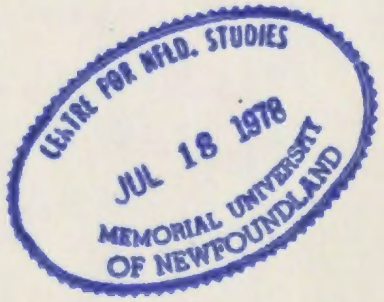
METAZOAN PARASITES OF FISHES FROM CENTRAL LABRADOR

VIMALA CHANDRA CHINNIAH


CENTRE FOR NFLD. STUDIES
JUL 18 1978
MEMORIAL UNIVERSITY
OF NEWFOUNDLAND

NOTICE

The quality of this microfiche is heavily dependent upon the quality of the original thesis submitted for microfilming. Every effort has been made to ensure the highest quality of reproduction possible.

If pages are missing, contact the university which granted the degree.

Some pages may have indistinct print especially if the original pages were typed with a poor typewriter ribbon or if the university sent us a poor photocopy.

Previously copyrighted materials (journal articles, published tests, etc.) are not filmed.

Reproduction in full or in part of this film is governed by the Canadian Copyright Act, R.S.C. 1970, c. C-30. Please read the authorization forms which accompany this thesis.

THIS DISSERTATION HAS BEEN MICROFILMED EXACTLY AS RECEIVED

AVIS

La qualité de cette microfiche dépend grandement de la qualité de la thèse soumise au microfilmage. Nous avons tout fait pour assurer une qualité supérieure de reproduction.

S'il manque des pages, veuillez communiquer avec l'université qui a conféré le grade.

La qualité d'impression de certaines pages peut laisser à désirer, surtout si les pages originales ont été dactylographiées à l'aide d'un ruban usé ou si l'université nous a fait parvenir une photocopie de mauvaise qualité.

Les documents qui font déjà l'objet d'un droit d'auteur (articles de revue, examens publiés, etc.) ne sont pas microfilmés.

La reproduction, même partielle, de ce microfilm est soumise à la Loi canadienne sur le droit d'auteur, SRC 1970, c. C-30. Veuillez prendre connaissance des formules d'autorisation qui accompagnent cette thèse.

LA THÈSE A ÉTÉ MICROFILMÉE TELLE QUE NOUS L'AVONS REÇUE

METAZOAN PARASITES OF FISHES FROM CENTRAL LABRADOR

A Thesis

Presented to

The Department of Biology

Memorial University of Newfoundland

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Vimala Chandra Chinniah B.Sc. (Hons.)

May, 1977

ABSTRACT

A total of 332 fish of eight species from fourteen locations in the Smallwood Reservoir complex of central Labrador were examined for metazoan parasites using conventional parasitological techniques. Fish autopsied include, 107 pike (*Esox lucius*, Linnaeus), 102 lake whitefish (*Coregonus clupeaformis* (Mitchill)), 68 brook trout (*Salvelinus fontinalis* (Mitchill)), 32 lake trout (*S. namaycush* (Walbaum)), 14 longnose suckers (*Catostomus catostomus* (Forster)), 5 Atlantic salmon (landlocked) (*Salmo salar* Linnaeus), 3 lake chub (*Couesius plumbeus* (Agassiz)), and 1 round whitefish (*Prosopium cylindraceum* (Pallas)).

Fifteen genera of parasites were recovered (two of Monogenea, two of Digenea, four of Cestoda, three of Nematoda, two of Acanthocephala and two of Copepoda). Seven new host records were noted.

There were significant differences in the prevalence of the parasites which were common to the different species of fish examined. Generally, each parasite equally infected both the male and the female host species. There was no correlation between the number of parasite species per infected fish and host age in the case of *Salvelinus fontinalis* and *S. namaycush*. However in the case of *Coregonus clupeaformis*, *Esox lucius* and *Catostomus catostomus* there was an increase in the number of parasite species per infected host with age, up to a certain age, after which it began to decline.

Food items of fish examined were also noted.

ACKNOWLEDGMENTS

I would like to express my sincere thanks to Dr. W. Threlfall, my faculty advisor, for his support, advice, guidance and encouragement throughout this study and for his valuable editorial assistance in the preparation of the thesis.

I am particularly grateful for the help and cooperation extended to me by the Fisheries Officers, Messrs. George Burke and Lienus Fitzpatrick stationed at Churchill Falls.

I am indebted to Messrs. Brian Nuss and Robert Bishop of Churchill Falls Labrador Corporation Ltd. for providing accommodation and laboratory facilities during my field trips at Churchill Falls.

I would also express appreciation to Dr. David Lewis, for the assistance in identifying some of the invertebrate food items.

Finally I would like to thank Sheila Gearin for all the help and encouragement given during the course of this study.

TABLE OF CONTENTS

	Page
ABSTRACT	ii
ACKNOWLEDGMENTS	iii
LIST OF TABLES	v
LIST OF FIGURES	vi
INTRODUCTION	1
MATERIALS AND METHODS	3
The Study Area	3
Procedures	4
RESULTS AND DISCUSSION	10
Salmo salar Linnaeus, 1758 (Atlantic salmon (landlocked))	10
Salvelinus fontinalis (Mitchill, 1815)(Brook trout)	19
Salvelinus namaycush (Walbaum, 1792) (Lake trout)	24
Coregonus clupeaformis (Mitchill, 1818) (Lake Whitefish)	28
Prosopium cylindraceum (Pallas, 1784) (Round whitefish)	34
Esox lucius Linnaeus, 1758 (Northern pike)	36
Catostomus catostomus (Forster, 1773) (Longnose sucker)	41
Couesius plumbeus (Agassiz, 1850) (Lake chub)	43
GENERAL DISCUSSION	45
SUMMARY	51
REFERENCES	55

LIST OF TABLES

Table		Page
1.	ORIGIN OF FISHES EXAMINED AND PERCENTAGE INFECTED WITH METAZOAN PARASITES	5
2.	DETAILS OF INFECTION WITH METAZOAN PARASITES OF FISHES FROM CENTRAL LABRADOR	11
3.	CHECKLIST OF PARASITOFAUNA AND LOCATION OF INFECTION	13
4.	MEASUREMENTS (IN MICRONS WITH AVERAGE IN PARENTHESES) OF *PHYLLODISTOMUM LACHANCEI* RECOVERED FROM *SALMO SALAR, SALVELINUS FONTINALIS, S. NAMAYCUSH* COMPARED WITH ORIGINAL DESCRIPTIONS OF *P. LACHANCEI* CHOQUETTE 1947, AND *P. LIMNOSA* SANDEMAN AND PIPPY 1967	17
5.	METAZOAN PARASITE INFECTIONS OF *SALVELINUS FONTINALIS* FROM THE VARIOUS STATIONS	20
6.	RELATIONSHIP BETWEEN THE NUMBER OF PARASITE SPECIES AND AGE OF *SALVELINUS FONTINALIS*	26
7.	METAZOAN PARASITE INFECTIONS OF *SALVELINUS NAMAYCUSH* FROM THE VARIOUS STATIONS	26
8.	RELATIONSHIP BETWEEN THE NUMBER OF PARASITE SPECIES AND AGE OF *SALVELINUS NAMAYCUSH*	29
9.	METAZOAN PARASITE INFECTIONS OF *COREGONUS CLUPEAFORMIS* FROM THE VARIOUS STATIONS	30
10.	RELATIONSHIP BETWEEN THE NUMBER OF PARASITE SPECIES AND AGE OF *COREGONUS CLUPEAFORMIS*	35
11.	METAZOAN PARASITE INFECTIONS OF *ESOX LUCIUS* FROM THE VARIOUS STATIONS	37
12.	RELATIONSHIP BETWEEN THE NUMBER OF PARASITE SPECIES AND AGE OF *ESOX LUCIUS*	40
13.	METAZOAN PARASITE INFECTIONS OF *CATOSTOMUS CATOSTOMUS* FROM THE VARIOUS STATIONS	42
14.	RELATIONSHIP BETWEEN THE NUMBER OF PARASITE SPECIES AND AGE OF *CATOSTOMUS CATOSTOMUS*	44
15.	FOOD ITEMS FOUND IN FISHES FROM CENTRAL LABRADOR	50

LIST OF FIGURES

Figure | Page

1. Sampling areas within the Smallwood Reservoir complex 6

INTRODUCTION

While some of the fishes from the Smallwood Reservoir complex of central Labrador, are distributed throughout the Holarctic e.g. northern pike (*Esox lucius*, Linnaeus), longnose sucker (*Catostomus catostomus* (Forster)) others have a much more restricted distribution. The brook trout (*Salvelinus fontinalis* (Mitchill)) under natural conditions is confined to northeastern North America while the landlocked Atlantic salmon (*Salmo salar*, Linnaeus) is found only in rivers and lakes in the coastal regions of the North Atlantic Ocean (Scott and Crossman, 1973).

A great number of parasitological investigations of fish have been carried out in the Holarctic, with particular reference having been paid to salmonids and coregonids due to their economic importance. The dauntingly large literature on North American fish parasites was gathered together by Hoffman (1967) while Yamaguti (1958, 1959, 1961, 1963a, 1963b) lists the parasites of many fish in his monumental taxonomic work.

However, few parasitological studies have been carried out in Labrador. Frost (1940), Munroe (1949), Davis (1953) and Andrews and Lear (1956) mentioned briefly the larger helminths of salmonids and coregonids. The main parasitological works on fishes of Labrador, all of the coast, are those of Threlfall and Hanek (1970a, 1970b), Hanek and Threlfall (1970a, 1970b, 1970c, 1970d), Hicks (MS., 1971) and Hicks and Threlfall (1973).

The present study of metazoan parasites of fishes in the

Smallwood Reservoir complex was undertaken for two main reasons, (1) because of our lack of knowledge of the parasitpfauna of fishes in the area and (2) because of the possibility that certain fishes there, may be commercially exploited in the future. Ideally studies of the present type should be undertaken before any major environmental modifications are attempted. Finally the present study afforded an opportunity to compare the parasitofauna of similar species of fishes from a land-locked area, with those of coastal (Labrador) and insular (Newfoundland) areas where similar studies have been completed.

MATERIALS AND METHODS

The Study Area

The Smallwood Reservoir complex lies between 53° and 55° North Latitude and 63° and 66° West Longitude. The hydroelectric storage reservoir, the largest in the western world and the third largest man-made lake in the world covers 2,200 square miles and drains an area of 26,744 square miles. When full the Smallwood Reservoir contains 1,000 billion cubic feet of water and the water level fluctuates approximately 28 feet between the spring high and the winter low.

Central Labrador is essentially a plateau 1500 to 1900 feet above sea level and forms the eastern part of the Canadian Shield, which extends to the northern part of the continent. The bedrock of this area is of archean granites and gneisses dating back to the Cambrian period. Glacial action during the past ten million years had scoured the granite bedrock leaving many dents and gouges. The dents filled with water and became scattered lakes and the gouges rivers. Practically the whole plateau is drained by a single river, the Churchill. Most of these lakes are now within the Smallwood Reservoir complex of Churchill Falls. They are interconnected and along the rim of the complex, dykes have been built to contain the water and to help channel it through the powerhouse for generation of electricity. The spent water flows into the lower Churchill River through two tailrace tunnels (Coté, 1972).

Studies conducted on the Smallwood Reservoir complex, by the Department of Environment, Fisheries and Marine Service, Newfoundland,

indicate that the reservoir is oligotrophic and the waters have a low nutrient concentration and are biologically unproductive. The pH ranges between 6.0 to 7.0 (Bruce, 1974; Ostrofsky MS., 1973).

The average annual precipitation of Churchill Falls is 760 mm of which nearly half is composed of snow. The mean daily temperature in January is -23°C and in July 13.6°C. In winter temperatures dip as low as -49°C and in summer rise as high as 30°C. The ice-free period for most lakes within the Smallwood Reservoir complex is from mid-June to early November.

Owing to the harsh climate only the hardiest plants survive. Black spruce *Picea mariana* (Mill.), white spruce *Picea glauca* (Moench), balsam fir *Abies balsamea* (L.), and white birch *Betula papyrifera*, Marsh, mostly stunted, predominate, with lichens, mosses and herbaceous plants providing ground cover.

Procedures

During the period June to August 1975, 332 fishes of eight species were caught at 14 locations in the Smallwood Reservoir of central Labrador (Table 1, Fig. 1). Approximately half were caught by angling and the rest by gill-nets. Most of the lake whitefish and the longnose suckers were caught in the nets while the majority of the trout and pike were caught by angling.

Fishes were either autopsied in the field, immediately after capture, or were deep frozen and then flown to Memorial University where they were stored in freezers for later examination.

Scales for aging were collected from the fishes as described by Lagler (1956). A Bausch and Lomb micro-projector was used for reading

TABLE 1

ORIGIN OF FISHES EXAMINED AND PERCENTAGE INFECTED WITH METAZOAN PARASITES

Species	No. Examined	Percentage infected	Location
Salmo salar	5	100	13
Salvelinus fontinalis	68	94.1	2,3,4,5,7,8,9,13,14
Salvelinus namaycush	32	100	1,3,4,8,11,12,13,14
Coregonus clupeaformis	102	82.3	2,3,4,8
Prosopium cylindraceum	1	100	8
Esox lucius	107	96.3	1,2,3,4,8,10,14
Catostomus catostomus	14	57.1	2,3,6,8
Couesius plumbeus	3	0	8

Key for locations:

1. Sim River
2. Sangirt Lake
3. Cabro Lake
4. Lobstick
5. Churchill River
6. Mile 66, Esker Road
7. Valley River
8. Ossokmanuan
9. Airport Stream
10. Mt. Hyde Lake
11. Mile 28, Orma Rd.
12. Mile 35, Orma Rd.
13. Michikamat River
14. Orma Lake

Figure 1

Sampling areas within the Smallwood Reservoir complex

Key for locations:

1. Sim River
2. Sangirt Lake
3. Gabro Lake
4. Lobstick
5. Churchill River
6. Mile 66, Esker Road
7. Valley River
8. Ossokmanuan
9. Airport Stream
10. Mt. Hyde Lake
11. Mile 28, Orma Road
12. Mile 35, Orma Road
13. Michikamat River
14. Orma Lake

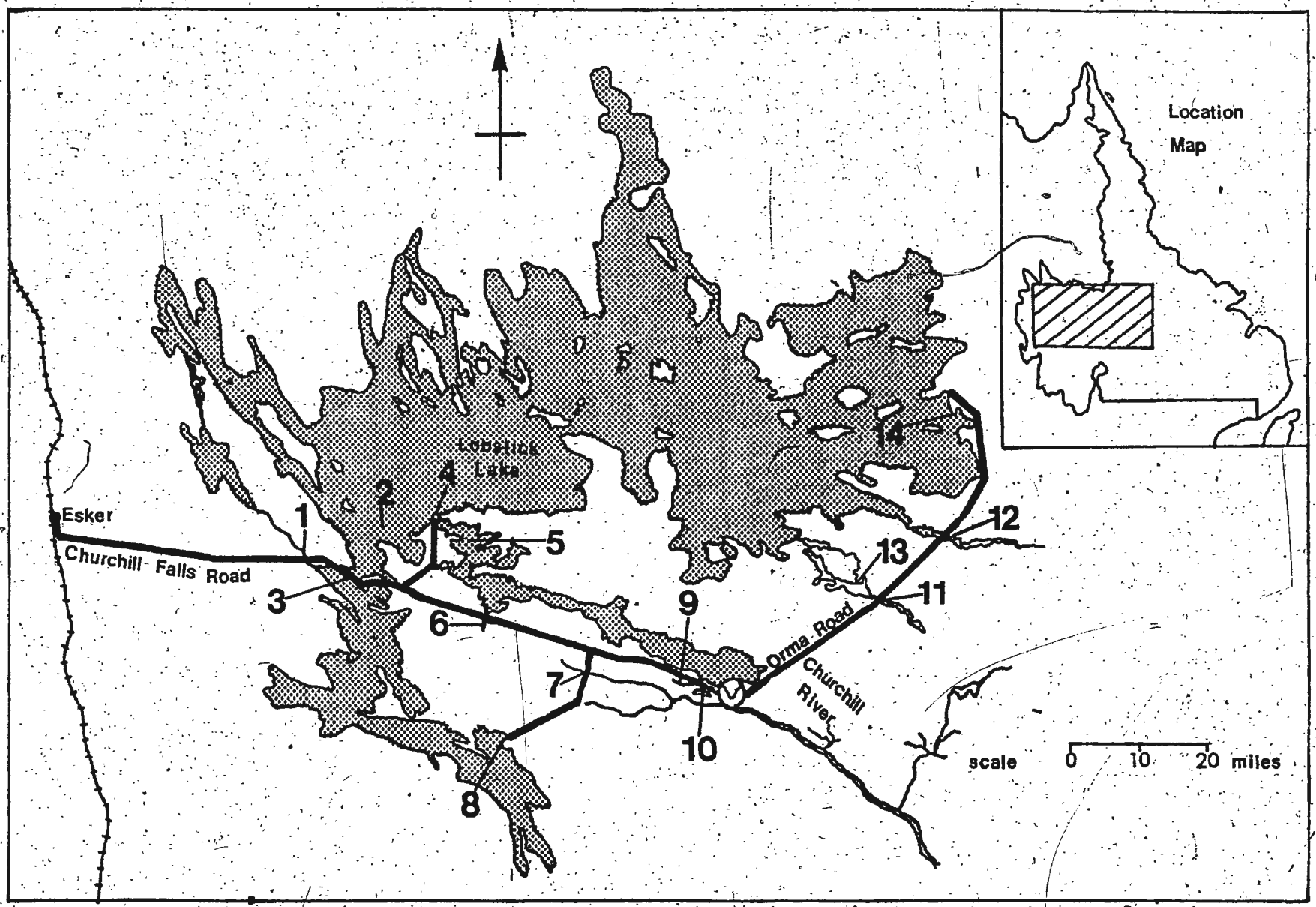


Fig. 1. Smallwood Reservoir, Labrador

the scales. The fork length, weight and sex of each fish was noted.

Conventional parasitological techniques were used in the examination of the fishes for metazoan parasites (Fernando *et al.*, 1972). The sites of infection/infestation were noted. The gut of all the fishes was divided into three regions (viz. 'stomach' which included the oesophagus, pyloric region and intestine).

Monogenetic trematodes were normally fixed and mounted directly in a mixture of glycerol and ammonium picrate (Malmberg, 1956). A few were fixed in 70% alcohol and later stained in Semichon's aceto-carmine and mounted in Canada Balsam. Digenetic trematodes and cestodes were relaxed in 1% ethyl carbamate then fixed and stored in 70% alcohol. Subsequently they were either stained in Semichon's aceto-carmine or in trichrome (Gomori) stain and mounted in Canada Balsam. Nematodes were fixed and stored in glycerine alcohol (Schell, 1962). Small nematodes were mounted directly in Rubin's fluid (Rubin, 1951) while the larger nematodes were first cleared in lactophenol before they were mounted either in glycerine jelly or in Rubin's fluid. Acanthocephala were relaxed in cold water, then fixed and stored in Demke's solution. Later some were mounted in Rubin's fluid while others were stained in Semichon's aceto-carmine and mounted in Canada Balsam. Copepods were fixed and stored in ethyl alcohol (70%). A number of them were mounted whole, in Rubin's fluid, while others were stained in Semichon's aceto-carmine and mounted in Canada Balsam. The mouth-parts, which are of taxonomic importance in many species, were removed from several specimens of each species and mounted in Rubin's fluid.

The statistical tests used in the present study were (2x2) or

(2xc) contingency classifications (Simpson, Roe, and Lewontin, 1960). Attempts were made to ascertain, whether there was any relationship between the age and sex of the fishes and their parasite burden. Further tests were performed to determine whether differences existed between the parasite burden of fishes from different localities and between the different fish species.

Terminology and taxonomy of the fishes follows the scheme of the American Fisheries Society, Special Publication No. 6 (1970) and that of the parasites follow Yamaguti (1958, 1959, 1961, 1963a, 1963b) and Kabata (1969).

RESULTS AND DISCUSSION

Three hundred and thirty-two fishes of eight species from the Smallwood Reservoir complex were autopsied, metazoan parasites belonging to 15 genera (2 of Monogenea, 2 of Digenea, 4 of Cestoda, 3 of Nematoda, 2 of Acanthocephala and 2 of Copepoda) being recovered (Table 2). Details of the sites of infection with the parasites found in the fishes are shown in Table 3.

Salmo salar Linnaeus, 1758 (Atlantic salmon (landlocked))

Five landlocked, male *Salmo salar* weighing from 1588 g to 4264 g (mean 2250 g), measuring 51 cm to 70 cm (mean 55.3 cm) in length, and between the ages of 7 and 12 years, from Michikamat River were examined. Seven genera of metazoan parasites (1 of Monogenea, 2 of Digenea, 3 of Cestoda and 1 of Copepoda) were recovered. Details of infection with metazoan parasites are given in Tables 2 and 3.

On the gills of one of the five fish autopsied, one specimen of *Discocotyle sagittata* (Leuckart, 1842) was recovered. Sandeman and Pippy (1967) found what they reported as *D. salmonis* Shaffer, 1916, on landlocked salmon from Gambo Pond and Ocean Pond in insular Newfoundland. It is now accepted by most workers (e.g. Price, 1943; Brinkman, 1952) that *D. salmonis* and *D. sagittata* are identical and hence synonymous. By virtue of the Law of Priority (Article 23 of The International Code of Zoological Nomenclature, 1964) *D. sagittata* (Leuckart, 1842) Diesing, 1850 stands as the valid name of the species.

TABLE 2

DETAILS OF INFECTION WITH METAZOAN PARASITES OF FISHES* FROM CENTRAL LABRADOR

	Salmo salar			*Salvelinus fontinalis*			*Salvelinus namaycush*			*Coregonus clupeaformis*			*Esox lucius*			*Catostomus catostomus*		
	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Tetraonchus monenteron	-	-	-	-	-	-	3.1	1	1	-	-	-	84	2-2280	232.4	-	-	-
Discocotyle sagittata	20	1	1	4.4	1-3	2	-	-	-	17.6	1-5	1.8	-	-	-	-	-	-
Crepidostomum farionis	-	-	-	60.3	1-422	42	9.3	1-185	62.3	4.9	1-27	5.2	-	-	-	-	-	-
Crepidostomum cooperi	20	1	1	-	-	-	3.1	24	24	2.9	1-4	2.3	-	-	-	-	-	-
Phyllodistomum coregoni	-	-	-	-	-	-	-	-	-	20.6	1-11	3.28	-	-	-	-	-	-
Phyllodistomum lachancei	20	3	3	72	1-51	7.5	15.6	1-28	9.2	-	-	-	-	-	-	-	-	-
Triaenophorus crassus	-	-	-	-	-	-	12.5	1-16	4.75	15.6	1-9	3.6	64.48	1-62	12.95	-	-	-
Eubothrium salvelini	100	25-302	98	64.7	1-38	5.5	56	1-26	3.8	-	-	-	-	-	-	-	-	-
Diphyllobothrium sp.	20	75	75	2.9	1-2	1.5	43.75	1-36	15.5	4.9	1-42	14.2	-	-	-	-	-	-
Proteocephalus pinguis	-	-	-	-	-	-	-	-	-	-	-	-	75.7	1-425	36.78	-	-	-
Proteocephalus tumidocollus	-	-	-	1.47	2	2	25	1-82	13.1	47	1-138	7.1	-	-	-	-	-	-
Proteocephalus sp. A	-	-	-	5.8	1-41	12.5	9.3	2-56	24	4.9	2-10	5.2	-	-	-	-	-	-
Proteocephalus sp. B	20	4	4	11.7	1-4	2.5	53	1-102	14	2.9	2-10	5	-	-	-	-	-	-
Raphidascaris sp.	-	-	-	7.3	1-72	15.2	9.3	1	1	0.98	2	2	-	-	-	-	-	-
Raphidascaris canadensis	-	-	-	-	-	-	-	-	-	-	-	-	51.4	1-46	7.4	-	-	-
Capillaria salvelini	-	-	-	4.4	1-5	2.3	59.3	1-444	74.4	19.6	1-10	2.6	-	-	-	-	-	-
Metabronema salvelini	-	-	-	2.9	1-4	2.5	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 2 (CONTINUED)

	Salmo salar			*Salvelinus fontinalis*			*Salvelinus namaycush*			*Coregonus clupeaformis*			*Esox lucius*			*Catostomus catostomus*		
	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Metechinorhynchus lateralis	-	-	-	2.9	1-23	12	-	-	-	-	-	-	0.93	1	1	-	-	-
Neoechinorhynchus crassus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	57.1	4-55	14.75
Ergasilus caerulus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.1	39	39
Salmincola extumescens	20	1	1	-	-	-	-	-	-	8.8	1	1	-	-	-	-	-	-
Salmincola coregonorum	-	-	-	-	-	-	-	-	-	0.98	1	1	-	-	-	-	-	-
Salmincola edwardsii	-	-	-	36.7	1-31	4.52	-	-	-	-	-	-	-	-	-	-	-	-
Salmincola tiscowet	-	-	-	-	-	-	3.1	1	1	-	-	-	-	-	-	-	-	-

*The lone *Prosopium cylindraceum* examined was infected with 5 *Phyllodistomum coregoni* while all 3 *Couesius plumbeus* were parasite free.

a = percentage of fish infected with that parasite.

b = range of parasite number per infected fish.

c = average number of parasites per infected fish.

TABLE 3

CHECKLIST OF PARASITOFAUNA AND LOCATION OF INFECTION

Species	*Salmo salar*	*Salvelinus fontinalis*	*Salvelinus namaycush*	*Coregonus clupeaformis*	*Prosopium cylindraceum*	*Esox lucius*	*Catostomus catostomus*
Tetraonchus monenteron	–	–	8	–	–	8	–
Discocotyle sagittata	8	8	–	8	–	–	–
Crepidostomum farionis	–	2,3,4	2,3	3,4	–	–	–
Crepidostomum cooperi	3	–	2,3	3	–	–	–
Phyllodistomum coregoni	–	–	–	7	7	–	–
Phyllodistomum lachancei	7	7	7	–	–	–	–
Triaenophorus crassus	–	–	11	11	–	2,3	–
Eubothrium salvelini	2	1,2,3	2,3,5	–	–	–	–
Diphyllobothrium sp.	1,2,3,5,6	1,2	1,2	1,2,10,6,5	–	–	–
Proteocephalus pinguis	–	–	–	–	–	1,2,3	–
Proteocephalus tumidocollus	–	2	2,3	1,2,3	–	–	–
Proteocephalus sp. A	–	3	2,3	2	–	–	–
Proteocephalus sp. B	2,3	3	2,3,5	2,3	–	–	–
Raphidascaris sp.	–	1,2,3	2,3	3	–	–	–
Raphidascaris canadensis	–	–	–	–	–	1,2,3	–
Capillaria salvelini	–	3	2,3,5	3	–	–	–
Metabronema salvelini	–	1	–	–	–	–	–
Metechinorhynchus lateralis	–	3	–	–	–	3	–

TABLE 3 (CONTINUED)

Species	*Salmo salar*	*Salvelinus fontinalis*	*Salvelinus namaycush*	*Coregonus clupeaformis*	*Prosopium cylindraceum*	*Esox lucius*	*Catostomus catostomus*
Neoechinorhynchus crassus	–	–	–	–	–	–	1,2,3,5
Ergasilus caerulus	–	–	–	–	–	–	8
Salmincola extumescens	8	–	–	8	–	–	–
Salmincola coregonorum	–	–	–	8	–	–	–
Salmincola edwardsii	–	8,9	–	–	–	–	–
Salmincola siscowet	–	–	9	–	–	–	–

Key: 1 - stomach; 2 - pyloric caeca; 3 - intestine; 4 - gall bladder; 5 - body cavity; 6 - liver; 7 - kidney; 8 gills; 9 fins; 10 - heart; 11 - body muscles;

A lone specimen of a digenean not previously reported in this host, namely *Crepidostomum cooperi* Hopkins, 1931 was also found in the rectum of one fish. Neither Sandeman and Pippy (1967) nor Hicks and Threlfall (1973) reported this species from the *Salmo salar* they examined in insular Newfoundland and coastal Labrador respectively. Hanek and Threlfall (1969) found six mature *C. cooperi* in (stickleback) *Gasterosteus aculeatus* Linnaeus, 1758 from insular Newfoundland.

Phyllodistomum lachancei Choquette, 1947 has previously been recorded from brook trout in Quebec (Choquette, 1947). Specimens of *P. lachancei* were taken from the ureter of one *S. salar* in the present study. Hicks and Threlfall (1973) did not find this parasite in any *S. salar* from the Labrador coast that they examined. However, Sandeman and Pippy (1967) found a *Phyllodistomum* sp., in 15.4% of the landlocked salmon they examined in insular Newfoundland. They described it as a new species, namely *P. limnosa*, on the basis of the presence of an accessory sucker on the oral sucker and its slightly smaller mean size when compared to *P. lachancei*. They did in fact note that many of their specimens fitted closely the descriptions and measurements of *P. lachancei*.

During the present study the "accessory sucker" was seen in specimens of not only *P. lachancei* from landlocked salmon, brook trout and lake trout but also in *P. coregoni* from lake whitefish. Choquette (1947) did not mention the presence of any "accessory sucker" in his original description. It may well be that the manner in which the specimens were prepared and mounted in this and other studies may account for the presence/absence (visible/not visible) of the "accessory sucker". The measurements of *P. lachancei* from *Salmo salar*, *Salvelinus fontinalis*

and *S. namaycush* are given in Table 4. The author considers *P. lachancei* and *P. limnosa* to be synonymous with the former name being valid according to the law of priority (Article 23 of the International Code of Zoological Nomenclature, 1964).

The majority of *Eubothrium salvelini* (Schrank, 1790), from the landlocked salmon, were immature. Sandeman and Pippy (1967) noted seasonal variation in the maturity of the specimens they recovered. Fish taken in spring and early summer contained mature cestodes while those collected in late August, September or later contained immature specimens only. The present specimens were collected in August (15th to 27th). The *E. salvelini* in the infected fish from insular Newfoundland (according to Sandeman and Pippy) mature during the winter and spring months and later die after releasing their eggs in late summer. This may also be the case in Labrador fish. Hicks and Threlfall (1973) did not find any *E. salvelini* in the *S. salar* they examined from coastal Labrador. They did, however recover *E. crassum* (Bloch, 1779) which was absent in the present study. Sandeman and Pippy (1967) found 69.2% of the landlocked salmon they examined to be infected. In the present study 100% of the *S. salar* were infected.

Four identical *Proteocephalus* sp. (one of which was unfortunately lost during the staining process) were recovered. The absence of an apical sucker suggested that they were immature specimens of *P. salvelini* (Linton, 1897). Hicks and Threlfall (1973) found an immature *Proteocephalus* sp. with a scolex bearing an apical sucker, in fish from St. Mary's River Labrador, which they called *Proteocephalus* sp. Type 1.

Plerocercoids of a *Diphyllobothrium* species were recovered from cysts on the outer wall of the stomach, intestine and liver of one fish. Some of the cysts were teased apart releasing plerocercoids from

TABLE 4

MEASUREMENTS (IN MICRONS WITH AVERAGE IN PARENTHESIS) OF *PHYLLODISTOMUM LACHANCEI* RECOVERED FROM *SALMO SALAR*, *SALVELINUS FONTINALIS* AND *S. NAMAYCUSH* COMPARED WITH ORIGINAL DESCRIPTIONS OF *P. LACHANCEI*, CHOQUETTE 1947, AND *P. LIMNOSA* SANDEMAN AND PIPPY, 1967

	Salmo salar	*S. fontinalis*	*S. namaycush*	*P. lachancei* Choquette, 1947	*P. limnosa* Sandeman and Pippy, 1967
Total length	2814-3907(3360)	2430-4860(3354)	2366-4144(3265)	2010-3680(2920)	1450-3660(2840)
Maximum width	762-939(850)	767-1663(1238)	553-1125(856)	960-1490(1310)	550-1590(865)
Oral Sucker	266-320(293)	234-365(322)	224-410(306)	220-360(278)	110-274(209)
Ventral Sucker	213-319(266)	266-437(366)	266-426(355)	240-420(346)	165-450(284)
Anterior testis	293-373(333)	266-887(548)	470-762(574)	190-540(410) by 310-740(500)	165-495(330)
Posterior testis	-	239-895(613)	470-856(656)	300-570(420) by 360-750(530)	
Ovary	160-266(213)	160-410(290)	208-341(271)	150-360(230) by 160-390(270)	-
Eggs	21-23(22) by 31-34(32.5)	21-29(26) by 26-37(31)	21-26(24.5) by 31-39(34)	20-30(20) 30-50(40)	14-23(17) by 23-43(29)

TABLE 4 (CONTINUED)

	Salmo salar	*S. fontinalis*	*S. namaycush*	*P. lachancei* Choquette, 1947	*P. limnosa* Sandeman and Pippy, 1967
Vitelline gland	-	133-250(180)	122-213(169)	70-220(150) 100-270(190)	-

14.2 to 26.9 mm length and from 0.9 to 1.5 mm width. This is a common parasite of several species of fish (Hoffman, 1967).

A single female *Salmincola extumescens* (Gadd, 1901) was found on the gills of one *S. salar*. This copepod has previously been found on various species of *Coregonus* from the USSR, USA and Canada (*vide* Hoffman, 1967 and Kabata, 1969) but never before on a landlocked salmon.

Salvelinus fontinalis (Mitchill, 1815) (Brook trout)

Sixty-eight brook trout weighing from 15 g to 2268 g (mean 1011 g), measuring 11.5 cm to 60 cm (mean 38 cm) in length and between the ages of 1 and 10 years were examined during the present study. This host contained the widest diversity of parasites of all the species of fishes examined. Eleven genera of metazoan parasites (one of Monogenea, two of Digenea, three of Cestoda, three of Nematoda, one of Acanthocephala and one of Copepoda) were found. Details of infection can be seen in Tables 2, 3 and 5.

Phyllodistomum lachancei was the most common trematode found in the brook trout examined (72% infection). This parasite has previously been found in *S. fontinalis* in Quebec, (Choquette, 1947) and in *S. gairdneri* in Wisconsin (Fischthal, 1947). Both Hicks and Threlfall (1973) and Sandeman and Pippy (1967) reported a species of *Phyllodistomum* which they described as *P. limnosa* from the brook trout they examined from coastal Labrador and insular Newfoundland respectively. As mentioned earlier *P. lachancei* and *P. limnosa* are synonymous.

Crepidostomum farionis (Muller, 1784) was a very common trematode of brook trout (60.3% infection). The majority of specimens were found in the intestine. Three individuals were found in the gall bladder.

TABLE 5

METAZOAN PARASITE INFECTIONS OF *SALVELINUS FONTINALIS* FROM THE VARIOUS STATIONS

	Sangirt			Gabro			Lobstick			Churchill R.			Ossok.			Airport S.			Valley R.			Mich. R.			Orma L.		
	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Diecocotyle sagittata	100	1	1	-	-	-	-	-	-	25	2-3	2.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Crepidostomum farionis	-	-	-	50	23	23	100	12-60	36	75	1-422	92.3	100	25	25	83	1-239	75.8	100	26	26	58.9	1-269	28.1	-	-	-
Phyllodistomum lachancei	100	6	6	50	5	5	100	3-6	4.5	50	1-2	1.2	-	-	-	-	-	-	-	-	-	92.3	1-24	7.2	75	4-51	15.5
Diphyllobothrium sp.	-	-	-	50	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.5	1	1	-	-	-
Proteocephalus tumidocollus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.5	2	2
Proteocephalus sp. A.	-	-	-	-	-	-	-	-	-	12.5	41	41	100	2	2	-	-	-	100	1	1	2.5	6	6	-	-	-
Proteocephalus sp. B.	-	-	-	-	-	-	-	-	-	25	6	3	-	-	-	-	-	-	-	-	-	75	1-4	2.3	-	-	-
Eubothrium salvelini	100	28	28	100	3-8	5.5	50	18	18	62.5	3-5	3.8	-	-	-	-	-	-	-	-	-	74.3	1-38	5.2	75	1-10	3
Raphidascaris sp.	-	-	-	-	-	-	-	-	-	12.5	1	1	100	72	72	-	-	-	100	1	1	5.1	1	1	-	-	-
Capillaria salvelini	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.5	1-4	2.3	-	-	-
Metabronema salvelini	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	1	1	-	-	-	12.5	4	4
Metechinorhynchus lateralis	-	-	-	50	23	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	1	1			
Salmincola edwardsii	-	-	-	50	31	31	-	-	-	12.5	1	1	-	-	-	16.6	2	2	-	-	-	46.1	1-13	37.1	50	2.6	2.75

a = percentage of fish infected with that parasite.

b = range of parasite number per infected fish.

c = average number of parasites per infected fish.

This parasite has previously been reported from brook trout in Ontario by Bangham and Venard (1946); MacLulich (1934b) and in many species of fishes in addition to salmonids from the United States and Europe (Hopkins, 1934; *vide* Hoffman, 1967). Sandeman and Pippy (1967) found that this species was prevalent in *S. fontinalis* and had a wide distribution in insular Newfoundland (62.6% infection) as did Threlfall and Hanek (1970c) (19% infection). Hicks and Threlfall (1973) found this digenean parasitised 34% of the brook trout they examined from coastal Labrador.

Eubothrium salvelini has been recovered from the brook trout in many regions of North America (*vide* Hoffman, 1967). In the present study *E. salvelini* was the most common cestode found in brook trout (64.7% infection). They were mostly found in the pyloric region with their scoleces embedded in the mucosa of the pyloric caecae. Hicks and Threlfall (1973) found a much lower prevalence in the brook trout (15% infection) they examined from coastal Labrador. Pippy (MS., 1965) found this parasite present (25.2% infection) in brook trout from various parts of insular Newfoundland while Threlfall and Hanek (1970c) recorded the presence of a *Eubothrium* sp. from the same host (9% infection).

A small number of larval or immature proteocephalids, which could not be identified to species level as they lacked diagnostic features, were found. They were divided on the basis of the presence or absence of an apical sucker. *Proteocephalus* sp. Type A had an apical sucker while *Proteocephalus* sp. Type B lacked an apical sucker. The former could be immature forms of *P. tumidocollus* Wagner, 1953

and the latter immature forms of *P. salvelini*. Linton (1897) found *P. salvelini* in lake trout from Lake Superior. The presence of small numbers of larval or immature proteocephalids, with few diagnostic features in brook trout, has been reported by Choquette (MS., 1953), and Lyster (1940) from Quebec. Hicks and Threlfall (1973) found that 11% of the brook trout they examined were infected with *Proteocephalus* sp. Type A and another 11% infected with *Proteocephalus* sp. Type B. During the present study, 5.8% of the *S. fontinalis* were infected with *Proteocephalus* sp. Type B and 11.7% with *Proteocephalus* sp. Type B. Sandeman and Pippy 1967 failed to find any species of *Proteocephalus* in the brook trout they examined from the various parts of the island of Newfoundland.

Proteocephalus tumidocollus was found in 1.5% of the brook trout examined. Since this cestode was first described in the rainbow trout from California in 1953 by Wagner, it has been found in a number of fishes. Hicks and Threlfall (1973) noted a prevalence of 4% in *S. fontinalis* from coastal Labrador.

Metabronema salvelini Fujita, 1920 was found in 2.9% of the *S. fontinalis* examined during the present study. Choquette (1948b) after examining various specimens came to the conclusion that *M. salvelini* Fujita, *M. harwoodi* Chandler 1931, *M. canadense* Skinker, 1931 and *M. truttae* Baylis, 1935 are one and the same species (i.e. he synonymizes them all with *M. salvelini*). *Metabronema salvelini* has been found in various species of fish in the USA, Canada and England. Both Hicks and Threlfall (1973) and Sandeman and Pippy (1967) found this parasite in the brook trout they examined.

Capillaria salvelini Polyanski, 1952 was recovered from three (4.4% infection) of the brook trout examined during the present study. Hicks and Threlfall (1973) noted a prevalence of 7% in the brook trout they examined from coastal Labrador. A much higher prevalence was recorded by Threlfall and Hanek (1969) who recovered this nematode in seven brook trout (63.6% infection) from a pond about 6 miles from St. John's, Newfoundland. However Sandeman and Pippy (1967) did not recover this parasite in *S. fontinalis* they examined in insular Newfoundland. The recovery of *C. salvelini* in central Labrador in the present study extends the geographic range of this nematode.

Immature specimens of a *Raphidascaris* sp. were recovered from the gut of the brook trout examined (7.3% infection). Identification to the species level was not possible due to the lack of special diagnostic features. However, Richardson (1937) described *R. laurentianus* from brook trout taken in Quebec. The present specimens may well be immatures of this species.

Metechinorhynchus lateralis (Leidy, 1851) was found in only two of the *S. fontinalis* (2.9% infection) examined. A much higher prevalence were noted in the same host, in coastal Labrador (Hicks and Threlfall, 1973 50% infection) and in insular Newfoundland (Sandeman and Pippy, 1967, 81.7% infection). It has also previously been found in Quebec (Choquette, 1948a; Richardson, 1936) in *S. fontinalis*.

Salmincola edwardsii (Olsson, 1869) was found on 36.7% of the brook trout examined. They were found on the gills and dorsal and pectoral fins. Hicks and Threlfall (1967) found a much lower prevalence

of this parasitic copepod on *S. fontinalis* (18% infection) from coastal Labrador. This parasite has previously been found on the same host in New York, Wisconsin, New Hampshire, Montana, British Columbia and Newfoundland (*vide* Kabata, 1969). Sandeman and Pippy 1967, described a new species *S. exsanguinata* on brook trout from insular Newfoundland. After examining the specimens of *S. exsanguinata* of Sandeman and Pippy 1967, Kabata synonymized the species with *S. edwardsii*.

No correlation between the number of parasite species found in the brook trout and the age of the fish (Table 6) was noted. There were also no significant differences in the burden of *Discocotyle sagittata*, *Crepidostomum farionis*, *Eubothrium salvelini* and *Salmincola edwardsii* with regard to the sex of the fish. There were no significant differences in the parasitic burden among the different locations where the brook trout were caught.

Salvelinus namaycush (Walbaum, 1792)(Lake trout)

During the present study, thirty-two lake trout weighing from 840 to 5897 g (mean 2155 g) measuring 42.5 to 81 cm (mean 56 cm) in length and between the ages of 6 and 16 years from eight locations were examined.

Ten genera of metazoan parasites were identified from the *S. namaycush* examined (1 of Monogenea, 2 of Digenea, 4 of Cestoda, 2 of Nematoda and 1 of Copepoda). Details of infection with metazoan parasites are shown in Tables 2, 3 and 7.

A single specimen of *Tetraonchus monenteron* (Wagener, 1857) not previously recorded from this host was found on a fish caught at

TABLE 6

RELATIONSHIP BETWEEN THE NUMBER OF PARASITE SPECIES AND AGE OF *SALVELINUS FONTINALIS*

Age class (years)	The Number of Parasite Species Found							
	0	1	2	3	4	5	6	7
0 – 1	–	–	33.3	66.7	–	–	–	–
1 – 2	7.2	21.4	28.6	21.4	21.4	–	–	–
2 – 3	–	–	33.3	44.5	22.2	–	–	–
3 – 4	–	–	–	50	50	–	–	–
4 – 5	–	–	25	75	–	–	–	–
5 – 6	25	–	25	37.5	–	–	–	12.5
6 – 7	12.5	12.5	12.5	12.5	50	–	–	–
7 – 8	–	–	–	60	20	20	–	–
8 – 9	–	28.6	14.2	28.6	28.6	–	–	–
9 – 10	–	50	–	–	50	–	–	–

Figures in Table show the percentage of fish in each age class

TABLE 7

METAZOAN PARASITE INFECTIONS OF *SALVELINUS NAMAYCUSH* FROM THE VARIOUS STATIONS

Species	Sim. R.			Gabro			Lobstick			Ossok.			Mile 28 Orma Road			Mile 35 Orma Road			Mich. R.			Orma L.		
	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
**Tetraonchus monenteron*		-			-			-			-			-		33	1	1		-			-	
Crepidostomum farionis		-			-			-			-			-		33.3	185	185	12.5	1	1	8.3	1	1
**Crepidostomum cooperi*		-			-			-			-			-			-			-		8.3	24	24
**Phyllodistomum lachancei*		-			-			-			-		100	1	1		-		12.5	7	7	25	2-28	12.6
Triaenophorus crassus		-		50	1	1	50	16	16		-			-		33.3	2	2		-			-	
Eubothrium salvelini		-		75	1	1	50	7	7	100	26	26		-		33.3	11	11	50	1-21	6.3	58.3	1-5	2
Diphyllobothrium sp.		-		50	33-34	33.5	50	30	30		-			-		100	8-19	13.3	62.5	5-36	19	25	1-4	2.3
Proteocephalus tumidocollus		-			-			-		100	2	2		-		66.6	1-6	3.5	37.5	1-82	28.3	16.6	4-7	5.5
Proteocephalus sp. A	100	36	36	25	2	2		-		100	56	56		-			-			-		8.3	10	10
Proteocephalus sp. B	100	44	44	75	2-25	11		-		100	102	102		-			-		62.5	1-5	3.2	58.3	1-19	6.1
Raphidascaris sp.		-		25	1	1		-		100	1	1	100	1	1		-			-			-	
Capillaria salvelini		-		25	1	1		-			-		100	191	191	66.6	3-12	7.5	100	8-442	108.1	58.3	1-12	48.8
Salmincola siscowet		-			-			-			-			-			-			-		8.3	1	1

a = percentage of fish infected with that parasite.

b = range of parasite number per infected fish.

c = average number of parasites per infected fish.

*new host record

Mile 35, Orma Road. It has previously been reported from various localities in Europe and in North America on the northern pike (*Esox lucius*).

Crepidostomum farionis was recovered from 9.3% of the lake trout examined, which is lower than the prevalence (39% infection) recorded by Hicks and Threlfall (1973). No difference in the prevalence or degree of infection with this parasite was found between the host sexes.

Crepidostomum cooperi, not previously recorded in *S. namaycush*, was found in 3.1% of the fish examined during the present study.

The presence of *Phyllodistomum lachancei* in the lake trout (15.6% infection) examined constitutes a new host record. Hicks and Threlfall (1973) failed to recover any *Phyllodistomum* from the *S. namaycush* they examined from the coast of Labrador.

Four (12.25% infection) of the lake trout examined were found to have plerocercoids *Triaenophorus crassus* Forel, 1868 encysted in their muscles. One lake trout harboured 16 cysts. The presence of this cestode in the lake trout is a new geographic record.

Proteocephalus tumidocollus was recovered from 25% of the lake trout examined in the present study. Hicks and Threlfall (1973) found a lower prevalence of this cestode in the *S. namaycush* they examined from coastal Labrador (10% infection). They also found in the same host, *Proteocephalus* sp. Type A (10% infection) and *Proteocephalus* sp. Type B (48% infection). During the present study, closely similar infection rates (9.3% and 53% respectively) were found in the same host.

The first record of a *Proteocephalus* in a species of trout in

North America was that of Linton who,. in 1897 described *Taenia salvelini (= Proteocephalus salvelini* (Linton), from the intestine of *Cristivomer namaycush (= S. namaycush)* from Lake Superior. In 1943, MacLulich (1943a) described *Proteocephalus parallacticus* in *S. namaycush* from Algonquin Park, Ontario.

Capillaria salvelini was the commonest nematode found in lake trout during the present study (59.3% infection). In one fish, 444 individuals of this species were collected. The above prevalence is similar to that noted by Hicks and Threlfall (1973, 55% infection).

A single specimen of *Salmincola siscowet* (Smith, 1874) which has previously been found in lake trout from Lake Superior and Lake Commandant, Quebec (*vide* Kabata, 1969) was found on the dorsal fin of a *S. namaycush* from Orma Lake. This is the first record of this parasite being found in lake trout from Labrador.

There was little correlation in the parasite burden between the number of parasite species found in *S. namaycush* and the age of the fish (Table 8). No differences were noted in the prevalence of parasitism and the sex of the fish.

Coregonus clupeaformis (Mitchill, 1818) (Lake Whitefish)

One hundred and two lake whitefish weighing from 12 g to 2177 g (mean 474 g), measuring 11 cm to 51 cm (mean 45.3 cm) in length and between the ages of 1 and 15 years were examined for metazoan parasites.

Nine genera of metazoan parasites (1 of Monogenea, 2 of Digenea, 3 of Cestoda, 2 of Nematoda and 1 of Copepoda) were found. Details of infection are shown in Tables 2, 3 and 9.

TABLE 8

RELATIONSHIP BETWEEN THE NUMBER OF PARASITE SPECIES AND AGE OF *SALVELINUS NAMAYCUSH*

Age Class (Years)	The Number of Parasite Species Found						
	0	1	2	3	4	5	6
5 - 6	-	-	-	-	-	-	-
6 - 7	-	-	-	-	100	-	-
7 - 8	-	14	29	14	14	29	-
8 - 9	-	20	20	-	40	20	-
9 - 10	-	-	50	50	-	-	-
10 - 11	-	-	40	30	30	-	-
11 - 12	-	100	-	-	-	-	-
14 - 15	-	-	100	-	-	-	-
15 - 16	-	-	100	-	-	-	-
16 - 17	-	-	100	-	-	-	-

Figures in Table show the percentage of fish in each age class.

*No lake trout under the age of 6 were caught.

TABLE 9

METAZOAN PARASITE INFECTIONS OF *COREGONUS CLUPEAFORMIS* FROM THE VARIOUS STATIONS

Species	Sangirt			Gabro			Lobstick			Ossok		
	a	b	c	a	b	c	a	b	c	a	b	c
Discocotyle sagittata				18.4	1-5	2.4	25	1-3	1.8	16.6	1-2	1.4
Crepidostomum farionis				10.5	1-27	12.2	4.1	3	3	3.3	2	2
Crepidostomum cooperi				7.9	1-4	2.3						
Phyllodistomum coregoni				23.7	1-11	4.3	25	1-6	2.3	20	2-5	2.8
Triaenophorus crassus				13.2	1-4	3.2	33.3	1-9	3.75	10	2-8	4
Diphyllobothrium sp.				5.2	4-5	4.5	12.5	1-42	20.6			
Proteocephalus tumidocollus	70	1-5	2	36.8	1-11	3.6	29	1-8	3.7	70	1-138	16.7
Proteocephalus sp. A.				7.9	2-4	3.3	8.3	6-10	8	3.3	2	2
Proteocephalus sp. B.				7.9	2-10	5				3.3	9	9
Capillaria salvelini	10	1	1	28.9	1-6	2	4.2	1	1	23.3	2-10	4
Raphidascaris sp.										3.3	2	2
Salmincola extumescens				13.1	1	1	12.5	1	1	3.3	1	1
Salmincola coregonorum										3.3	1	1

a - percentage of fish infected with that parasite.

b - range of parasite number per infected fish.

c - average number of parasites per infected fish.

Discocotyle sagittata was recovered from 17.6% of the whitefish autopsied, a figure that is somewhat higher than that of Hicks and Threlfall (1973) of 7%. This parasite has previously been found in a variety of coregonids from various parts of North America (*vide* Hoffman, 1967).

Both species of *Crepidostomum* were recovered from the whitefish examined (4.9% infection with *C. farionis*, 2.9% with *C. cooperi*). The prevalence of *C. farionis* is similar to that found by Hicks and Threlfall (1973), of 8%. They failed however, to find any *C. cooperi* in their specimens. Sandeman and Pippy (1967) did not recover any *Crepidostomum* from the whitefish they examined from the island of Newfoundland.

Dechtiar (1966) described *Phyllodistomum coregoni* from the ureters of *C. clupeaformis* taken in Ontario. During the present work, this trematode was found in 20.6% of the fish examined. This is the first record of this parasite being found in Labrador.

Plerocercoids of *Triaenophorus crassus*, encysted in the muscles were quite common in this host (15.6% infection). Although the parasites themselves do no harm to humans if ingested, they are unsightly and make the fish aesthetically undesirable. The cysts, white to cream in colour, contain a single plerocercoid which is bathed in a milky fluid, composed of broken down host tissue which it feeds on. Typically the cyst is spindle shaped and formed essentially of host connective tissue. This parasite has a wide geographic distribution and has been recorded everywhere that coregonids and pike are found (Lawler and Scott, 1954; Kuperman, 1968; Michajlow, 1962). This species of cestode is quite a serious problem in Canada where the whitefish is commercially

exploited. Over 17,000,000 pounds of whitefish are caught annually in Canada with a value in excess of six million dollars. The majority of the catch (90%) goes to the United States (Lawler, 1970). When the whitefish is heavily infected marketability is affected due to the unpleasant appearance of the flesh of the fish. Miller (1952) described the life cycle of *T. crassus* which in brief is as follows: parasite eggs are passed out in the faeces of the northern pike (*Esox lucius*) the definitive host, from April to June. Coracidia, which are viable for about 2-3 days, emerge from the eggs and are eaten by a suitable intermediate host (a copepod, usually *Cyclops bicuspidatus* Claus 1857, in Canada). A procercoid stage then develops in the haemocoel of the intermediate host. If an infected copepod is eaten by a coregonid fish, the procercoid is released and develops after migration, into a plerocercoid stage. The latter may live up to four to five years before dying. If the infected coregonid is eaten by a pike the larval form develops in the host's intestine and reaches maturity the following spring. There have been many attempts to reduce *T. crassus* infection in whitefish. One exceptionally successful experiment was the Heming Lake Experiment (Lawler, 1970) which involved a reduction in the numbers of the final host, the pike. This resulted in eradication of *T. crassus* in the whitefish. Although this could be done in a small area, the method is not practical in a large body of water, such as the Smallwood Reservoir. Neither Hicks and Threlfall (1973) nor Sandeman and Pippy (1967) found any plerocercoids of *T. crassus* in the whitefish they examined. This is not totally unexpected in the case of insular Newfoundland as the definitive host *Esox lucius* is absent from the island.

This is the first record of this parasite in whitefish from Labrador.

Plerocercoids of *Diphyllobothrium* sp. encysted on the outer wall of the alimentary canal were found in 4.9% of the lake whitefish examined. Plerocercoids of diphyllobothid species have been described from various coregoind fishes in North America (Vergeer, 1942: Thomas, 1946; Hoffman, 1967).

Proteocephalus tumidocollus was recovered from 47% of the whitefish examined. In one of the specimens an abnormal proglottid was seen. Instead of the usual one cirrus sac within a single proglottid, two were found. Studies conducted by Hicks and Threlfall (1973) revealed the presence of this cestode in 7% of whitefish from coastal Labrador. Other reports of proteocephalids in coregonids in North America include those of *P. exiguus*, La Rue 1911, in Michigan (Bangham, 1955) *P. larusi*, Faust 1919 in Michigan, Wisconsin and Wyoming (Bangham, 1940, 1944, 1951, 1955) and *P. wickliffi*, Hunter and Bangham 1933 in Lake Erie (Hunter and Bangham, 1933).

Hicks and Threlfall (1973) found *Proteocephalus* sp. Type A (13% infection) and *Proteocephalus* sp. Type B (40% infection) in the whitefish they examined from coastal Labrador. These figures are far greater than those in the present study (4.9% and 2.9% respectively).

Salmincola extumescens (Gadd, 1901) was found in 8.8% of the whitefish examined. This copepod has previously been found in several species of *Coregonus* from the USSR and North America (*vide* Kabata, 1969). Neither Sandeman and Pippy (1967) nor Hicks and Threlfall (1973) found this parasite. However Hicks and Threlfall (1973) did find *S. extensus* on *C. clupeaformis* and *S. thymali* on *Prosopium cylindraceum* from coastal Labrador.

One specimen of *S. coregonorum* (Kessler, 1868) was found on a whitefish from Ossokmanuan. This is the first record of this copepod being found on a whitefish in the Province of Newfoundland and Labrador.

An increased number of parasite species was noted with increased age of the fish host (Table 10). However, as the fish ages a point is reached after which the number of parasite species begins to drop. Various authors have been cited by Dogiel (1958) including Bykhovsky (1936), Bykhovskya-Pavlovskaya (1940), Rakova (1954), Kazadaev (1954) and Layman (1955) who have noted this phenomenon in a variety of fish species. During the present study of *C. clupeaformis*, no significant differences in the prevalence of *Discocotyle sagittata*, *Crepidostomus farionis*, *Phyllodistomum coregoni*, *Triaenophorus crassus*, *Diphyllobothrium* sp., *Capillaria salvelini*, and *Salmincola extumescens* were noted in the male and female hosts ($p>0.05$). There were also no significant differences in the overall helminth fauna of *C. clupeaformis* from the four locations where they were caught.

Prosopium cylindraceum (Pallas, 1784) (Round whitefish)

A lone, three year old, *P. cylindraceum*, from Lake Ossokmanuan, weighing 70 g and measuring 20 cm in length was examined for metazoan parasites. Only a single species, namely *P. coregoni* was found. This is a new host record. Dechtiar (1966) first reported the presence of *P. coregoni* in *Coregonus clupeaformis* from Western Ontario. Hicks and Threlfall (1973) found one specimen of *P. limnosa* in a *P. cylindraceum* caught in the Naskaupi River in eastern Labrador.

TABLE 10

RELATIONSHIP BETWEEN THE NUMBER OF PARASITE SPECIES AND AGE OF *COREGONUS CLUPEAFORMIS*

Age Class (years)	The Number of Parasite Species Found				
	0	1	2	3	4
0 - 1	-	-	-	-	-
1 - 2	20	80	-	-	-
2 - 3	23	43	26	8	-
3 - 4	14	14	43	29	-
4 - 5	14	14	44	14	14
5 - 6	-	-	-	-	-
6 - 7	-	-	100	-	-
7 - 8	25	25	12.5	25	12.5
8 - 9	-	33	33	11	23
9 -10	28	14	29	29	-
10 -11	-	80	20	-	-
11 -12	-	100	-	-	-
12 -13	12.5	50	37.5	-	-
13 -14	-	50	50	-	-
14 -15	-	-	-	100	-
15 -16	-	50	25	25	-

Figures in Table show the percentage of fish in each age class.

Esox lucius Linnaeus, 1758 (Northern pike)

During the present study, 107 pike weighing from 131 g to 5012 g (mean 1540 g) measuring 26.5 cm to 97 cm (mean 57 cm) in length and between the ages of 2 and 20 years, from 7 locations were examined.

Five genera of metazoan parasites (one of Monogenea, two of Cestoda, one of Nematoda and one of Acanthocephala) were recovered. Details of infection may be seen in Tables 2, 3 and 11.

Tetraonchus monenteron was found on 84% of the pike autopsied. The average number of parasites per infected fish was 232.4 (range 2-2280). This monogenean has been found on pike in Europe (Diesing, 1858), in New York (Van Cleave and Mueller, 1934), and in Wisconsin (Mizelle and Regensberger, 1945). Threlfall and Hanek (1970) examined four northern pike from the Eagle and Naskaupi Rivers, Labrador and found *T. monenteron* in smaller numbers than in the present work (35-250/host). There was no significant difference in the prevalence of infection with parasites in the male and female pike.

Triaenophorus crassus was a very common cestode among the pike examined (64.5% infection, mean 12.9 worms per infected host, range 1-62). This is the first record of this cestode in Labrador. No significant difference in the prevalence of *T. crassus* in the two sexes was noted (62% of the males and 66% of the females infected).

Three species of *Triaenophorus* are recognized in Canadian fishes, namely *T. crassus* Forel, 1868, *T. nodulosus* (Pallus, 1760) and *T. stizostedionis* Miller, 1945. Cooper (1918) was the first person to record *T. crassus* in North America. He reported it as *T. robustus* from the intestine of *Esox lucius* and the muscles of *Leucichthys artedi*.

TABLE 11

METAZOAN PARASITE INFECTIONS OF *ESOX LUCIUS* FROM THE VARIOUS STATIONS

	Sim. R.			Sangirt.			Gabro			Lobstick			Ossok.			Mt. Hyde L.			Orma L.		
	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Tetraonchus monenteron	100	21	21		-		97.6	4-2280	271.4	60.6	15-346	164.4	96.1	2-1200	230.2		-		100	263	263
Triaenophorus crassus		-			-		85.7	1-48	16.2	72.7	1-62	10.6	34.6	1-36	6.3		-			-	
Proteocephalus pinguis		-		100	2-5	3.5	71.4	1-145	25.5	75.7	1-425	43.6	92.3	1-278	48		-		100	3	3
Raphidascaris canadensis		-		100	1	1	38	1-3	1.3	57.5	1-46	10.8	69	1-42	9.9		-			-	
Metechinorhynchus lateralis		-			-		2.38	1	1		-			-			-			-	

a = percentage of fish infected with that parasite.

b = range of parasite number per infected fish.

c = average number of parasites per infected fish.

In 1928 Hjortland recorded *T. crassus* (which he also referred to as *T. robustus*) from pike, and cisco *Leucichthys tullibee* (Richardson) in Minnesota. Later Wardle (1932) found *T. crassus* and *T. nodulosus* in Manitoba fishes (which he reported as varieties of *T. tricuspidatus*, *Morpha megadentatus* and *Morpha microdentatus*). In 1935 Ekbaum studied Canadian and European material and showed that the North American material and showed that the North American material consisted of *T. nodulosus* and *T. crassus* and explained the synonymy involved. The conclusions drawn by Ekbaum were confirmed by Miller (1943). The third species, *T. stizostedionis*, was described by Miller (1945) from the pike-perch (*Stizostedion vitreum* (Mitchill, 1818)). During the present study it was found that in heavy infections the intestine wall is greatly thickened in the regions where the scoleces of the *T. crassus* were attached. The thickenings were visible to the naked eye. The scoleces were deeply buried in the intestinal wall and lay in the submucosa in deep pits. During the present study a cestode was once seen dangling from the anus of the pike while the fish was still being played on a line prior to landing. Presumably the posterior gravid proglottids break off and pass out of the host. This is presumably the method by which the eggs are released from the host to the water.

In the present study, no significant difference in the prevalence of *T. crassus* in the two sexes was noticed (62% of the males and 66% of the females infected).

Proteocephalus pinguis LaRue 1911, was found to be the most common cestode of pike (75.7% infected). Once again there was no significant difference in the prevalence of the parasite in the male and female hosts (74.0% of males, 78.5% of females infected). Threlfall

and Hanek (1970b) found this cestode in the 4 pike they examined from coastal Labrador. Previously this cestode has been recorded in pike from various locations in North America (*vide* Hoffman, 1967). Hunter (1929) in his work on the life history of *P. pinguis* found various fish may serve as second intermediate hosts. He also discovered that the pike may be infected with *P. pinguis* either by feeding on the infected crustaceans or by feeding on other fish which have acquired the larval parasites from infected crustaceans.

Raphidascaris canadensis Smedley, 1933 was the only nematode recovered from the pike during the present study (51.4% infection). No significant difference in the prevalence of this nematode in the male and female hosts ($P>0.05$) was noted. Its presence in Labrador is a new geographic record. Smedley in 1933 first described this nematode from *E. lucius* collected in Saskatchewan, Manitoba and other localities in Western Canada. Thomas (1937) recovered adult nematodes from pike, and larvae, encysted in the liver and mesenteries, from minnows and perch taken in Illinois.

Metechinorhynchus lateralis a common parasite of salmonids was found for the first time in a pike in central Labrador during the present study. This is the second time this parasite has been recovered in pike. Threlfall and Hanek (1970b) first found this helminth in a pike from Eagle River in coastal Labrador.

Generally an increase in the number of parasite species was noted with increased age of fish host (Table 12). This follows the rule of age dynamics put forward by Dogiel (1958). Using the (2xc) contingency tests, it was found that there was a significant difference

TABLE 12

RELATIONSHIP BETWEEN THE NUMBER OF PARASITE SPECIES AND AGE OF *ESOX LUCIUS*

Age Class (years)	The Number of Parasite Species Found					
	0	1	2	3	4	5
0 - 1	-	-	-	-	-	-
1 - 2	-	-	-	-	-	-
2 - 3	33.3	33.3	33.3	-	-	-
3 - 4	-	-	-	-	-	-
4 - 5	-	-	50	50	-	-
5 - 6	5.3	-	36.8	42.1	15.8	-
6 - 7	-	13	21.7	34.8	30.5	-
7 - 8	6.25	12.5	25	31.25	25	-
8 - 9	5	10	10	40	35	
9 - 10	-	-	30	40	30	-
10 - 11	-	-	50	33.3	-	16.7
11 - 12	-	-	-	66.7	33.3	-
12 - 13	-	-	-	50	50	

*100% of the pike in the (13 - 14), (17 - 18) and (20 - 21) age classes were infected with 3, 2, and 3 parasite species respectively.

($P<0.05$) in the overall helmith fauna of pike caught from the seven locations. This was becasue the pike caught from Mt. Hyde Lake (which is isolated and not connected with the Smallwood Reservoir system) were uninfected while the pike caught from all other locations were infected. When the data from Mt. Hyde Lake was omitted it was found that there were no significant differences between the other six locations.

Catostomus catostomus (Forster, 1773) (Longnose sucker)

Fourteen longnose suckers, weighing 10 g to 1,500 g (mean 561 g), measuring 10 to 46 cm (mean 31 cm) in length and between the ages of 2 and 11 years, from four locations were examined.

Two genera of metazoan parasites (1 of Acanthocephala, and 1 of Copepoda were recovered (Tables 2, 3 and 13).

Neoechinorhynchus crassus Van Cleave 1919, was the most common parasite recovered from this fish (57% infection). It was more prevalent in the male (62% infection) than in the female hosts (33%). This parasite has been recovered from a variety of fishes (especially suckers) from several parts of North America (Hoffman, 1967), but not previously from Newfoundland and Labrador. Threlfall and Hanek (1970) found *N. cristatus* Lynch 1936 and *N. strigosum* Van Cleave 1949 in the *C. catostomus* they examined from coastal Labrador.

Ergasilus caeruleus Wilson 1911, was noted on 7% of the fish examined, which is lower than the prevalence (14% infection) recorded by Threlfall and Hanek (1970) who worked on the same host from Grand Lake, Labrador. This copepod has previously been found in a wide spectrum of fishes, including the suckers, in North America (*vide*

TABLE 13

METAZOAN PARASITE INFECTIONS OF *CATOSTOMUS CATOSTOMUS* FROM THE VARIOUS STATIONS

Species	Mile 66 Esker Rd.			Sangirt			Gabro			Ossokmanuan		
	a	b	c	a	b	c	a	b	c	a	b	c
Neoechinorhynchus crassus	100	6	6	-	-	-	55.5	4-55	20	100	4-8	6
Ergasilus caerulus	-	-	-	-	-	-	-	-	-	11	39	39

a = percentage of fish infected with that parasite.

b = range of parasite number per infected fish.

c = average number of parasites per infected fish.

Hoffman, 1967).

Although only 14 fish were examined there was a trend towards an increase of parasite species with increase in age of fish. However as the fish aged, a point was reached where the parasitic burden dropped gradually (Table 14).

Couesius plumbeus (Agassiz, 1850) (Lake chub)

Three *C. plumbeus*, weighing from 10 g to 12 g (mean 11.3 g), measuring 10 to 11.5 cm (mean 10.8 cm) in length, which were removed from the stomach of a large pike caught in Ossokmanuan Lake, were found to be parasite free.

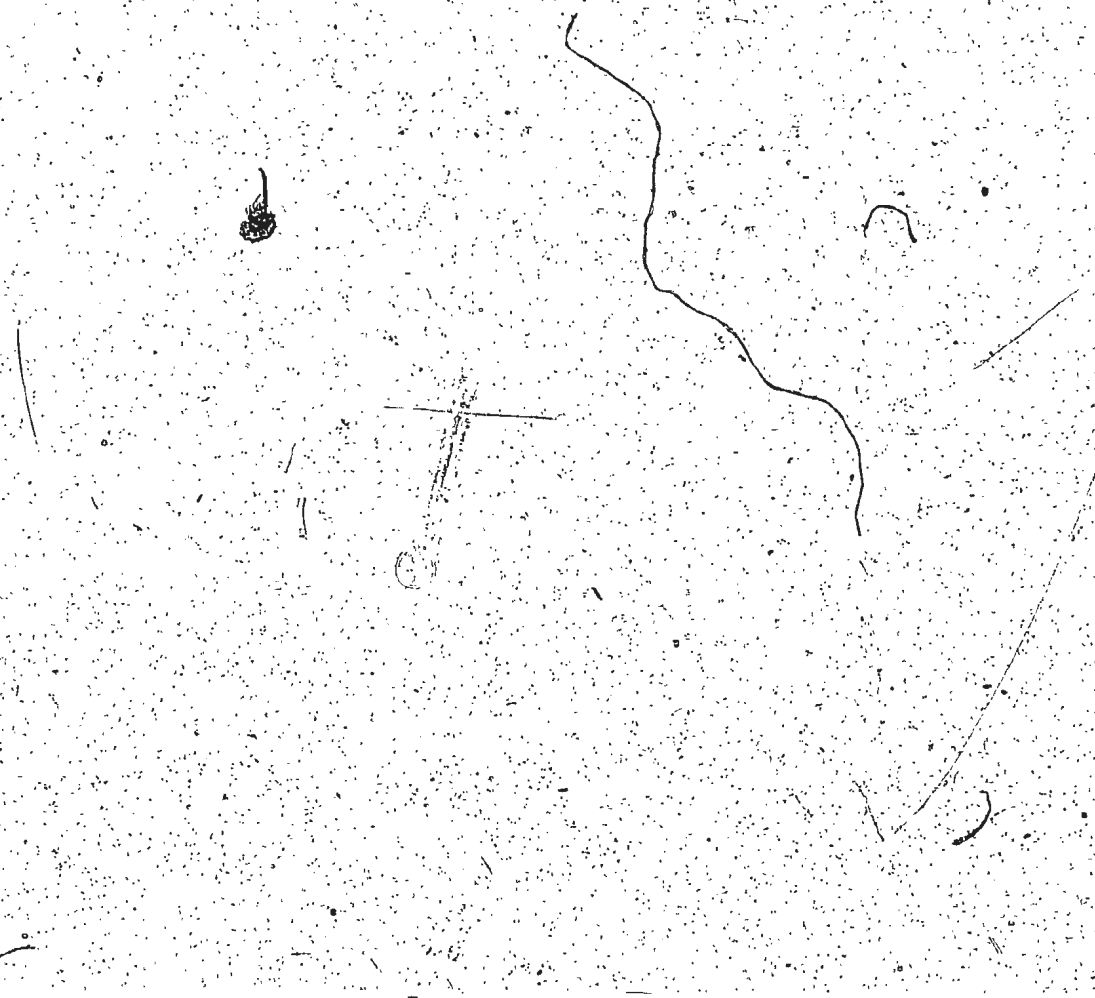


TABLE 14

RELATIONSHIP BETWEEN THE NUMBER OF PARASITE SPECIES AND AGE OF *CATOSTOMUS CATOSTOMUS*

Age Class (years)	The Number of Parasite Species Found		
	0	1	2
0 - 1	-	-	-
1 - 2	-	-	-
2 - 3	100	-	-
3 - 4	-	-	-
4 - 5	-	-	-
5 - 6	-	100	-
6 - 7	-	50	50
7 - 8	-	-	-
8 - 9	-	-	-
9 - 10	50	50	-
10 - 11	-	100	-
11 - 12	67	33	-
12 - 13	-	-	-

Figures in Table show the percentage of fish in each age class

GENERAL DISCUSSION

Tetraonchus monenteron was found in *E. lucius* (84% infection) and *S. namaycush* (3.1% infection). The infection in *S. namaycush* was probably accidental. This is however a new host record and the usual host is the pike. There was a significant difference ($P<0.05$) between the incidence of this parasite in the pike and lake trout.

Crepidostomus farionis was present in *S. fontinalis* (60.3% infection), *S. namaycush* (9.3% infection), and *C. clupeaformis* (4.9% infection). When they were compared using a (2xc) contingency classification a significant difference was noted ($P<.05$) with a distinct predilection for *S. fontinalis* being noted. Sandeman and Pippy (1967) found this parasite had a wide distribution and was common in salmonids in insular Newfoundland (*S. fontinalis*, 62.6% infection; *S. salar* landlocked, 45.2% infection; *S. gairdneri*, 74.7% infection). A much lower percentage of infection was noted by Threlfall and Hanek (1970) and Hicks and Threlfall (1973) (19% and 34% respectively) than was seen in *S. fontinalis* during the present work. Many factors could have accounted for these differences in infection for example the availability of intermediate hosts or differences in diet.

Crepidostomum cooperi was found in *S. salar* (20% infection), *S. namaycush* (3.1% infection) and *C. clupeaformis* (2.9% infection). There was no significant difference in the incidence of the parasite in *S. namaycush* and *C. clupeaformis*. As the sample size of *S. salar* was very small (only 5) no test of significance was carried out for

that species of fish. Neither Sandeman and Pippy (1967) nor Hicks and Threlfall (1973) found this parasite present in any of the fishes they examined from insular Newfoundland and coastal Labrador respectively. This trematode was recorded for the first time in Labrador in these three species of fishes. Choquette (MS., 1953) however found this parasite fairly common in brook trout from Laurentide Park, Quebec, (107 of 210 fish infected).

Phyllodistomum lachancei was found in all three salmonids examined (*S. salar*, 20% infection; *S. fontinalis*, 72% infection; and *S. namaycush*, 15.6% infection). When the brook trout and lake trout were compared using a (2x2) contingency test, a distinct predilection was noted for the brook trout ($P<.05$). The presence of this trematode in *S. salar* and *S. namaycush* constitutes new host records.

During the present study, *Phyllodistomum coregoni* was found in lake whitefish (20.6% infection), and round whitefish (100% infection). Sandeman and Pippy (1967) did not find this parasite in the *C. clupeaformis* they examined from insular Newfoundland and Hicks and Threlfall (1973) found *P. limnosa* (3% infection) in the lake whitefish but they failed to find any species of *Phyllodistomum* in the round whitefish they examined from coastal Labrador.

Hicks and Threlfall (1973) found metacercariae of *Diplostomum spathaceum* common to both salmonids (*S. salar*, 8% infection; *S. fontinalis*, 26% infection; *S. namaycush*, 39% infection) and coregonids (*C. clupeaformis*, 67% infection; *P. cylindraceum*, 53% infection), from coastal Labrador. During the present study, this parasite was not found in any of the fishes examined despite the fact that definite hosts

(ducks and a few gulls) are present in the area. This may possibly be due to a scarcity of the first intermediate host *Lymnaea* sp. It was noted that there were fewer trematodes found in the fish hosts from the Smallwood Reservoir complex, than cestodes. Both Ostrofsky (MS., 1973) and Bruce (1974) have stated that the waters in the Smallwood Reservoir complex are weak in mineral content. This may account for the scarcity of the Molluscs.

Trianophorus crassus was found in the northern pike (64.48% infection) lake trout (12.5% infection) and whitefish (15.6% infection). While the adult stage was only found in the pike, the plerocercoid stage was found in the lake trout and more commonly in the lake whitefish. This is the first record of the presence of this cestode in Labrador. When the fishes were compared using (2xc) contingency classification, a predilection was noted for the pike, however no significant difference in the prevalence of *T. crassus* was noted between the lake trout and lake whitefish ($P>.05$).

Hydro-electric schemes which result in the formation of reservoirs, lead to changes in the parasitofauna of fishes and other organisms found in the area. Peterson (1969) noted changes in *T. crassus* infection in some Swedish lakes that have been regulated. Bottom feeding coregonids (i.e. those with low gill-raker counts) have turned to a more planktonic diet with the result these fishes were more heavily parasitised with *T. crassus* than they had been before the water was regulated (Lawler, 1970).

Eubothrium salvelini was found in *Salmo salar* (100% infection), *Salvelinus fontinalis* (64.7% infection) and *S. namaycush* (56% infection).

No significant difference was noted in the prevalence of *E. salvelini* in the *S. fontinalis* and *S. namaycush* (P>.05). Hicks (MS., 1973) in his studies of fishes from coastal Labrador recovered this cestode from *S. fontinalis* (15% infection), *S. namaycush* (13% infection) but none were found in *S. salar*. However, *E. crassum* was found in his specimens of *S. salar* (40% infection) and *S. namaycush* (3% infection). During the present study *E. crassum* was not found.

Kennedy (1976) reviewed the taxonomy of *E. salvelini* and *E. crassum* and came to the conclusion that there are two races of *E. crassum*, which replace one another as the fish moves from fresh water to marine and both are specific to the genus *Salmo*. He noted that the fresh water race is restricted to Europe and in North America there is no valid record of *E. crassum* from a purely fresh water habitat. This theory is supported by the present study. Kennedy (1976) further concluded that *E. salvelini* is quite specific to *Salvelinus* in Europe but in North America it has replaced *E. crassum* and has a wider host range than in Europe. It is lost at sea and has never been found in returning adult *Oncorhynchus*. Kennedy (1976) feels there is a third race in Asia, which has a fresh water life cycle, and can survive marine migration as well as infect fish in the marine environment. So there appears to be a morphologically indistinguishable complex of races which differ in their specificity, distribution and biology. The *E. salvelini* found in the present study is purely a fresh water species.

Capillaria salvelini was found in *S. fontinalis* (4.4% infection), *S. namaycush* (59.3% infection) and *C. clupeaformis* (19.6% infection). When the fishes were compared using (2xc) contingency test a significant

difference was found ($P < 0.05$) with a predilection for the lake trout being noted. Hicks (MS., 1973) similarly noted that *S. namaycush* was more heavily infected than other members of the family.

Adults of *Raphidascaris canadensis* were located in *E. lucius* (51.4% infection) while larval *Raphidascaris* sp. were found in *S. fontinalis* (7.3% infection), *S. namaycush* (9.3% infection) and *C. clupeaformis* (0.98% infection) during the present study. The larval stages may well be that of *R. canadensis*. Arthur *et al.* 1976, working on fishes from Yukon Territory found larvae present in both *S. namaycush* and *C. clupeaformis*. Threlfall and Hanek (1970b) found one of four pike they examined from coastal Labrador to be infected with a *Raphidascaris* sp.

During the present study the gut contents of the fishes were also collected and analysed. Food items that were found are shown in Table 15.

Many factors, such as mode of feeding, behaviour, migratory movements and the presence/absence of suitable intermediate hosts could account for the differences in the parasitic burden of the fishes studied.

The data obtained during the present study will serve as a base-line for future studies in the Central Labrador area. Progressive changes in the parasitofauna of the various fish species resulting from the development of the Smallwood Reservoir complex can now be monitored.

TABLE 15

FOOD ITEMS FOUND IN FISHES FROM CENTRAL LABRADOR

Species	Food items
Salmo salar (landlocked)	fish vertebrae
Salvelinus fontinalis	Coleoptera (Dytiscidae), Trichoptera (caddis-fly larvae and adults) Diptera (chironomid larvae and pupae, Araneae (spider), Plecoptera (stonefly larvae), Hemiptera (Corixidae; water boatmen), Acarina (tick), vegetation, fish remains.
Salvelinus namaycush	Plecoptera (stonefly adults), Hemiptera (back swimmers), Trichoptera (caddis-fly larvae and adults) Diptera (chironomid larvae and pupae), fish and insect remains.
Coregonus clupeaformis	Trichoptera (caddis-fly larvae), Mollusca (gastropods and bivalves), Hemiptera, Ephemeroptera (May-fly nymphs, *Daphnia*, *Cyclops*.
Prosopium cylindraceum	empty stomach
Esox lucius	Amphipoda, Mollusca (bivalves), Trichoptera (caddis-fly larvea and case), Ephemeroptera (May-fly larvae), stickleback, lake chub, whitefish, sucker (*C. catostomus*) fish remains.
Catostomus catostomus	Mollusca (bivalves), Trichoptera (caddis-fly larvae) Amphipoda, Diptera (chironomid larvae), *Cyclops*
Couesius plumbius	Trichoptera (caddis-fly larvae), chitinous remains of insects.

SUMMARY

1. This study was undertaken due to the lack of information on the metazoan parasite of fishes from Central Labrador.

2. Using conventional parasitological techniques 332 fish of eight species (*Salmo salar*, *Salvelinus fontinalis*, *S. namaycush*, *Coregonus clupeaformis*, *Prosopium cylindraceum*, *Esox lucius*, *Catostomus catostomus* and *Couesius plumbeus*) from fourteen different locations from the Smallwood reservoir complex of Central Labrador were examined for metazoan parasites.

3. Contingency tests (2x2 and 2xc) were performed to ascertain whether any significant differences existed in the parasitic burden with respect to the sex, location of fish capture and species.

4. A total of 15 genera (2 of Monogenea, 2 of Digenea, 4 of Cestoda, 3 of Nematoda, 2 of Acanthocephala and 2 of Copepoda) were recovered from the fish examined.

5. *Salmo salar* contained 7 genera of metazoan parasites (1 of Monogenea, 2 of Digenea, 3 of Cestoda, and 1 of Copepoda). Three parasite species namely, *Crepidostomum cooperi*, *Phyllodistomum lachancei* and *Salmincola extumescens* were recovered from this host for the first time.

6. *Salvelinus fontinalis* had the widest diversity of parasites of the different species of fish examined. Eleven genera of metazoan parasites (one of Monogenea, two of Digenea, three of Cestoda, three of Nematoda, one of Acanthocephala and one of Copepoda) were found.

Raphidascaris sp. was discovered for the first time in this host in Labrador.

There were no significant differences in the burden of *Discocotyle sagittata*, *Crepidostomum farionis*, *Eubothrium salvelini* and *Salmincola edwardsii* with regard to the sex of the fish. *Phyllodistomum lachancei*, *Proteocephalus tumidocollis*, *Raphidascaris* sp. and *Metabronema salvelini* were found to occur more frequently in the male than female fish while the reverse was true in the case of *Diphyllobothrium* sp. There were no significant differences in the parasite burden among the different locations where the brook trout were caught. There was also no correlation between the number of parasite species found in the fish and the age of the fish.

7. *Salvelinus namaycush* had the second widest diversity of metazoan parasite of the different species of fish examined. Ten genera (1 of Monogenea, 2 of Digenea, 4 of Cestoda, 2 of Nematoda, and 1 of Copepoda) were found. *Tetraonchus monenteron*, *Crepidostomum cooperi*, *Phyllodistomum lachancei* and *Triaenophorus crassus* (plerocercoid) were discovered for the first time in this host in Labrador. The presence of *T. monenteron* and *P. lachancei* in this fish constitute new host records.

No differences were detected in the prevalence of parasitism and the sexes of *S. namaycush*. There were also no significant differences in the parasite burden of fish from different locations.

8. *Coregonus clupeaformis* were found to be infected with 9 genera of metazoan parasites (1 of Monogenea, 2 of Digenea, 3 of Cestoda, 2 of Nematoda and 1 of Copepoda).

The presence of *Phyllodistomum coregoni*, *Crepidostomum cooperi*, *Raphidascaris* sp., *Salmincola extumescens* and *S. coregonorum* in *C. clupeaformis* from Labrador constitute new geographic records.

No significant differences were noted in the parasite burden of the two sexes and the different locations where the fish were caught. There was a trend towards an increased number of parasite species with an increase in age of fish host. However as the fish ages, a point is reached where the parasitic burden gradually decreases.

9. A lone *Prosopium cylindraceum* was found to be infected with *Phyllodistomum coregoni*. This constitutes a new host record.

10. *Esox lucius* was parasitised by 5 genera of metazoan parasites (1 of Monogenea, 2 of Cestoda, 1 of Nematoda, and 1 of Acanthocephala).

There were no significant differences in the parasite burden with *Tetraonchus monenteron*, *Triaenophorus crassus*, *Proteocephalus pinguis*, and *Raphidascaris canadensis* and the sex of the pike. *Triaenophorus crassus* and *R. canadensis* was recorded for the first time in pike from Labrador. Like the lake whitefish, the number of parasite species increased with the age of the pike up to a certain point after which it started to gradually decline.

11. *Catostomus catostomus* were found to be infected with 2 genera of metazoan parasites (one of Acanthocephala and one of Copepoda).

Neoechinorhynchus crassus was found in this host for the first time in Labrador. Although only 14 *C. catostomus* were examined, it was found that generally the number of parasite species increased with

the age of the fish up to a point, after which the parasitic burden started to decline.

12. All 3 *Couesius plumbeus* examined were found free of metazoan parasites.

13. The gut contents of the fishes were collected and food items found were identified.

REFERENCES

American Fisheries Society, Committee on Names of Fishes, 1970. A list of common and scientific names of fishes from the United States and Canada. (3rd. ed.) Am. Fish. Soc. Publ. No. 2: 149 pp.

Andrews, C. W. and E. Lear. 1956. The biology of Arctic char (*Salvelinus alpinus* L.) in northern Labrador. J. Fish. Res. Bd. Canada, 13(6): 843-860.

Anonymous. 1964. International Code of Zoological Nomenclature adopted by the XV International Congress of Zoology. Int. Trust. Zool. Nomenclature, London. 176 pp.

Arthur, J. W., L. Margolis, and H. P. Arai. 1976. Parasites of Fishes of Aishihik and Steven Lakes, Yukon Territory and potential consequences of their interlake transfer through a proposed water diversion for hydroelectrical purposes. J. Fish. Res. Bd. Canada, 33(11): 2489-2499.

Bangham, R. V. 1940. Parasites of fish of Algonquin Park lakes. Prog. Fish-Cult., Memo., I-131(52): 37.

Bangham, R. V. 1944. Parasites of northern Wisconsin fish. Tr. Wisconsin Acad. Sci., Arts and Lett., 36: 291-325.

Bangham, R. V. 1951. Parasites of fish in the upper Snake River drainage and in Yellowstone Lake, Wyoming. Zoologica, Scient. Contrib. New York Zool. Soc., 36(3): 213-217.

Bangham, R. V. 1955. Studies on fish parasites of Lake Huron and Manitoulin Island. Am. Midl. Nat., 53(1): 184-194.

Bangham, R. V. and J. R. Adams. 1954. A survey of the parasites of freshwater fishes from mainland of British Columbia. J. Fish. Res. Bd. Canada, 11(6): 673-708.

Bangham, R. V. and C. E. Venard. 1946. Parasites of fish of Algonquin Park lakes. Publ. Ontario Fish. Res. Lab. No. 53: 33-46.

Brinkman, A. (Jr.). 1952. Fish trematodes from Norwegian waters. Univ. Bergen Aarbok, Natur. Redk., (1): 134.

Bruce, W. J. 1974. The limnology and fish populations of Jacopie Lake, West Forebay, Smallwood Reservoir, Labrador. Tech. Report Series No. New/T-74-2, Resource Dev. Br. Nfld. 74 pp.

*Bykhovsky, B. E. 1936. Parasitological investigations in lakes Barabinskye. Mag. Parasit., Moscow, VI.

Bykhovsky, B. E. (ed.) 1962. Key to parasites of freshwater fishes of the U.S.S.R. Publ. House Acad. Sci. U.S.S.R., Moscow-Leningrad. (Transl. from Russian by Israel Program for Sci. Transl., Jerusalem, 1964).

*Bykhovskaya-Pavlovskaya, I. E. 1940. The influence of age on parasitic fauna of perch. Mag. Parasit., Moscow, VIII.

Chen, M. Y. MS 1967. Aspects of the biology of the lake whitefish, *Coregonus clupeaformis* (Mitchill) in Hogan's Pond, Avalon Peninsula, Newfoundland. M. Sc. Thesis, Memorial University of Newfoundland, St. John's, Newfoundland.

Choquette, L. P. E. 1947. *Phyllodistomum lachancei* sp. nov. a trematode from the ureters of *Salvelinus fontinalis* (Mitchill), with a note on its pathogenicity. Can. J. Res., D, 25: 131-134.

Choquette, L. P. E. 1948a. Parasites of freshwater fish. IV. Internal helminths parasitic in speckled trout (*Salvelinus fontinalis* Mitchill) in rivers and lakes of the Laurentide Park, Quebec, Canada. Can. J. Res., D, 26: 204-211.

Choquette, L. P. E. 1948b. On the species of the genus *Metabronema* Yorke and Maplestone, 1926, parasitic in trout and char. Can. J. Res. D, 26(6): 329-333.

Choquette, L. P. E. MS. 1953. Studies on some helminths parasitic in the trout *Salvelinus fontinalis* (Mitchill) in Quebec. Ph.D. Thesis, McGill University, Montreal.

Cooper, A. R. 1918. North American Pseudophyllidean cestodes from fishes. Illinois Biol. Monogr., 4: 289-541.

Cotè, L. 1972. Heritage of Power. Gazette Printing Co. Ltd. Montreal. 76 pp.

Davis, H. S. 1953. Culture and diseases of game fishes. Univ. Calif. Press., Berkeley. 332 pp.

Dawes, B. 1968. The Trematoda, with special reference to British and European forms. Camb. Univ. Press London. 644 pp.

Dechtiar, A. 1966. A new species of *Phyllodistomum* (Trematoda: Gorgoderidae) from *Coregonus clupeaformis* (Mitchill) from Lake of the Woods (Ontario). Can. J. Zool. 44(1): 135-140.

*Diesing, K. M. 1858. Revision der Myzhelminthen, Abtheilung: Trematoden, Situngsb. K. Akad. Wissensch. Wien, Math.-Naturw., 32(23): 307-390.

Dogiel, V. A. 1958. Ecology of the parasites of freshwater fishes In: Parasitology of Fishes. Ed. Dogiel, V. A., G. K. Petrushevski and Y. I. Polyanski. Oliver and Boyd, Edinburgh and London. Transl. by Z. Kabata, 1961.

Ekbaum, E. 1935. Notes on the species of *Triaenophorus* in Canada. J. Parasit., 21(4): 260-263.

Fernando, C. H., J. I. Furtado, A. V. Gussey, G. Hanek, and S. A. Kakonge. 1972. Methods for the study of freshwater fish parasites. Univ. of Waterloo, Biology Series No. 2. 76 pp.

Fischthal, J. H. 1947. Parasites of northwest Wisconsin fishes. I. The 1944 survey Tr. Wisconsin Acad. Sci., Art and Lett., 37: 157-220.

Freze, V. I. 1965. Essentials of Cestodology. Vol. V. Proteocephalata in fish, amphibians, and reptiles. Academy of Sciences of the U.S.S.R. Helminthological Laboratory. 597 pp.

Frost, N. 1940. A preliminary study of Newfoundland trout. Newfoundland Research Bull. 9: 1-30.

Fujita, T. 1941. New names for *Metabronema salvelini* Fujita and *Cystidicola minuta* Fujita. J. Parasit., 27: 542.

Hanek, G. and W. Threlfall. 1970a. Parasites of the threespine stickleback (*Gasterosteus aculeatus*) in Newfoundland and Labrador J. Fish. Res. Bd. Canada. 27: 901-907.

Hanek, G. and W. Threlfall. 1970b. Metazoan parasites of the American eel (*Anguilla rostrata* (Le Sueur)) in Newfoundland and Labrador. Can. J. Zool. 48(3): 597-600.

Hanek, G. and W. Threlfall. 1970c. Parasites of the ninespine stickleback *Pungitius pungitius* (L.) in Newfoundland and Labrador. Can. J. Zool. 48(3): 600-602.

Hanek, G. and W. Threlfall. 1970d. Monogenetic trematodes from Newfoundland Canada. 2. New species of the genus *Gyrodactylus* Nordmann, 1832 from Labrador cottids. Can. J. Zool. 48(5): 915-918.

Hart, J. L. 1931. The food of the whitefish, *Coregonus clupeaformis* (Mitchill), in Ontario waters, with a note on the parasites. Contrib. Canadian Biol. Fish., N. S. 6(21): 447-454.

Hicks, F. J. MS 1971. Metazoan parasites of salmonids and coregonids from coastal Labrador. M.Sc. Thesis, Memorial University of Newfoundland, St. John's, Newfoundland.

Hicks, F. J. and W. Threlfall. 1973. Metazoan parasites of salmonids and coregonids from coastal Labrador. J. Fish. Biol. 5: 399-415.

Hjortland, A. L. 1928. On the structure and life history of an adult *Triaenophorus*. J. Parasit. 14: 38-44.

Hoffman, G. L. 1967. Parasites of North American Freshwater Fishes. Univ. of California Press. Berkeley and Los Angeles. 486 pp.

Hopkins, S. H. 1934. The papillose Allocreadiidae. Illinois Biol. Monogr., 13(2): 45-124.

Hunter, G. W. III. 1929. Life history studies of *Proteocephalus pinguis* LaRue. Parasit. 21: 487-496.

Hunter, G. W. III and R. V. Bangham. 1933. Studies on the fish parasites of Lake Erie. II. New Cestoda and Nematoda. J. Parasit. 19(4): 304-311.

Kabata, Z. 1969. Revision of the genus *Salmincola* Wilson, 1915 (Copepoda: Lernaepodidae) J. Fish. Res. Bd. Canada. 26: 2987-3041.

*Kazadaev, V. I. 1954. Parasitic invasions of tench and their influence on the fish. Report, Mosrybvtuz.

Kuperman, B. I. 1968. New species of the genus *Triaenophorus* Rud. (Cestoda, Pseudophyllida). Parasitologia, Acad. Sci. U.S.S.R. II (6): 495-501.

Kennedy, C. R. 1969. Occurrence of *Eubothrium crassum* (Cestoda: Pseudophyllidea) in *Salmo salar* and trout *S. trutta* of the River Exe. J. of Zoology. 157 (1): 1-9.

Kennedy, C. R. 1976. Biological races within the cestode genus *Eubothrium*. Proc. Scand. Soc. Parasit. 20-22: 465.

Lagler, K. L. 1956. Freshwater fishery biology. Wm. C. Brown Co., Dubuque Iowa. 421 pp.

Lawler, G. H. 1970. Parasites of coregonid fishes. p. 279-309. In C. C. Lindsey and C. S. Woods (ed.) Biology of coregonid fishes. Univ. Manitoba Press, Winnipeg, Man. 560 pp.

Lawler, G. H. and W. B. Scott. 1954. Notes on the geographical distribution and hosts of the cestode genus *Triaenophorus* in North America. J. Fish. Res. Bd. Canada. 11(6): 884-893.

*Layman, E. M. 1955. The age dynamics of infestation of fish with parasites. Tr. Mosrybrtuza, VII.

Linton, E. 1897. Notes of cestodes parasites of fishes. Proc. U. S. Nat. Mus., 20: 424.

Linton, E. 1940. Trematodes from fishes mainly from the Woods Hole region, Massachusetts. Proc. U. S. Nat. Mus., 88: 1-172.

Lyster, L. L. 1940. Parasites of freshwater fish. II. Parasitism of speckled and lake trout and the fish found associated with them in Lake Commandant, Quebec. Can. J. Research. D, 18(2): 66-78.

MacLulich, D. A. 1943a. *Proteocephalus parallacticus*, a new species of tapeworm from lake trout, *Cristivomer namaycush*. Can. J. Res. D, 21: 145-149.

MacLulich, D. A. 1943b. Parasites of trout in Algonquin Provincial Park, Ontario. Can. J. Res. D, 21: 405-412.

*Malmberg, G. 1956. Om forekomsten av *Gyrodactylus* pa svenska fiskar, Skr. Utgivna Sodra Sveriges Fiskeriforening Arsskr. 1956: 19-76.

Michajlow, W. 1962. Species of the genus *Triaenophorus* Cestoda and their hosts in various geographical regions. Acta Parasitologica Polonica X(1): 1-38.

Meyer, M. C. 1954. The larger animal parasites of freshwater fishes of Maine. Maine Dept. Inland Fish and Game. Fish. Res. and Manag. Div. Bull. No. 1: 92 pp.

Miller, M. J. 1941. A critical study of Stafford's report on "Trematodes of Canadian Fishes" based on his trematode collection. Can. J. Res. 19(1): 28-52.

Miller, R. B. 1943. Studies on cestodes of the genus *Triaenophorus* from fish of Lesser Slave Lake, Alberta. I. Introduction and life of *Triaenophorus crassus* Forel and *T. nodulosus* (Pallas) in the definitive host *Esox lucius*. Can. J. Res., D, 21: 160-170.

Miller, R. B. 1945. Studies on cestodes of the genus *Triaenophorus* from fish of Lesser Slave Lake, Alberta. V. Description and life history of *Triaenophorus stizostedionis* n. sp. Ibid., 117-127.

Miller, R. B. 1952. A review of the *Triaenophorus* problem in Canadian lakes. Bull. Fish. Res. Bd. Canada. 95: 42 pp.

Mizelle, J. D. and B. R. Regenberger. 1945. Studies on monogenetic trematodes XII. Dactylogyridae from Wisconsic fishes. Am. Midl. Nat., 34 (3): 673-700.

Munroe, E. G. 1949. Notes on the fish of the interior of Labrador Peninsula, Arctic, 2(3): 165-173.

Ostrofsky, M. L. MS. 1973. The limnology of Lakes on the Labrador Plateau and some effects of impoundment. M.Sc. Thesis. Univ. of Waterloo. 103 pp.

*Petersson, Ake. 1969. Cestodfaunan hos släktet *Coregonus* i sverge. 151 p. mimeo. cited by Lawler 1970.

Pippy, J. H. C. MS. 1965. Studies on the parasites of freshwater fishes (Salmonidae and Coregonidae) of insular Newfoundland. M.Sc. Thesis, Memorial University of Newfoundland, St. John's, Newfoundland.

Pippy, J. H. C. MS. 1969. Preliminary report on parasites as biological tags in Atlantic salmon (*Salmo salar*). 1. Investigations 1966-1968. Fish. Res. Bd. Canada, Tech. Rept. No. 134: 1-44.

Price, E. W. 1943. North American monogenetic trematodes. VII. The Family Discocotylidae (Diclidophoroidea). Proc. Helminth. Soc. Wash. 10(1): 10-15.

*Rakova, V. M. 1954. Infestations of *Leuciscus idus* and their influence on that fish. Report, Mosk, tekhn. in-t ryb. prom. khoz.

Richardson, L. R. 1936. Observations on the parasites of the speckled trout in Lake Edward, Quebec. Tr. Am. Fish. Soc. 66: 343-356.

Richardson, L. R. 1937. *Raphidascaris laurentianus* sp. n. (Ascaroidea) from *Salvelinus fontinalis* (Mitchill) in Quebec. Can. J. Res. D, 15: 112-115.

Roberts, L. S. 1970. *Ergasilus* (Copepoda: Cyclopoida): Revision and Key to species in North America. Tr. Am. Micr. Soc. 89(1): 134-161.

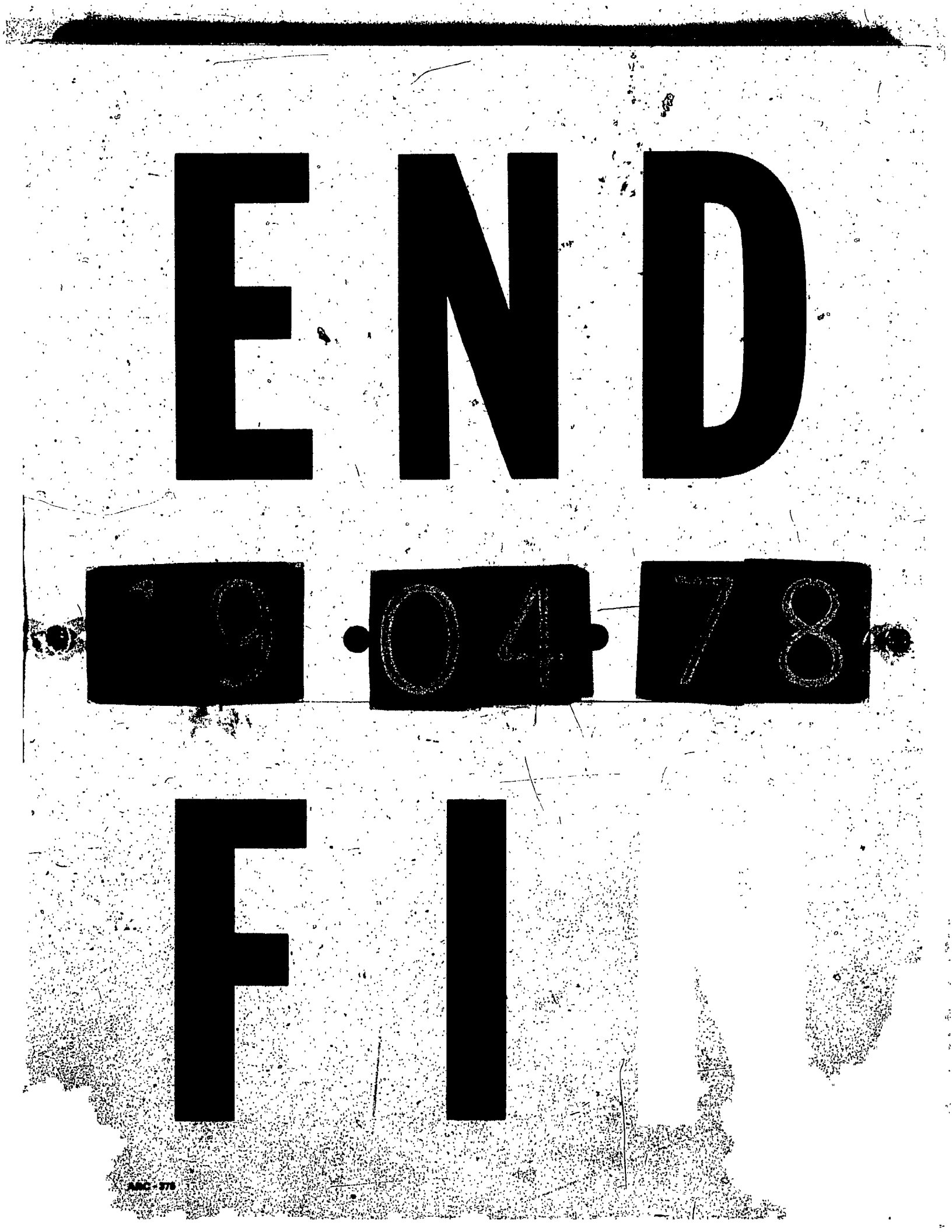
Rubin, R. 1951. A rapid method for making permanent mounts of nematodes. Stain Technology 26(4): 257-260.

Sandeman, I. M. and J. H. C. Pippy. 1967. Parasites of freshwater fishes (Salmonidae and Coregonidae) of insular Newfoundland. J. Fish. Res. Bd. Canada. 24(9): 1911-1943.

Schell, S. C. 1962. Parasitology Laboratory Manual, John Wiley and Sons Inc., New York/London.

Scott, W. B. and E. J. Crossman. 1973. Freshwater fishes of Canada. Bull, Fish. Res. Bd. Canada, No. 184. 966 pp.

Simpson, G. C., A. Roe and R. C. Lewontin. 1960. Quantitative Zoology. Harcourt, Brace and World Inc. New York, Chicago, San Francisco, Atlanta (Revised). 440 pp.


END
89-04-78
FI

Wardle, R. A. and J. A. McCleod. 1952. The Zoology of Tapeworms. University of Minnesota Press. 780 pp.

Yamaguti, S. 1958. Systema helminthum. Vol. I, Parts I and II. Digenetic trematodes of vertebrates. Interscience, New York, 1575 pp.

Yamaguti, S. 1959. Systema helminthum. Vol. II. The cestodes of vertebrates. Interscience, New York, 860 pp.

Yamaguti, S. 1961. Systema helminthum. Vol. III. Parts I and II. The nematodes of vertebrates. Interscience, New York. 1261 pp.

Yamaguti, S. 1963a. Systema helminthum. Vol. IV. Monogenea and Aspidocotylea. Interscience, New York. 699 pp.

Yamaguti, S. 1963b. Systema helminthum. Vol. V. Acanthocephala. Interscience, New York, 421 pp.

Yamaguti, S. 1963c. Parasitic Copepoda and Branchiura of Fishes. Interscience, New York, 1104 pp.

* - not seen.

Smedley, E. M. 1933. Nematode parasites from Canadian marine and freshwater fishes Contrib. Canad. Biol. and Fish., 8(14): 169-179.

Thomas, L. J. 1937. Life cycle of *Raphidascaris canadensis* Smedley, 1933, a nematode from the pike, *Esox lucius*. J. Parasit., 23(6): 572.

Thomas, L. J. 1946. New pseudophyllidean cestodes from the Great Lakes region. I. *Diphyllobothrium oblongatum* n. sp. from gulls. J. Parasit., 32(1): 1-6.

Threlfall, W. and G. Hanek. 1969. *Capillaria salvelini* Polyanski, 1952 from *Salvelinus fontinalis* (Mitchill). Can. J. Zool. 47(5): 1088-1090.

Threlfall, W. and G. Hanek. 1970a. Metazoan parasites excluding Monogenea, from longnose and white suckers. J. Fish. Res. Bd. Canada. 27: 1317-1319.

Threlfall, W. and G. Hanek. 1970b. Helminths from northern pike (*Esox lucius* L.) in Labrador. J. Parasit. 56(4): 662.

Threlfall, W. and G. Hanek. 1970c. Metazoan parasites of salmonids and coregonids from the Avalon Peninsula, Newfoundland. J. Fish. Res. Bd. Canada. 27: 1894-1897.

Van Cleave, H. J. 1949. The acanthocephalan genus *Neoechinorhynchus* in the Catostomid fishes of N. America, with descriptions of two new species. J. Parasit. 35(5): 500-512.

Van Cleave, H. J. and J. F. Mueller. 1934. Parasites of Oneda Lake fishes. Part 3. A biological and ecological survey of the worm parasites. Roosevelt Wild Life Ann. 3: 1-134.

Vergeer, T. 1942. Two new pseudophyllidean tapeworms of general distribution in the Great Lakes region. Tr. Am. Micr. Soc., 61(4): 373-382.

Wagner, E. D. 1953. A new species of *Proteocephalus* Weinland, 1858 (Cestoda), with notes on its life history. Tr. Am. Micr. Soc. 72(4): 364-369.

Wagner, E. D. 1954. The life history of *Proteocephalus tumidocollus* Wagner, 1953 (Cestoda), in rainbow trout. J. Parasit., 40(5): 489-498.

Wardle, R. A. 1932. The cestoda of Canadian fishes. II. The Hudson Bay drainage system. Contrib. Canad. Biol. and Fish. 7(30): 377-403.