevalence and intensity of infestations often result in mass mortalities of fishes or increased mortalities of particular populations of fish (Dechtiar 1972b). We investigated an unusually heavy mortality of adult rainbow smelt in the spring of 1967 in the Bay of Quinte, and found that *Glugea hertwigi* was one of the contributing factors. Similar cases of mortality of rainbow smelt in Lake Erie in 1971 were reported by Nepszy and Dechtiar (1972), and mortality of YOY rainbow smelt in Lake Erie due to *Glugea hertwigi* was observed and investigated by Nepszy et al. (1978). An estimated mass mortality of 35,000 kg of perch *(Perca fluviatilis)* in the Bodensee from infestation by *Diplostomum volvens*[10] in 1966 was reported by Nümann (1972). Such mass mortalities were not known before eutrophication.

Parasitic and bacterial infections may be mainly sublethal and may alter survival rates of particular species of fish. Increases in rates of eutrophication will favor increased densities of white perch, yellow perch, freshwater drum, brown bullhead, channel catfish and rainbow smelt. When populations of these fish become dense, massive fish kills are more likely to occur, first with white perch, yellow perch and rainbow smelt, and possibly with cyprinid, catostomid and salmonid fishes.

The most dangerous diseases which could create problems in Lake Ontario fish populations are caused by: *Proteocephalus* spp. in lake whitefish, lake herring, smallmouth and largemouth bass; *Cyathocephalus* spp. in lake whitefish; *Triaenophorus* spp. in yellow perch, white bass and white perch; microsporidiosis in rainbow smelt and gizzard shad; *Ichthyophthirius* spp. in channel catfish and eel; metacercariosis in coregonines, percids, centrarchids and cyprinids; *Acanthocephalus* spp. in salmonids, percids and centrarchids; *Gyrodactylus* spp. and *Dactylocyrus* spp. in cyprinids; nematodosis in percids, centrarchids, salmonids and *Ergasilus* spp. in percids and centrarchids.

[10]Correct *name* for *Diplostomum volvens* is *Diplostomum spathaceum.*

If serious parasitic diseases become established, control in the lake will be difficult. One of the most drastic methods of control is through fish removal, as for example the association of rainbow smelt and the parasite *Glugea hertwigi.*

As more knowledge of the parasites of fishes is accumulated, it may be possible to use this information in combination with other physico-chemical and biological data in the solution of biological problems concerning fish populations.

ACKNOWLEDGMENTS

We thank Dr. D.A. Hurley for the many years of cooperation in the sampling program of fishes. Thanks are due to K. Scott and W. Miller for help and to all other staff of the Glenora Fisheries Research Station who collected the fish. A.H. Lawrie, N. Martin and Dr. W.A. Dillon (University of Tennessee) reviewed the manuscript and we are grateful for many helpful suggestions with the final preparation of the manuscript. Dr. D.K. Cone, St. Mary's University, Halifax, Nova Scotia, also provided a valuable review. We especially thank Dr. Mary Beverley-Burton, University of Guelph, Guelph, Ontario, and Dr. John D. Smith, Ontario Ministry of Health, Ottawa, Ontario, for their exhaustive and extremely helpful reviews.

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