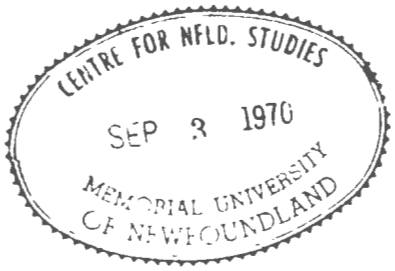
HELMINTH PARASITES OF NEWFOUNDLAND MAMMALS

FREDERICK REGINALD SMITH, B.Sc.

16679


CENTRE FOR NFLD. STUDIES
SEP 3 1970
MEMORIAL UNIVERSITY
OF NEWFOUNDLAND

HELMINTH PARASITES OF NEWFOUNDLAND MAMMALS

BY

© Frederick Reginald Smith, B.Sc.

A Thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Science

Department of Biology
Memorial University of Newfoundland

St. John's Newfoundland

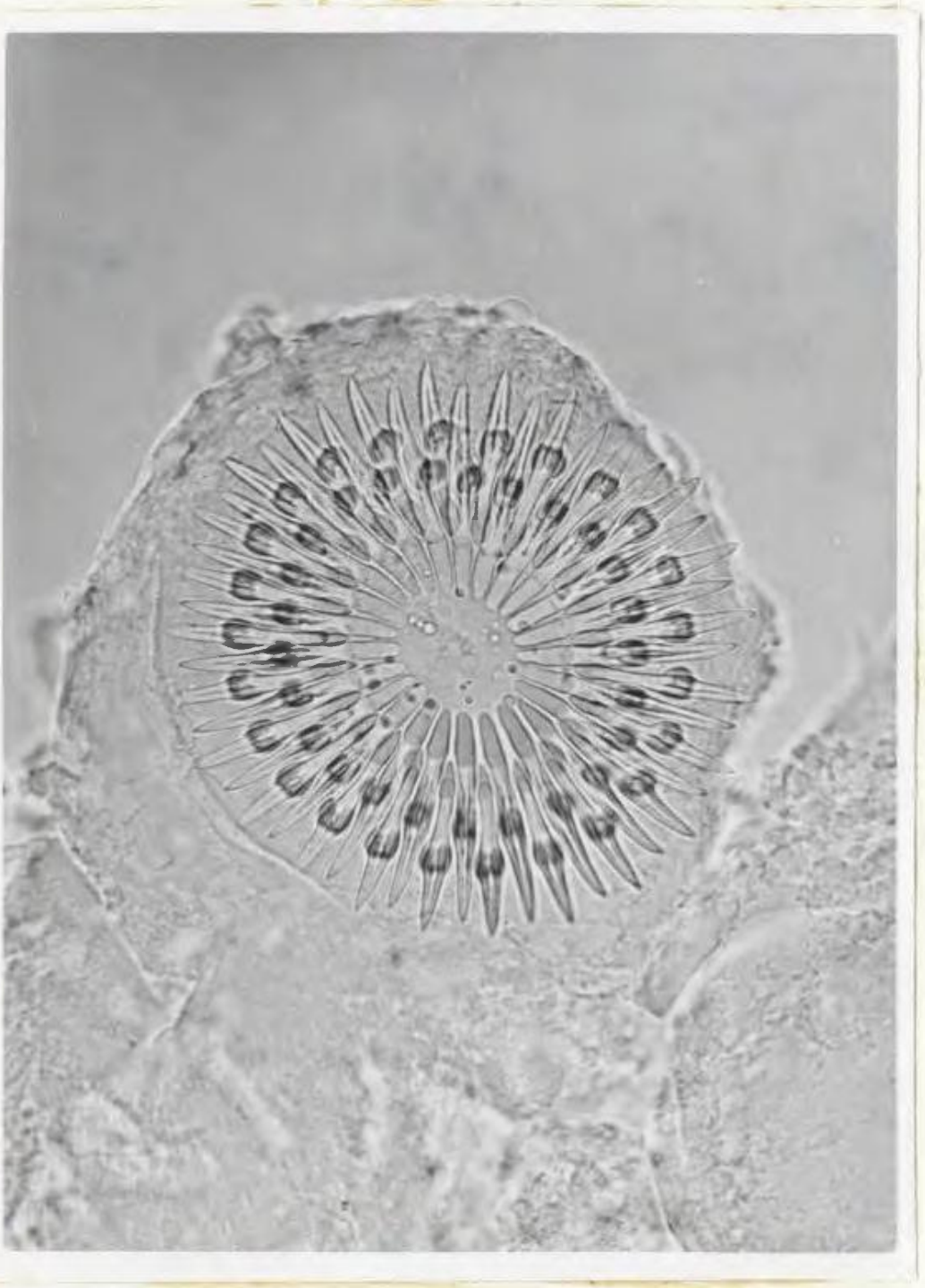
April 1970

ABSTRACT

Eighteen species of mammals from insular Newfoundland were examined for their helminth burden.

Fifty-five species of helminths were recovered, of which three were trematodes, fourteen cestodes, thirty-seven nematodes and one acanthocephalan. Thirty-six species were recovered for the first time from Newfoundland mammals, one of which Anophryocephalus anophrys is a new host record for Phoca groenlandica.

One domestic cat was found to harbour one specimen of a trematode, Plagiorchis massino, the only other occurrence of which in North America is in foxes in Alaska. Other than Alaska, the only other record of this worm is in cats and dogs in Armenia and Kazakhstan, U.S.S.R.



Frontispiece. Bright-field image of the hooks of an unidentified larval cestode from Microtus pennsylvanicus.

ACKNOWLEDGEMENTS

I wish to express my appreciation for all the assistance I received in researching and writing this thesis.

First of all I would like to thank the many people who supplied specimens: Mr. R.R. Riewe, Dr. W.O. Pruitt, Dr. G. Jones, Dr. S. McAllister, Mr. Payne, Newfoundland Farm Products Corporation, and Mr. Claude Bishop.

Also, thank-you to the persons - listed in the bibliography - who supplied information which helped further this work.

Most of all, I am indebted to my supervisor, Dr.W. Threlfal whose suggestions and other assistance helped to make this work possible.

Also I must express my gratitude to the Department of Biology for supplying all the necessary equipment and facilities.

Finally a thank-you to all those friends and associates who listened to my complaints, offered suggestions, and encouraged me in my work.

TABLE OF CONTENTS

Page.

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

The literature concerning the helminth fauna of mammals from insular Newfoundland is scanty and hard to trace among the dauntingly large literature on mammalian helminths. A major problem encountered was that the papers involved were often misleading as to location. Newfoundland joined Canada in 1949 and papers published since that date may concern Newfoundland but be classed as Canadian helminthology; however papers published prior to this date referring to Canada do not apply to Newfoundland but may apply to Labrador.

Another problem was whether or not to include papers on marine mammals. For example, Lyster (1940) described the helminths from Canadian sea mammals collected in the eastern Arctic and in the Gulf of St. Lawrence, but it is considered here that these results apply equally to Newfoundland marine mammals.

The earliest reference found concerning the helminths of Newfoundland mammals was that of Cameron et al (1940), who surveyed the parasites of sledge-dogs in the Province. Two checklists of parasites of North American domestic mammals were found, (Dikmans 1945, Becklund 1964), both of which use the terms "generally in North America" and "in Eastern Canada", but only Becklund refers specifically to Newfoundland. In a research note,

Choquette and Pimlott (1956) listed three species of helminths found in a survey of eighty-nine beavers. Attempting to discover the cause of the high mortality of caribou calves, Peters and King (1959) investigated all aspects of caribou health, including the helminth fauna. Dodds and Mackiewicz (1961) examined 630 snowshoe hares from various areas in Newfoundland and found seven species of helminths while Cowan (1967) surveyed fifty-five pilot whales and reported seven species. Threlfall (1967, 1969) reported three species of helminths from ten moose and a further eighteen species from twelve species of Newfoundland mammals. The latest work found was that of Rausch and Margolis (1969) who reported a new genus and species of cestode from the pilot whale. These studies are summarized in Appendix I which is a preliminary list of the helminths found in Newfoundland mammals as reported in the literature.

This survey was to investigate the helminth fauna of wild and domesticated mammals in insular Newfoundland. It is primarily qualitative in approach but where large samples were available , quantitative analysis was performed.

Key to Figure 1.

Aquaforte.....3

Avalon Peninsula.....6

Bauline.....3

Cape Broyle.....3

Colinet.....1

Great Northern Peninsula.....9

Kilbride.....4

Logy Bay.....4

Manuels.....5

Mount Pearl.....4

Notre Dame Bay.....8

Ocean Pond.....7

Portugal Cove.....5

Robin Hood Bay.....4

St. John's.....4

St. Phillips.....5

St. Shotts.....2

Topsail Pond.....5

Witless Bay.....3

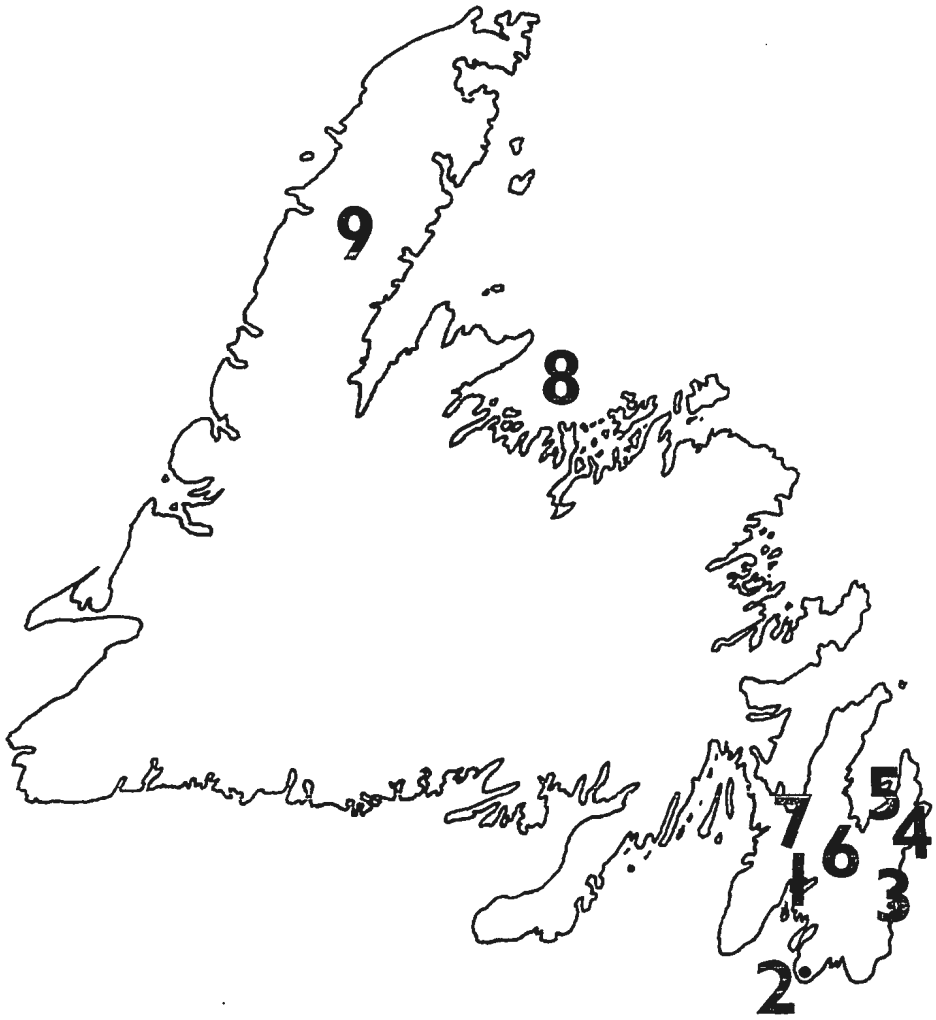


Figure 1. Map of the island of Newfoundland showing the locations mentioned in the text.

MATERIALS AND METHOD

All the animals, which were obtained from several locations in the island (Figure 1), were examined using conventional parasitological techniques. Only the viscera (excluding edible portions) of pigs, sheep and cows (exclusive of rumen) were examined; all animals except four cows from Prince Edward Island were native to Newfoundland.

Helminths recovered were preserved in 10% formalin (4% aqueus formaldehyde). After fixation, trematodes and cestodes were stained with Semichon's Acetic Carmine*, dehydrated in ethanol, cleared in xylene and mounted in Permount*. Squash preparations of coeneuri were made in Rubin's fluid* and examined by both conventional and phase microscopy. Other larval forms such as strobilocerci were treated as adult worms.

Nematodes were treated in one of three ways. Some were mounted directly from formalin in Rubin's fluid. Others were heated in lactophenol*, and placed in glycerol jelly* between two coverslips and then mounted in Permount. In the third method, nematodes were cleared in hot lactophenol as above, examined as temporary mounts in lactophenol and either returned to the appropriate container or mounted in Rubin's fluid. For routine

---

* Appendix II

identifications, lactophenol was found to be better than Rubin's fluid since it clears the specimens much more rapidly. However excellent results were obtained using Rubin's fluid which acts both as a clearing agent and a mounting fluid.

Any nodules or cysts found in the gut were teased apart under a dissecting microscope and helminths found were treated as above.

Several faecal samples were examined both as wet mounts and by direct centrifugal floatation in a saturated solution of sodium chloride.

Although parasitic protozoa have been recovered from Newfoundland mammals (Smith 1969), no attempt was made to collect and study them during the present survey.

RESULTS AND DISCUSSION

A total of eighteen species of mammals were examined. Fifty-five species of helminths (Table 1), including 3 species of trematodes, 14 of cestodes, 37 of nematodes and 1 of acanthocephala, were recovered.

The classification of mammals in the present work follows the scheme of Simpson (1945), except that unparasitized animals are grouped together.

Snowshoe Hare-*Lepus americanus* Bangs

Number examined 3 Place of origin-Avalon Peninsula -Ocean Pond

The snowshoe hare has been studied in detail in Newfoundland (Dodds and Mackiewicz, 1961) and therefore no attempt was made to acquire a large sample. Only three animals were examined. A total of four helminth species were recovered, compared to the seven found by Dodds and Mackiewicz (1961).

Coenurus taenia-serialis was found in the muscles of one animal and in the muscles and lungs of another, the meristic characters of the helminths fitting those given by Joyeux and Baer (1936). Dodds and Mackiewicz (1961) reported *Multiceps sp.* from this host

Table I. List of helminths found together with the number of each host infected.

* First record for Newfoundland.
** New host record.

Species of Helminth	Host	Number Infected
TREMATODA		
*Plagiorchis massino (Petrowet and Tichonoff, 1927)	Cat	1
Dicrocoelium dendriticum (Rudolphi, 1819)	Cattle	1
*Campula oblonga (Cobbold, 1876)	Porpoise	1
CESTODA		
Schistocephalus solidus (Muller, 1776)	Otter	1
Diphyllobothrium dendriticum (Nitzsch, 1824)	Cat	1
Diphyllobothrium latum (Linnaeus, 1758)	Dog	1
**Anophryocephalus anophrys Baylis, 1922.	Seal	1
*Anoplocephala perfoliata (Goeza, 1782)	Horse	1
*Moniezia expansa (Rudolphi, 1810)	Sheep	3
Moniezia sp.	Sheep	4
*Monoecocestus sp. Beddard, 1914	Vole	3

Table I. Continued.

*Paranoplocephala troeschi Rausch, 1946		Vole	17
*Paranoplocephala sp.		Vole	6
Dipylidium caninum (Linnaeus, 1758)		Dog	1
Taenia pisiformis (Bloch, 1780)		Hare Dog	1 3
Coenurus taenia-serialis (Gervais, 1847)		Hare	2
*Hydatigera taeniaeformis (Batsch, 1786)	(larvae) (mature)	Rat Cat	6 1
Hymenolepids		Rat	4
Anoplocephalid cestode fragments		Vole	7
Unidentified larval cestode		Vole	1
NEMATODA			
*Heterakis spumosa Schneider, 1866		Rat	2
*Trichuris ovis (Abildgaard, 1795)		Sheep	10
*Trichuris opaca Barker and Noyes, 1915		Vole	6
Trichuris vulpis (Froelich, 1789)		Dog	1
*Strongylus edentatus (Looss, 1900)		Horse	1
*Strongylus vulgaris (Looss, 1900)		Horse	1
*Triodontophorus serratus (Looss, 1900)		Horse	1

Table I. Continued.

*Triodontophorus minor (Looss, 1900) Looss 1902	Horse	1
*Bunostomum trigonocephalum (Rudolphi, 1808)	Sheep	3
Uncinaria stenocephala (Railliet, 1884)	Dog	10
*Trichonema catinatum (Looss, 1900)	Horse	1
*Cylicocyclus elongatum (Looss, 1900) Ershov, 1939	Horse	1
*Cylicocyclus nassatus (Looss, 1900) Ershov, 1939	Horse	1
*Petrovinema poculatum (Looss, 1900) Ershov, 1943	Horse	1
Oesophagostomum radiatum (Rudolphi, 1803)	Cattle	1
*Oesophagostomum venulosum (Rudolphi, 1809)	Sheep	7
Cooperia oncophora (Railliet, 1898)	Cattle	1
*Ostertagia circumcincta (Stadelmann, 1894)	Sheep	2
*Nematospiroides dubius Baylis 1926	Vole	1
*Nematodirus triangularis Boughton, 1932	Hare	1
*Nematodirus abnormalis May, 1920	Sheep	1
*Nematodirus spathiger (Railliet, 1896)	Sheep	2

Table I. Continued.

*Angiostrongylus vasorum (Railliet, 1866)	Fox	2
Crenosoma vulpis (Dujardin, 1845)	Dog	2
	Fox	2
*Dictyocaulus filaria (Rudolphi, 1809)	Sheep	2
Dictyocaulus viviparus (Bloch, 1782)	Cattle	1
*Halocercus inflexocaudatus (v. Sieb., 1842)	Porpoise	1
*Halocercus sp. Baylis and Daubney, 1925	Porpoise	1
*Pseudostenurus sp. Yamaguti, 1951	Porpoise	1
*Irukanema dalli Yamaguti, 1951	Porpoise	1
*Ascaris suum Goeze, 1782	Pig	1
*Parascaris equorum (Goeze, 1782)	Horse	1
Toxascaris leonina (Linstow, 1902)	Cat	2
	Dog	3
Toxocara canis (Werner, 1782)	Dog	16
Toxocara mystax (Zeder, 1800)	Cat	33
*Contracaecum osculatum (Rud., 1802)	Seal	1

Table I. Continued.

Contracaecum sp. larvae	Porpoise	1
*Protospirura muris (Gmelin, 1790) Seurat, 1915	Vole	10
ACANTHOCEPHALA		
Acanthocephalus lateralis (Leidy, 1851)	Otter	1

in Newfoundland, the commonest species of Multiceps recorded from wild lagomorphs being M. serialis (Gervais). They found that only hares from the St. John's area, where there is a large number of dogs that are allowed to roam about freely, were infected with this worm. They did not find the helminth in other parts of the island where the dog population is lower. The three hares examined in this survey were caught on the Avalon Peninsula.

One hare was found to have a multiple infection with Coenurus taenia-serialis, Taenia pisiformis and Nematodirus triangularis. Dodds and Mackiewicz (1961) found T. pisiformis but did not report N. triangularis. Erickson (1944) discussed the periodic fluctuations of helminths in snowshoe hares and gave a key to the identification of helminths from this host. He found a very low infection with N. triangularis from June to November, but a high burden from January to Febuary. Dodds and Mackiewicz (1961) took a small sample of hares during the latter months, thus explaining why they did not recover this nematode.

An immature female strongylid nematode was recovered from the lungs of one animal. As the specimen was immature it was impossible to identify it using available keys. It is hoped that in the future, both adult male and female worms may be recovered and an identification made.

Meadow Vole - Microtus pennsylvanicus (Ord)

Number examined 113 Place of origin - Notre Dame Bay
- Great Northern Peninsula
- TCH near St. John's*

This is the first helminthological survey of meadow voles in Newfoundland. Three of the infected animals harboured helminths belonging to the genus Monoecocestus Beddard, 1914, this genus having been discussed by Wardle and McLeod (1952) and Spasskii (1951). The specimens were poorly preserved, consequently no attempt was made to identify the specimens to the species level. Rausch and Tiner (1949) did not report this genus in their survey of voles of the North Central States, but Yamaguti (1959) reported M. variabilis (Douthitt, 1915) Freeman, 1949 from Microtus in North America.

The most frequently found helminth was the cestode Paranoplocephala troeschi which was described by Rausch (1946) and can be differentiated from closely related species using the morphological criteria given by Hansen (1947) and Rausch (1948). Rausch (1946) stated that the normal habitat of this worm is in the region of the ileo-caecal junction but that it is found more frequently in the caecum than the lower small intestine.

* TCH - Trans Canada Highway

Table II. Details of the distribution of helminths in voles.

Helminth species	Number Infected	Percent of Animals Examined	Total Worms Recovered
Monoecocestus sp.	3	2.7	4+
Paranoplocephala troeschi	17	15.0	21
Paranoplocephala sp.	6	5.3	7+
Anoplocephalid cestode fragments	7	6.2	?
Unidentified larval cestode	1	0.9	76
Trichuris opaca	6	5.3	17
Nematospiroides dubius	1	0.9	4
Protospirura muris	10	8.9	19

Table II Continued.

Helminth species	Range	Average Number of Worms per Infected Animal
Monoecocestus sp.	1-2+	1.3
Paranoplocephala troeschi	1-2	1.2
Paranoplocephala sp.	1-2+	1.1
Anoplocephalid cestode fragments	?	?
Unidentified cestode larvae	76	76
Trichuris opaca	1-7	2.8
Nematospiroides dubius	4	4.0
Protospirura muris	1-5	1.9

Table III. Distribution of helminth infections according to the sex of the host.

	Male	Female	Unrecorded Sex	Total
Number of animals examined	59	53	1	113
Number of animals infected	19	19	0	38
Percent animals infected	32.2	35.8	0	33.7

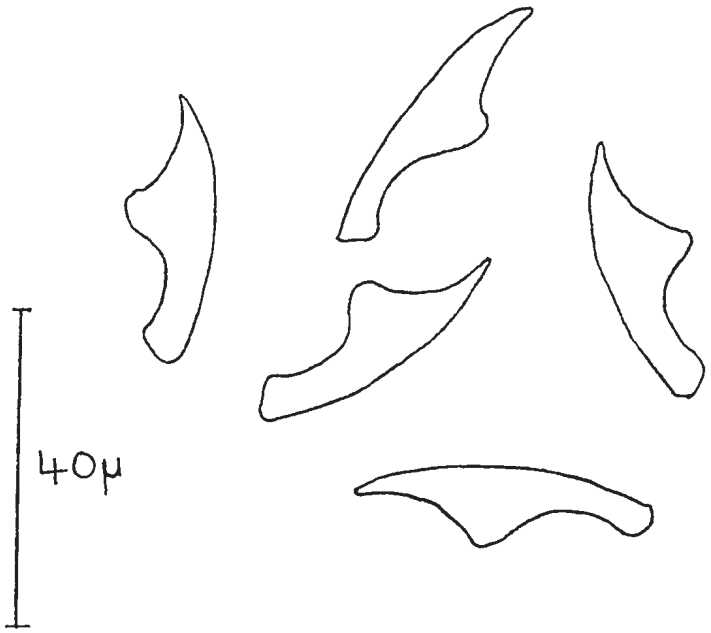


Figure 2. Drawing of the hooks of an unidentified larval cestode recovered from Microtus pennsylvanicus.

In this survey the large and small intestines contained approximately equal numbers of worms. However the majority of the specimens found were taken from the caecum. In no case were more than two worms found in any animal which agrees with the data presented by Rausch (1946) who found that usually only 1-2 helminths were present, rarely more than three. In six cases specimens were diagnosed as Paranoplocephala sp. due to the poor state of preservation which did not allow identification to the species level.

Seven animals contained many individual ruptured proglottids which could not be identified even to genus. However, on the basis of a double excretory system and egg morphology it is likely that the worms belonged to the family Anoplocephalidae.

Seventy-five larval cestodes were found in the urogenital tract and one in the lungs of a single animal. The larvae had invaginated scolices bearing fifty hooks, 25 large (50-58 u long) and 25 small (42-47 u long), arranged in a double circle (frontispiece and Figure 1). An extensive search of the literature failed to reveal the identity of these larvae. It is possible that the examination of other animals in the area will reveal adult forms which are referable to this larva.

The second most commonly recovered helminth was

the nematode Protospirura muris. Hall (1916) described this species and reported that it occured in large numbers in mice but did not mention voles. Rausch and Tiner (1949) did not report this species in their survey. The worms were found in either the stomach or the caecum.

Specimens of Trichuris opaca, which was also redescribed by Hall (1916), were found in the caecae of six animals. Rausch and Tiner (1949) recorded T. opaca in 1.93% of 570 animals which they examined, the degree of infection being much lower in their work than in the present survey (5.31% infected).

The helminth infections discussed above were in animals collected from islands in Notre Dame Bay. Four animals collected on the Avalon Penninsula were helminth-free. Of three voles collected on the Great Northern Penninsula, one was found to be infected with Nematospiroides dubius. N. dubius is differentiated from N. carolinensis Dikmans 1931 and N. longispiculatus Dikmans 1931, on the basis of various morphological criteria (e.g. spicule length). Rausch and Tiner (1949) recovered a Nematospiroides sp. from Microtus pennsylvanicus which occured in a greater percentage of animals than did N. dubius in the present study (5.61 : 0.88 respectively).

Rausch and Tiner (1949) recovered more species

of helminths from meadow voles than did the present worker. This may be due to the fact that the present specimens were obtained from isolated islands which would only have limited sources of infection. In addition, collections were made only during the fall and winter, the summer population possibly showing a different fauna both qualitatively and quantitatively.

It is interesting to note that Spurlock (1943) found a difference in susceptibility to N. dubius among various strains of lab mice, but it is not known if this applies to voles.

Brown Rat - Rattus norvegicus (Berkenhout)

Number examined 40 Place of origin-Robin Hood Bay
-Logy Bay
-Topsail Pond

Threlfall (1969) examined one rat but found it to be unparasitized, this apparently being the only published record of anyone examining rats in Newfoundland for parasites.

Strobilocerci of Hydatigera taeniaeformis were found encysted in the livers of six animals. Identification was based on hook measurements and morphology presented by Wardle and McLeod (1952) and Esch and Self (1965). All the rats appeared to be healthy, with no sign of the malignant changes reported to be associated with such cysts (Soulsby 1968).

Gravid proglottids, identifiable only as Hymenolepids, were recovered from the intestines of four rats and generic identification was not possible since egg morphology and measurements did not present sufficient criteria to enable such identification. Oldham (1931) listed twelve species of Hymenolepis from rats.

Two of the rats examined were infected with Heterakis spumosa which was redescribed by Hall (1916). This worm is a cosmopolitan parasite of rats (Oldham 1931). Since most of the rats examined came from the same area

Table IV. Details of infection of brown rats with helminths.

Helminth species	Number of Infected Animals	Percent of Animals Examined	Total Worms
Hydatigera taeniaeformis (cyst)	6	15.0	10
Hymenolepids	4	10.0	5
Unidentified cestode	1	2.5	1
Heterakis spumosa	2	5.0	2

Table IV Continued

Helminth species	Range	Average Number of Worms per Animal
Hydatigera taeniaeformis (cyst)	1-3	1.6
Hymenolepids	1-2	1.2
Unidentified cestode	1	1.0
Heterakis spumosa	1	1.0

Table V. Distribution of helminths according to the sex of the host.

	Male	Female	Total
Number Animals Examined	26	14	40
Number Animals Infected	5	4	9
Percent Animals Infected	19.2	28.6	22.5

(ie. St. John's City Dump, Robin Hood Bay), it is possible that if rats from other areas were examined a larger variety of helminths would be found.

Harbour Porpoise - Phocoena phocoena (Linnaeus)

Number examined 1 Place of origin-Witless Bay

One recently post parturient porpoise was examined, the animal having been caught in a gill net at Witless Bay. There were no ectoparasites on the creature, which was heavily infected with endoparasites.

The liver appeared to have fibrous bands running through parts of its parenchyma, these being fibrous thickenings of the bile ducts presumably caused by the liver flukes, Campula oblonga, found therein.

Many nematodes were found in the lungs, but only seventy were sufficiently well preserved for identification. Three of the worms fitted the description of Halocercus inflexocaudatus and were differentiated from closely related species using data presented by Yamaguti (1951). The rest of the nematodes were Irukanema dalli which was described from the accessory nasal sinus of Phocaenoides dalli by Yamaguti (1951).

Over 90 nematodes were found in the esophagus, the majority being I. dalli which may have migrated from the lungs. Several specimens of Pseudostenurus sp. and Halocercus sp. were also found in the esophagus but it is not known if they were migrants from the lungs or were normal esophageal parasites.

One Contracaecum sp. larva was found in the small intestine and two in the large intestine. The small intestine also yielded one specimen of Irukanema sp. and one of Halocercus sp.

Few records concerning the helminths of the Harbour Porpoise were found.

Domestic Dog - Canis familiaris Linnaeus

Number examined 69 Place of origin-St. John's
Mount Pearl
Bauline
Kilbride
Manuels
Cape Broyle
Logy Bay

Dogs were obtained from two main sources, firstly local veterinarians (these animals normally being household pets,) and secondly, dogs from the local pound (strays).

Many of the animals from the private sources were destroyed because they were suffering from a debilitating disease such as neoplasia or distemper. Many of these diseases may have affected the helminth burden of the animals since in chronic conditions the animals may have become more susceptible to parasitism. On the other hand, diarrhoea accompanied many of these diseases and could have resulted in a reduction of the number of worms present.

Toxocara canis was the most prevalent species recovered, but Uncinaria stenocephala also showed a relatively high rate of infection. Eight species of helminths were found, as opposed to six found by Threlfall (1969). No trematodes were found in this survey but Cameron et al (1940) recorded Cryptocotyle lingua (Creplin 1825) from the west coast of Newfoundland.

Table VI. Details of helminth infections in domestic dogs from private sources (a), from the St. John's City Pound (b). The total number of animals examined is represented by (c).

Helminth species		Number Infected	Percent of Animals Examined	Total Worms Recovered
Diphyllobothrium latum	(a)	1	3.3	1
	(b)	0	0.0	0
	(c)	1	1.5	1
Dipylidium caninum	(a)	0	0.0	0
	(b)	1	2.6	1
	(c)	1	1.5	1
Taenia pisiformis	(a)	2	6.7	2
	(b)	1	2.6	1
	(c)	3	4.5	3
Trichuris vulpis	(a)	1	3.3	2
	(b)	0	0.0	0
	(c)	1	1.5	2
Uncinaria stenocephala	(a)	2	6.7	20
	(b)	8	20.5	128
	(c)	10	14.5	148
Crenosoma vulpis	(a)	0	0.0	0
	(b)	2	5.1	25
	(c)	2	2.9	25
Toxascaris leonina	(a)	0	0.0	0
	(b)	3	7.7	4
	(c)	3	4.5	4
Toxocara canis	(a)	4	13.3	153*
	(b)	12	30.8	182
	(c)	16	23.2	335*

* Includes one animal examined by direct centrifugal floation of the faeces.

Table VI Continued.

Helminth species		Range	Average Number of Worms per Infected Animal
Diphyllobothrium latum	(a)	1	1.0
	(b)	0	0.0
	(c)	1	1.0
Dipylidium caninum	(a)	0	0.0
	(b)	1	1.0
	(c)	1	1.0
Taenia pisiformis	(a)	1	1.0
	(b)	1	1.0
	(c)	1	1.0
Trichuris vulpis	(a)	2	2.0
	(b)	0	0.0
	(c)	2	2.0
Uncinaria stenocephala	(a)	1-19	10.0
	(b)	1-108	16.0
	(c)	1-108	14.8
Crenosoma vulpis	(a)	0	0.0
	(b)	2-23	12.5
	(c)	2-23	12.5
Toxascaris leonina	(a)	0	0.0
	(b)	1-2	1.3
	(c)	1-2	1.3
Toxocara canis	(a)	4-96	38.3*
	(b)	1-99	15.2
	(c)	1-99	20.9*

* Includes one animal examined by direct centrifugal flotation of the faeces.

Table VII. Distribution of helminth infections according to the sex and source of the host.

	Private Source	St. John's Pound	Total
Number Animals Examined	30	39	69
Number Animals Infected	8	22	30
% Infected	26.7	56.4	43.5
Number Male Animals	14	25	39
Number Male Infected	2	14	16
% Male Infected	14.3	56	40.0
Number Female Animals	13	12	25
Number Female Infected	3	6	9
% Female Infected	23.1	50	36.0
Unrecorded Sex	3	2	5
Number Unrecorded Sex Infected	3	2	5
% Unrecorded Sex Infected	100	100	100

One specimen of Dipylidium caninum was found in the small intestine of an adult male dog received from the pound. This worm is reported to be one of the more important cestodes affecting dogs in North America (Siegmund, 1967), occuring in 38% of dogs in Mexico City (Styles, 1967) and in 29% in New Jersey (Lillis, 1967). Cameron et al (1940) and Threlfall (1969) did not find Dipylidium caninum in dogs in Newfoundland and consequently this appears to be a new record for the province. However Becklund (1964) reported the species as occuring generally in North America.

Soulsby (1968) stated that D. caninum is the commonest tapeworm of dogs in most parts of the world. In this survey however, the most commonly recovered cestode was Taenia pisiformis . This helminth has been found previously in Newfoundland, Threlfall (1969) reporting two infections in dogs which had been allowed to roam freely in the vicinity of a local abattoir. Two of the infected dogs in this survey were from the St. John's area and the third was from Manuels. T. pisiformis has been reported as being particularly common in suburban, farm and hunting dogs which eat rabbits and rabbit viscera (Siegmund, 1967). Dodds and Mackiewicz (1961) and the present worker have found T. pisiformis in snowshoe hares, which could be a source of infection

for dogs. It is interesting to note that none of the T. pisiformis infections occured alone, all being accompanied by Uncinaria stenocephala. Since this nematode was found in other animals both as single and multiple infections with other worms, it is possible that U. stenocephala makes its host more susceptible to infection with T. pisiformis.

One infection with Diphyllobothrium latum was noted, several mature and gravid proglottids being passed in the faeces of the infected animal, which came from a private source outside St. John's. The dog may have become infected by eating raw fish (salmonids) which harbour Diphyllobothrium plerocercoids (Sandeman and Pippy 1967). Cameron et al (1940) did not find this species in dogs in Newfoundland, nor did Threlfall (1969). Becklund (1964) reports this species as occuring principally in the Great Lakes region.

The most abundant nematode was Toxocara canis. The usual mode of infection with this nematode is prenatal from larvae in the tissues of the bitch (Siegmund, 1967). There were 16 infections with T. canis, 8 of which were recovered from dogs less than six months of age (66.66 % infected) and 8 infections among 56 dogs older than 6 months (14.03 % infected). This nematode is of public

health importance since the larvae have been known to cause visceral larva migrans in humans (Soulsby, 1968; Siegmund, 1967; Styles, 1967; Nichols, 1956a,b.)

Three adults were found to be infected with Toxascaris leonina. The intensity of infection (1-2 worms) was very close to that found by Threlfall (1969) (1-3 worms). The number of animals infected in this survey was approximately half that found by Threlfall (1969). Cameron et al (1940) did not record T. leonina or T. canis in Newfoundland dogs but did state that most of the ascarid nematodes found in northern Canada were T. leonina. This is possibly because this species is often acquired by ingestion of wild animals carrying the nematodes. In a helminthological survey of dogs in Mexico City, Styles (1967) did not recover T. leonina at all, but Schantz and Biagi (1968) recorded 68% infection with T. canis and 22% infection with T. leonina in the same area. In New Jersey, Lillis (1967) found 22.5% infection with T. canis and 65.4% infection with T. leonina. Schantz and Biagi (1968) reported that in Mexico City there was no age difference in the T. leonina infection rate but there was a great difference with T. canis. The ratio of T. canis to T. leonina varies from country to country; T. leonina being much more common than T. canis in dogs in Alaska but the reverse true for Australia

(Siegmund, 1967). In Montreal, T. canis is much more common than T. leonina (Choquette, 1950).

Uncinaria stenocephala was the second most commonly recovered nematode from dogs. Threlfall (1969) recovered this species from 5.7% of Newfoundland dogs and Cameron et al (1940) recovered eggs of this species in dogs from several areas of the province. There appeared to be an age difference in infection rates, 8.33% of dogs less than 6 months of age being infected and 15.79% of dogs over 6 months being infected. Uncinaria stenocephala was the only hookworm found in this survey and as far as is known Ancylostoma caninum (Ercolani, 1859) has never been found parasitizing Newfoundland animals, although Threlfall (1969) diagnosed A. caninum in the faeces of a dog imported from the U.S.A. U. stenocephala is much better adapted to Newfoundland conditions, its optimum temperature for larval growth being 20°C. (Gibbs and Gibbs, 1959) as opposed to a 30°C. optimum temperature for A. caninum. Larval growth is possible for U. stenocephala between 7.5°C. and 27°C. when the time of development to the infective larvae varies inversely with the temperature (Gibbs and Gibbs 1959). U. stenocephala larvae can resist drying to a much greater extent than the ensheathed larvae of A. duodenale and N. americanus (Goodey, 1925). Possibly of significance

is the fact that U. stenocephala larvae penetrate the skin without loosing their sheaths (Goodey, 1925). However the usual mode of infection is by ingestion of the larvae.

Two infections with Crenosoma vulpis were found. This parasite is normally a parasite of foxes (Soulsby, 1968) and has been found in foxes in Newfoundland by Threlfall (1969) and by the present worker. This worm is not unknown in dogs (Ershov, 1956; Lapage, 1968) but this appears to be the first record of C. vulpis in local dogs. One of the infected dogs was an adult male which harboured 5 male and 18 female worms in its lungs and had a concurrent infection with T. canis and U. stenocephala in the small intestine.

Two female Trichuris vulpis were found in a two year old male Beagle which belonged to a fisherman in Bauline. These worms are reported to be fairly common in southern Canada (Cameron et al, 1940) but apparently not in the Arctic. It is possible that a North-South gradient exists, the parasites being less common with increasing latitude. This would explain why such a low degree of infection was found. This is the first record of T. vulpis in dogs from Newfoundland.

It is interesting to note that the percentage

of infections was much higher in dogs from the pound than those from private sources (56.41% and 26.66 % respectively). *D. caninum*, *T. leonina* and *C. vulpis* were not recovered from pet dogs whereas *D. latum* and *T. vulpis* were not recovered from strays. *T. canis* was found in only 13.33% of pet animals but in 30.77% of strays. However the average number of worms per infected animal was much higher in pet dogs. Over 20% of the dogs obtained from the pound were infected with *U. stenocephala*, but only 6.66% of dogs from private sources harboured this worm.

Red Fox - Vulpes fulva (Linnaeus)

Number examined 3 Place of origin-Aqua Forte
Notre Dame Bay

Three foxes were examined for their helminth burden, two of which had lungworm infections . Angiostrongylus vasorum was found in both infected animals, 23 worms occurring in one fox and 3 in the other. This nematode normally occur in the pulmonary artery and rarely in the right ventricle (Soulsby, 1968) but in the animals examined the worms were found in the esophagus, trachea and bronchi. None of the pathological lesions described by Soulsby (1968) were observed but histopathological examination was not undertaken.

One of the infected animals had a concurrent infection with Crenosoma vulpis, a species that parasitizes several species of mammals. Threlfall (1969) found 2 female C. vulpis in Newfoundland foxes, while in the present survey 9 female worms were recovered. It is of interest to note that no males have been found to date.

River Otter - Lutra canadensis (Schreber)

Number examined 3 Place of origin - Nfld.

Three otters were examined, but only one was found to be parasitized. A damaged plerocercoid of Schistocephalus solidus was found in the intestine. This species has been described from a variety of freshwater fishes in North America (Hoffman, 1967) and occurs most frequently in sticklebacks (Gasterosteus sp., Pygosteus sp.). Its presence in other hosts is probably accidental (Hopkins and Smith, 1951).

Two female Acanthocephalus lateralis were found in the same otter. It is not known if these were true parasites of the otter or if they were liberated from ingested food. This acanthocephalan is common in a variety of Newfoundland fish (Sandeman and Pippy, 1967; Threlfall and Hanek, pers. comm.).

Domestic Cat - Felis catus Linnaeus

Number examined 69 Place of origin - St. John's

Male animals from both sources appeared to be more heavily infected than females, and both males and females from the private sources appeared more heavily infected than those from the pound (Table IX). However the relatively high number (8) of animals of unrecorded sex from the private sources as opposed to only one from the pound may have caused a discrepancy in these figures. The overall infection figures show that the cats from the private sources were only slightly more highly infected. (50% : 57.14%)

Five species of helminths were found (Table VIII) but only one species, Toxocara mystax, was found in any great number of animals.

This species of worm was found in a higher proportion of cats from the private sources than in those from the pound. However if only infected animals - those infected with any species of worm - are considered, then the percentages of animals infected with T. mystax from both sources are the same.

Threlfall (1969) recovered four species of helminths from domestic cats. In this work, Dipylidium caninum was not found but specimens of Plagiorchis massino and Hydatigera taeniaeformis were recovered. Becklund (1964)

Table VIII. Details of helminth infections in domestic cats from private sources (a), from the city pound (b). The total number of animals is represented by (c).

		Number Animals Infected	% of Animals Examined	Total Number Worms Recovered
Plagiorchis massino	(a)	0	0.0	0
	(b)	1	2.1	1
	(c)	1	1.4	1
Diphyllobothrium dendriticum	(a)	1	4.8	1
	(b)	0	0.0	0
	(c)	1	1.4	1
Hydatigera taeniaeformis	(a)	1	4.8	1
	(b)	0	0.0	0
	(c)	1	1.4	1
Toxascaris leonina	(a)	1	4.8	1
	(b)	1	2.1	3
	(c)	2	2.9	4
Toxocara mystax	(a)	11	52.4	61
	(b)	22	45.8	70
	(c)	33	47.8	131
Damaged Ascarid	(a)	0	0.0	0
	(b)	1	2.1	1
	(c)	1	1.4	1

Table VIII. Continued.

		Range	Average Number Worms per Infected Animal
Plagiorchis massino	(a)	0	0
	(b)	1	1
	(c)	1	1
Diphyllobothrium dendriticum	(a)	1	1
	(b)	0	0
	(c)	1	1
Hydatigera taeniaeformis	(a)	1	1
	(b)	0	0
	(c)	1	1
Toxascaris leonina	(a)	1	1
	(b)	3	3
	(c)	1-3	2
Toxocara mystax	(a)	1-13	5.6
	(b)	1-20	3.2
	(c)	1-20	3.9
Damaged Ascarid	(a)	0	0
	(b)	1	1
	(c)	1	1

Table IX. Distribution of helminth infections according to the sex and source of the host.

	Private Sources	Pound	Total
Number Animals Examined	21	48	69
Number Infected	12	24	36
% Infected	57.1	50	52.2
Number Males	5	20	25
Number Males Infected	5	12	17
% Males Infected	100	60	68
Number Females	8	27	35
Number Females Infected	7	12	19
% Females Infected	87.5	44.4	54.3
Number Unrecorded Sex	8	1	9
Number Unrecorded Sex Infected	0	0	0
% Unrecorded Sex Infected	0	0	0

lists H. taeniaeformis as occuring generally in North America. However the record of P. massino is a new host record for North America, this species having previously been recovered from red foxes in Alaska (Babero and Rausch 1952). The lone trematode was found in the small intestine of a young female cat received from the city pound, and was identified using the key given by Olsen (1937). There was no history other than that the cat came from St. John's. Apparently this trematode has only been found previously in Armenia and Kazakhstan, U.S.S.R., in dogs and cats (Dawes, 1946; Yamaguti, 1961; Olsen, 1937). This was the only trematode found in cats during the present study but it is possible that if more cats are examined from areas where fish form a large part of their diet, other trematodes will be found, eg. Cryptocotyle lingua. Trematodes have only been reported infrequently from cats in North America (Burrows and Lillis, 1965) even though Becklund (1964) reported seventeen species from dogs and cats. Becklund (1964) also reported Metorchis conjunctus as occurring from Saskatchewan to Newfoundland but no reference was cited to support this statement.

H. taeniaeformis is one of the most important cestodes infecting cats in North America (Siegmund, 1967), but this appears to be the first record for domestic cats

in Newfoundland. The parasite was identified using data given by Esch and Self (1965), Soulsby, (1968), Cameron (1951) and Wardle and McLeod (1952). The infected animal was an adult male received from a private source and was suffering from a pancreatic abnormality. Neither P. massino nor H. taeniaeformis occured alone, both were accompanied by T. mystax infections.

Threlfall (1969) reported a natural occurrence of Diphyllobothrium dendriticum from cats in North America for the first time. The same species was found in this work and was identified and differentiated from closely related species using the keys to identification of Markowsky (1949) and Meyer and Robinson (1963). The infected cat was a seven year old male which was suffering from feline panleukopenia (feline distemper).

Two nematodes that are cosmopolitan in their distribution (Yamaguti, 1961), Toxocara mystax (47.77%) and Toxascaris leonina (2.89%) were found in the animals examined. There were two infections with T. leonina, one in an adult animal and one in an immature animal, both hosts being male. The incidence of T. mystax infections varies from country to country but is usually between 20% and 60%, T. leonina being relatively uncommon in cats (Oldham, 1965). The age of the animal is a very important

factor relative to infection, young cats being more susceptible to T. mystax than older ones, although infection can occur at any age (Oldham, 1965). In this work, the highest number of worms recovered from an individual adult animal was 20, whereas the highest number in any one immature cat was four. In general, the older cats showed a slightly higher intensity of infection than young animals. Twenty-eight of the 69 animals examined were more than one day old and less than 6 months, 12 (42.8%) being infected with T. mystax while one (3.6%) was infected with T. leonina. The rate of infection with T. mystax was higher (51.2%) in adult animals, but infection with T. leonina was lower (2.4%).

It may be noted that the distinction between pet and stray cats may not be as significant as that between pet and stray dogs, since even pet cats if not closely watched, will roam.

Harp Seal - Phoca groenlandica Erxleben

Number examined 1 Place of origin - Notre Dame Bay

The only seal examined was a one year old harp, killed in Notre Dame Bay (49°50'N, 54°35'W). A single tapeworm found in its stomach was identified as Anophryocephalus anophrys Baylis,1922 (Joyeux and Baer, 1936). King (1964) records this cestode as occurring in Phoca hispida Schreber but not in P. groenlandica. No previous records of this worm from Harp Seals were found, this constituting a new host record.

Two hundred fifty four specimens of Contracaecum osculatum were found in its stomach together with many nematode fragments which could not be identified or enumerated. A further four C. osculatum were found in the esophagus, and two in the lower small intestine. The fauna consisted of a mixture of IV stage larvae and adults (Berland, 1963). Lyster (1940) did not recover this nematode from P. groenlandica although he recorded the worm in P. hispida and P. vitulina Linnaeus. King (1964) however, included it in a list of helminth parasites of P. groenlandica. Lyster (1940) stated that the worms are found in the esophagus, stomach and small intestine of the more heavily infected animals.

Domestic Horse - Equus caballus Linnaeus

Number examined 1 Place of origin - Witless Bay

Threlfall (1969) examined a faecal sample from a horse and found eggs and specimens of three nematodes (Appendix I). As far as is known this is the only documentation of Newfoundland equine helminthiases.

The one horse examined in this work was killed by a car in the Witless Bay area. The specimen was partly eviscerated in the accident and since some time elapsed before autopsy, the body was in a somewhat degenerate condition and only samples of gut contents were obtained.

A single species of cestode was found, namely Anoplocephala perfoliata. Fifty seven of these worms were found but this number probably does not reflect the true picture of parasitism due to loss of helminths in the gut contents that were lost after the accident. This species has been recorded from many areas of North America (Becklund, 1964), but identification was based on the description given by Skrjabin and Spasskii (1951).

Two specimens of the equine ascarid, Parascaris equorum, were found. Only small numbers of this helminth are usually found in adult horses (Siegmund, 1967).

The large strongyles, Strongylus edentatus and S. vulgaris, were recovered from the stomach contents. No gross pathological lesions were seen in the intestinal walls but the degree of degeneracy could have masked any small lesions.

Species of the genus Triodontophorus Looss, 1902 are common in horses in North America (Becklund, 1964); two species, namely T. serratus and T. minor being found in the present work. The more pathogenic species, T. tenuicollis Boulenger, 1916, was not seen. Triodontophorus species are reported (Soulsby, 1968) to produce deep ulcers in the intestinal wall, but these were not found in the animal examined.

Petrovinema poculatum and Trichonema catinatum, both of which are reported to occur in Canada (Popova, 1955) were found in the horses stomach, as were Cylicocyclus elongatum and C. nassatum which occur generally in North America (Becklund, 1964). These small strongylids were identified using the work of Popova (1955). There is much confusion in the taxonomy of these nematodes which involves a long history of controversy. Ershov (1943) divided the existing genus Trichonema, Cobbold, 1874, into five genera as follows: Trichonema, Cobbold 1874;

Cylicocyclus (Ihle, 1922) Ershov, 1939; Cylicodontophorus (Ihle, 1922), Ershov, 1939; Petrovinema Ershov, 1943; and Schulzitrichonema Ershov, 1943. MacIntosh (1951) suggested that the genus Trichonema should be called Cyathostomum Molin, 1861, because the latter is not synomynous with Cyathostoma Blanchard, 1849; and therefore proposed the following classification scheme for the trichonemas: Cyathostomum Molin 1861 s. str.; Cylicocercus Ihle, 1922; Cylicodontophorus Ihle, 1922; Cylicostephanus Ihle, 1922; Cylicotetrapedon Ihle, 1925; and Cylicobrachytus Cram, 1924.

The above discussion appears to indicate that the eggs reported by Threlfall (1969) as Cyathostoma sp. were actually Cyathostomum or one of the other genera listed, since most have Cyathostomum or Cyathostoma synonyms. Barus (1966) constructed a key to differentiate the genera of nematodes normally found in horses.

Domestic Pigs - Sus scrofa Linnaeus

Number examined 99 Place of origin - Avalon Pen.

The abdominal viscera of 63 pigs and the thoracic viscera of 99 pigs were examined. Only one animal was found to parasitized, having five Ascaris suum in its small intestine. This helminth occurs generally in North America (Becklund, 1964) and is extremely resistant, surviving temperatures as low as -26.8°C. and is capable of development at 12°C. (Mozgovoi, 1953).

The animals examined were all specific pathogen free (S.P.F.) pigs which were fed an approved diet and consequently had a reduced chance of picking up helminths. In addition, the pigs were treated with an anthelminthic (McAllister, 1969, pers. comm.). It was noted that the stomach of the one infected pig contained different ingesta from that found in all of the others.

Pig livers are often found with subcapsular scars similar to those produced by the migrating stage of Ascaris suum larvae, but in the absence of helminths. Histopathological examination of these, which are termed "parasitic livers", revealed that only a small proportion were caused by parasites (Smith, 1969, pers. comm.). Such terminology can lead to a misleading view of the situation regarding the number of pigs in an area infected with helminths.

Domestic Cattle - Bos taurus Linnaeus

Number examined 7 Place of origin - P.E.I.
- Portugal Cove
- Avalon Penn.

Four cows, imported from Prince Edward Island and in Newfoundland for a short but undetermined time, were found to be parasitized by Oesophagostomum radiatum (1 infection) and Cooperia oncophora (1 infection). O. radiatum occurs generally in North America (Becklund, 1964) and has been found in Newfoundland cattle which were grazing on reclaimed peat pastures at Colinet (Rayment and Nickolson, 1965). Apparently peat pastures offer conditions suitable for the propagation of some helminths (Rayment and Nickolson, 1965) and consequently pasture rotation and anthelminthic procedures must be followed.

O. radiatum is one of the more pathogenic species of helminths of cattle when it is present in large numbers (Soulsby, 1968). Nodular formations were seen throughout the digestive tracts of all four imported animals, but only in one animal were worms (O. radiatum) found. All nodules were teased apart but only centers of caseation were found. It is possible that in the three cows in which no worms were found that none of the larvae had reached the intestinal lumen (Smith and Jones, 1966).

The other nematode, C. oncophora, has also been found in this province, in cows raised on peat pastures

(Rayment, 1969, pers. comm.). The small number of worms found were probably of little clinical significance since none of the pathological characteristics described by Smith and Jones (1966) and Siegmund (1967) were observed.

A liver supplied by a local veterinarian contained over 400 specimens of the fluke Dicrocoelium dendriticum. No gross pathological effects such as thickening of the bile ducts and peri-portal fibrosis (Smith and Jones, 1966) were observed. This fluke appears to be endemic to certain areas of the island (Smith, 1966 pers. comm.). A second liver, also from a local cow was unparasitized.

A lung tip was found to contain 130 lungworms (Dictyocaulus viviparus). It is not known how many worms were in the complete lungs of the cow but sufficient were present for the infection to prove fatal. The adults of this species exert serious pathological effects on the host animal by irritating and obstructing the air passages, while larvae in the alveoli and parenchyma (Siegmund, 1967) disrupt normal respiratory physiology. These organisms are the causative agent of verminous bronchitis. Dictyocaulus viviparus is widely distributed in Canada, verminous bronchitis being the cause of severe losses in many parts of the country (Choquette, 1954).

Domestic Sheep - Ovis aries Linnaeus

Number examined 12 Place of origin - St. Shotts

No published report was found regarding any parasitological examinations of Newfoundland sheep, but local veterinarians do diagnose and treat sheep helminthiasis (McAllister, 1969 pers. comm.; Smith, 1969, pers. comm.) Most lambs are treated with Phenothiazine (McAllister, 1969, pers. comm.) but some helminths (eg. Haemonchus contortus) have a tolerance to the drug. Although phenothiazine is much used, it is not 100% effective as an anthelminthic (Colglazier et al, 1968). Many other factors, such as rotational grazing (Spedding, 1956; Lundahl et al, 1963), could have affected the results of this investigation. Another important factor is seasonal periodicity and availability of infective stages of the helminth (Morgan et al 1950, 1951; Parnell 1962; Tetley 1959). All of these affect the helminth burden of animals both qualitatively and quantitatively.

No trematodes were found in the sheep examined but Newfoundland sheep are known to be parasitized by flukes (Smith 1969, pers. comm.).

Specimens belonging to the genus Moniezia were found in seven (58.3) of twelve sheep examined. Three animals were infected with M. expansa. Only fragmented

Table X. Details of the distribution of helminths in the gastrointestinal tracts of sheep.

Helminth species	Number Infected	% of Animals Examined	Total Number Worms
Moniezia expansa	3	24.9	29-34
Moniezia sp.	4	33.3	4-5
Trichuris ovis	10	83.3	255
Bunostomum trigonocephalum	3	24.9	11
Oesophagostomum venulosum	7	58.3	106
Oesophagostomum sp.	5	41.7	31
Ostertagia circumcincta	2	16.7	30
Nematodirus abnormalis	1	8.3	4
Nematodirus spathiger	2	16.7	2
Nematodirus sp.	2	16.7	16
Unidentified nematodes	5	41.7	11
Total	11	91.7	

Table X. Continued

Helminth species	Range	Average Number of Worms per Infected Animal
Moniezia expansa	1-30+	10.0
Moniezia sp.	1-24	1.3
Trichuris ovis	1-69	25.5
Bunostomum trigonocephalum	1-5	3.7
Oesophagostomum venulosum	1-39	15.1
Oesophagostomum sp.	1-19	6.2
Ostertagia circumcincta	1-29	15.0
Nematodirus abnormalis	4	4.0
Nematodirus spathiger	1	1.0
Nematodirus sp.	1-15	8.0
Unidentified nematodes	1-4	2.2

worms were recovered from the other four hosts, these being identifiable only to the generic level. The dimensions of the proglottids fell within the limits given by Soulsby (1968) for M. expansa but could not be differentiated from M. benedeni (Moniez, 1879) as the interproglottidal glands (Wardle and McLeod, 1952) were not visible.

Trichuris ovis was found in 10 (83%) of the sheep examined. The high percentage infection found may be due partly to the fact that phenothiazine is not effective against this species. All twelve animals came from the same locality (St. Shotts) and probably from the same flock. Consequently all were exposed to the same sources of infection.

Only two of the sheep examined were infected with Ostertagia circumcincta, these nematodes being located in the small intestine. This helminth is normally an abomasal inhabitant (Soulsby, 1968) but may have migrated in this case. The low intensity of infection may have been caused by treatment of the animals with anthelminthics. The larvae of this worm appear to be quite hardy and resist considerable drying in the shade and show an optimum rate of development in the temperature range 22°C. to 25°C. (Cameron, 1951). It is interesting

to note that among the three principal stomach worms of sheep: Haemonchus contortus, Ostertagia circumcincta and Trichostrongylus axei, only O. circumcincta was found. Since T. axei was found in local cattle (Rayment 1969, pers. comm.) it is possible that examination of a larger sample of sheep from various parts of the island would reveal the presence of these species.

Crofton (1957) stated that with the exception of Nematodirus sp., O. circumcincta was the species detected earliest in the year and it was present in appreciable numbers from early June onwards. The number increased rapidly and this species made the major contribution to egg - counts during spring and early summer. It was present in considerable numbers during August and September, but was no longer the dominant species. The sheep examined in this survey were obtained in October, this fact possibly explaining the low incidence.

The specimens of Bunostomum trigonocephalum were identified and differentiated from closely related species using data presented by Cameron (1923, 1927). This species was redescribed as Monodontus trigonocephalus (Rud) Railliet 1900 by Cameron but is synonymous with B. trigonocephalum. Phenothiazine is not the most effective drug for use against this worm but nevertheless either

because of poor environmental conditions or resistance of the sheep, both the percentage infection and the intensity of infection were low. Ershov (1956) states that under the conditions in the Southern Urals, symptoms of the infection appear initially at the beginning of August, and by the end of the month and at the beginning of September, severe clinical symptoms are already observed in infected animals. In the Uzbek S.S.R. the infection in lambs reaches its maximum in October. The intensity of infection may reach 5000-6000 worms per animal. Consequently if much the same conditions hold for Newfoundland, then the infections diagnosed in the local sheep were at a maximum and of little clinical significance.

Eight of the sheep examined were lightly infected with Oesophagostomum sp. Popova (1958) discusses this genus, the keys in his work being used to identify the specimens from seven animals as O. venulosum. Unfortunately worms from five animals were so poorly preserved that it was felt unwise to identify them to the specific level. The helminths were found in the small intestine, caecum and large intestine, although they are reported (Soulsby, 1968) to occur in the colon. O. venulosum is relatively harmless and seldom produces nodules in the intestinal wall (Soulsby, 1968). The

absence of nodules in all the viscera examined suggests that all the helminths recovered were O. venulosum. A closely related oesophagostome of sheep, O. columbianum (Curtice, 1890) does produce nodules. It should be noted that this is not conclusive evidence, since in sheep with no resistance to O. columbianum the larvae evoke no reaction and no nodules are formed (Soulsby, 1968). Cameron (1951) suggested that O. columbianum is commoner in sub-tropical and tropical countries as well as those with warm summers; but O. venulosum has a wider distribution and is common in temperate and warm countries. Becklund (1964) reported O. columbianum from Manitoba to the Atlantic coast and O. venulosum in British Columbia, Ontario and Quebec.

Four sheep were infected with Nematodirus sp. One animal contained worms identifiable only to the genus, while two animals were infected with N. spathiger and one with N. abnormalis. These were identified using the descriptions and measurements given by Skrjabin et al (1954). Becklund (1964) reported N. spathiger from the United States while Skrjabin et al (1954) reported N. abnormalis from North America. The gut contents of a fifth sheep contained a number of eggs measuring 175.5 x 97.5 u. These measurements together with the

morphology of the few parts of the worm found, showed that it was either a Nematodirus sp. or a Marshallagia sp. but differentiation was not possible. Since Nematodirus sp. was found in other sheep, it is possible that these specimens were also Nematodirus sp. Becklund (1964) lists Marshallagia sp. as occuring in the Western United States. In areas where clinical infections with Nematodirus sp. are common, the disease has a characteristic seasonal pattern (Siegmund, 1967). The eggs passed by infected lambs lie dormant through the rest of the grazing season and winter, but large numbers of larvae appear during the early grazing period of the following year. When susceptible lambs are exposed to these larvae, infection developes (Siegmund, 1967). The sheep examined in this survey were not obtained during the early grazing period, this being a possible reason for the low intensity of infection.

Four sheep were found to contain fragmented nematodes which were impossible to identify because of their poor condition.

The lungs of two sheep were found to contain Dictyocaulus filaria, two worms being found in one animal and five in the other. Since the thoracic and abdominal viscera were separated and could not be matched, the relation of the pulmonary infections to the gastrointestinal infections could not be determined.

Unparasitized Animals

One Little Brown Bat (Myotis lucifugus (LeConte)), one Red Squirrel (Tamiasciurus hudsonicus (Erxleben)), four House Mice (Mus musculus Linnaeus), five Ermine (Mustela erminea Linnaeus) and one Mink (Mustela vison Schreber) were found to be unparasitized by helminths. If a larger number of these animals were examined, parasites would probably be found in them. Threlfall (1969) examined 25 Red Squirrels and one Ermine and found them to be helminth free. However he did find one House Mouse to be infected with Syphacia obvelata (Rudolphi, 1802).

General Discussion

Several species of helminths were found to infect more than one species of host. This could indicate a source of infection or a life cycle, or both. For example, Taenia pisiformis was found in both snowshoe hares and dogs, the latter being able to acquire infection from the former. Coenurus taenia-serialis was also found in hares, possibly a survey of foxes and dogs from rural areas would reveal adult worms.

Rats were found to be infected with larval Hydatigera taeniaeformis while cats were found infected

with adult forms of this helminth.

Dogs and foxes (Threlfall, 1969) appear to be susceptible to infection with Uncinaria stenocephala, while dogs, cats and lynx (Threlfall, 1969) are final hosts for Toxascaris leonina. Dogs and foxes were both found to be hosts for the lungworm Crenosoma vulpis.

In areas where domestic animals can roam and/or graze in the territory occupied by wild animals, there are opportunities for the transmission of helminth eggs and infective larvae from the final host to the intermediate and vice-versa.

Newfoundland presents an interesting situation, being an isolated island with few endemic species of mammals. In many areas of the province domestic animals are fed a raw fish diet from which they can acquire helminth infections (Cameron, 1945). On the other hand, the province's isolation has prevented certain species of helminths from reaching the island. For example, in most areas of Canada there is to some extent, infection of dogs, moose, elk, caribou and other animals with Echinococcus granulosus (Cameron, 1961), but this worm has never been reported in Newfoundland. A very good reason for not introducing white tailed deer into Newfoundland is the fact that Pneumostrongylus tenuis

which is carried by these animals, can be transmitted to both moose and caribou (Anderson and Strelive, 1968). Moose neurologic disease has been reported in Nova Scotia (Anderson and Strelive, 1968) but because of the separation of the island of Newfoundland from the mainland of Canada, local cervids have no opportunity to acquire this helminth. There are many noticable absences in the helminth fauna of Newfoundland mammals, most of which can be explained by isolation but some by the little parasitological work done on local mammals.

Many of the worms found in mammals are of public health importance because of their potential zoonotic properties. The variety of Ascaris lumbricoides normally found in pigs may not be commonly found in humans but it is a potential parasite of man even though it does not mature in this host. Nevertheless larval migration may occur and induce sensitivity (Cameron, 1962). The human variety of A. lumbricoides is not a common parasite of man in Newfoundland (Dept. Health Annual Report 1959-67)

Dicrocoelium dendriticum has not been reported in man in Newfoundland but rare cases are known elsewhere (Cameron, 1962). Diphyllobothrium latum was found in a dog in this survey, but is rarely found in humans in this province.

Larval stages of Toxocara canis are known to cause visceral larva migrans in humans and adults of Toxascaris leonina have been reported in the small intestine of man. Many other animal parasites infect man, eg. Anisakis (Cameron, 1962) but it is not known if these are true or accidental infections. Because of the possible parallel evolutionary development of both parasite and host, the further away an accidental host is from the parasite's normal host, the greater will be the reaction of the abnormal host.

Reports have from time to time been made concerning outbreaks of swimmers itch in Newfoundland bathers, but the etiological agent has never been found (Severs, 1969, pers. comm.). The only schistosome recovered to date in Newfoundland is Ornithobilharzia lari (McLeod, 1937) from the Herring Gull (Larus argentatus Pont.) (Threlfall, 1968). The cercariae of this worm have not been found nor have the snails from which they are released. Pippy (1969, pers. comm.) stated that he investigated swimmers itch in the Maritime Provinces and found that the snails at the edge of the water were not infected, but the same species occuring in deep water were. Cercariae were released from the infected snails, rose to the surface and were blown by the wind to areas where humans were swimming. Thus the wind

direction and velocity are important clues in searching for the source.

Trichinella spiralis has not been reported in Newfoundland to date, but it is possible that if more mammals are examined, especially bears and caribou, this helminth will be found.

CONCLUSIONS

Fifty-five species of helminths were recovered. Three species of trematodes were found, one of which, Plagiorchis massino, is the first record of this species in domestic cats in North America. This trematode has been found in foxes in Alaska, but no explanation of its occurrence in foxes on the west coast and in cats on the east coast could be found. The only other recorded occurrence of this worm is in dogs and cats in Armenia and Kazakstan, USSR.

Fourteen species of cestodes were recovered, one of which, Anophryocephalus anophrys, constitutes a new host record, having not previously been found in Phoca groenlandica. Eight of the cestode recoveries constitute new host records for Newfoundland.

Thirty-seven species of nematodes were found, twenty-six being new host records for Newfoundland. One species of acanthocephalan was found, Acanthocephalus lateralis, this being a common occurrence in Newfoundland salmonids.

In all, this survey of mammals revealed thirty-six species of helminths not previously recovered. This points to the fact that much more work is needed before we have a complete picture of the helminth fauna of Newfoundland mammals.

REFERENCES

Anderson, R.C. and U.G. Strelive. 1968. The Experimental Transmission of Pneumostrongylus tenuis to Caribou (Rangifer tarandus terraenovae). Can. J. Zool. 46: 503-510.

Babero, B.B. and R. Rausch. 1952. Notes On Some Trematodes Parasitic In Alaskan Canidae. Proc. Helminthol. Soc. Wash. 19 (1): 15-17.

_____ and L.J. Thomas. 1960. A Record of Pharurus oserkaiae (oserskaiae) (Skrjabin, 1942) in an Alaskan Whale. J. Parasit. 46 (6): 726.

Barŭs, V. and M.T. del Valle. 1966. Neuvos Registros de Nematodos que parasiten en caballos (Equus caballus Linne) de Cuba. Poeyana. Serie A, No. 27: 1-10.

Becklund, W.W. 1964. Revised Check List of Internal and External Parasites of Domestic Animals in the United States and Possessions and in Canada. Am. J. Vet. Res. 25 (108): 1380-1416.

Berland, B. 1963. Phocascaris cystophorae, sp. nov. (Nematoda) From the Hooded Seal, With an Emendation of the Genus. Arbok For Universitetet I Bergen. Nat. - Naturv Serie. 7: 3-21

Burrows, R.B. and W.G. Lillis. 1965. Trematodes of New Jersey Dogs and Cats. J. Parasit. 51 (4): 570-574.

Cameron, T.W.M. 1923. The Anatomy of Monodontus trigonocephalus (Rud) of Sheep. J. Helminthol. 1 (3): 99-117.

_____.1923. On the Biology of the Infective Larva of Monodontus trigonocephalus (Rud.) of Sheep. J. Helminthol. 1 (5): 205-214.

_____.1927. On the Parasitic Development of Monodontus trigonocephalus, the Sheep Hookworm. J. Helminthol. 5 (3): 149-162.

_____.1945. Fish carried Parasites in Canada. Can. J. Comp. Med. 9:245-254, 283-286, 302-311.

_____.1951. The Parasites of Domestic Animals. J.B. Lippincott Company, Philadelphia.

_____.1961. The Incidence and Diagnosis of Hydatid Cyst in Canada. Echinococcus granulosus var. canadensis. Parassitologia. Vol. II N.3, 381-390.

_____.1962. Helminths of Animals Transmissible to Man. Am. J. Med. Sci. 243 (3): 354-381.

_____, I.W. Parnell, and L.L. Lyster. 1940. The Helminth Parasites of Sledge-dogs in Northern Canada and Newfoundland. Can. J. Res. 18 (9): sec. D. 325-332.

Carleton, H.M. and R.A.B. Drury. 1957. Histological Technique. Oxford University Press. London. 343 pp.

Choquette, L.P.E. 1954. Verminous Bronchitis in Cattle. Can. J. Comp. Med. 18 (10): 347-356.

_____ and L. de G. Gelinas. 1950. The incidence of intestinal nematodes and protozoa in dogs in the Montreal District. Can. J. Comp. Med. 14 (2): 33-38.

_____and D.H. Pimlott. 1956. Gastrointestinal Parasites of Beaver in Newfoundland. Can. J. Zool. 34 (3):289.

Colglazier, M.L., I.L. Lindahl, J.H. Turner, G.I. Wilson, G.E. Whitmore, and R.L. Wilson. 1968. Effect of Management Systems on the Growth of Lambs and Development of Internal Parasitism. II. Field Trials Involving Medication with National Formulary and Purified Grades of Phenothiazine. J. Parasit. 54 (1): 89-97.

Cowan, D.F. 1967. Helminth Parasites of the Pilot Whale Globicephala melaena (Traill, 1809). J. Parasit. 53 (1): 166-167.

Crofton, H.D. 1957. Nematode Parasite Populations in Sheep on Lowland Farms. III. The Seasonal Incidence of Species. Parasitology. 47: 304-318.

Dawes, B. 1946. The Trematoda. Cambridge: University Press, Cambridge.

Department of Health Annual Reports. 1959-1967. Government of Newfoundland and Labrador.

Dikmans, G. 1940. A note on the Genera Nematospiroides Baylis, 1926, and Sincosta Roe, 1929, (Nematoda, Heligmosomidae), with descriptions of two new species of Nematospiroides. Proc. Helminthol. Soc. Wash. 1 (2): 79-82.

_____.1945. Check List of the Internal and External Parasites of Domestic Animals in North America. Am. J. Vet. Res. 6: 211-241.

Dodds, D.G. and J.S. Mackiewicz. 1961. Some Parasites of Snowshoe Hares in Newfoundland. J. Wildlife Management. 25 (4): 409-414.

Erickson, A.B. 1944. Helminth Infections in Relation to Population Fluctuations in Snowshoe Hares. J. Wildlife Management 8 (2): 134-153.

Ershov, V.S. 1943. Differentsial'nyi diagnoz nematod roda Trichonema, parazitiruyushchikh u loshadei. (Differential Diagnosis of Nematodes of the Genus Trichonema Found in Horses). Trudy Kirovskogo Zooveterinarvogo Instituta. 5 No. 1 (17): 61-86.

_____.1956. Parazitologuja i invazionnye bolezni sel'skokhozyaist vennykh zhivotnylsh. (Parasitology and Parasitic Diseases of Livestock) Moscow (Israel Program for Scientific Translation, 1960.)

Esch, G.W. and J.T. Self. 1965. A Critical Study of the Taxonomy of Taenia pisiformis Bloch, 1780; Multiceps multiceps (Leske, 1780); and Hydatigera taeniaeformis Batsch, 1786. J. Parasit. 51 (6): 932-937.

Gibbs, H.C. and K.E. Gibbs. 1959. The Effects of Temperature on the Development of the Free-living Stages of Dochmoides stenocephala (Railliet, 1884) (Ancylostomidae: Nematoda). Can. J. Zool. 37 (4): 247-257.

Goodey, T. 1925. Observations on Certain Conditions Requisite for Skin Penetration by the Infective Larvae of Strongyloides and Ankylostomes. J. Helminthol. 3 (2): 51-62.

_____.1925. Skin Penetration by the Infective Larvae of Dochmoides stenocephala. J. Helminthol. 3 (3-4): 173-176.

Hall, M.C. 1916. Nematode Parasites of Mammals of the Order Rodentia, Lagomorpha and Hyracoidea. Proc. U.S. Nat. Mus. 50 (2131):1-258.

Hansen, M.F. 1947. Three Anoplocephalid Cestodes from the Prairie Meadow Vole, with Description of Andrya microti. n. sp. Trans. Amer. Microsc. Soc. 66: 279-282.

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

Hopkins, C.A. and J.D. Smyth. 1951. Notes on the Morphology and Life History of Schistocephalis solidus (Cestoda: Diphyllobothriidae). Parasitology. 41: 283-291.

Joyeux, Ch. and J.G. Baer. 1936. Faune de France: Cestodes. 30 : 1-615.

King, J.E. 1964. Seals of the World. The British Museum (Natural History), London. 154 pp.

Lapage, G. 1968. Veterinary Parasitology, 2nd. ed. Oliver and Boyd, Edinburgh and London.1182 pp.

Lillis, W.G. 1967. Helminth Survey of Dogs and Cats in New Jersey. J. Parasit. 53 (5): 1082-1084.

Lindahl, I.L., K.C. Kates, J.H. TUrner, F.D. Enzie and G.E. Whitmore, 1963. Effect of Management Systems on the Growth of Lambs and Development of Internal Parasitism. I. Dry Lot vs. Two Pasture Rotation Systems. J. Parasit. 49 (2): 209-217.

Lyster, L.L. 1940. Parasites of Some Canadian Sea Mammals. Can. J. Res. 18 (12): sec. D, 395-409.

McAllister, S., St. John's Veterinarian. Personal Communication.

Markowski, S. 1949. On the Species of Diphyllobothrium Occurring in Birds and Their Relation to Man and Other Hosts. J. Helminthol. 23 (3/4): 107-126.

Meyer, M.C. and E.S. Robinson. 1963. Description and Occurrence of Diphyllobothrium sebago (Ward, 1910) J. Parasit. 49 (6): 969-973.

Morgan, D.O. 1950. Further Observations on the Seasonal Variation in Worm Egg Output in Scottish Hill Sheep. J. Helminthol. 24 (3): 101-122.

_____. I.W. Parnell and C. Rayski. 1951. The Seasonal Variations in the Worm Burden of Scottish Hill Sheep. J. Helminthol. 25: (3/4): 177-212.

Mozgovoi, A.A. 1953. Askaridaty zhivotnykh i cheloveka i vyzyvaemye imi zabolevaniya (Ascaridata of Animals and Man and the Diseases Caused by them.) Akad. NaukSSSR, Moscow. (Israel Program for Scientific Translations, Jerusalem, 1968).

Nichols, R.L. 1956a. The Etiology of Visceral Larva Migrans. I. Diagnostic Morphology of Infective Second-Stage Toxocara larvae. J. Parasit. 42 (4): 349-362.

_____. 1956b. The Etiology of Visceral Larva Migrans. II. Comparative Larval Morphology of Ascaris lumbricoides, Necator americanus, Strongyloides stercoralis and Ancylostoma caninum. J. Parasit. 42 (4): 363-399.

Oldham, J.N. 1931. On the Arthropod Intermediate Hosts of Hymenolepis diminuta (Rudolphi, 1918). J. Helminthol. 9: 21-28.

_____. 1931. The Helminth Parasites of Common Rats. J. Helminthol. 9 (2): 49-90.

_____. 1965. Observations on the Incidence of Toxocara and Toxascaris in Dogs and Cats from the London Area. J. Helminthol. 39 (2/3): 251-256.

Olsen, O.W. 1937. A Systematic Study of the Trematode Subfamily Plagiorchiinae Pratt, 1902. Trans. Amer. Microsc. Soc. 61 (3): 311-339.

Parnell, I.W. 1962. Observations on the Seasonal Variations in the Worm Burdens of Young Sheep in Southern Western Australia. J. Helminthol. 36 (1/2): 161-188.

Peters, S.S. and J.M. King. MS 1959. Newfoundland Caribou Disease Investigation (1958). Progress Report (Tech. No. 1).

Pippy, J.H.C. Fisheries Research Board of Canada. Personal Communication.

Popova, T.I. 1955. Strongiloidei zhivotnykh i cheloveka (Strongyloids of Animals and Man.) Akad. Nauk SSSR, Moscow. (Israel Program for Scientific Translations, Jerusalem, 1965).

Rausch, R. 1946. Paranoplocephala troeschi, New Species of Cestode From the Meadow Vole, Microtus p. pennsylvanicus Ord. Trans. Amer. Microsc. Soc. 65: 354-356.

_____.1948. Notes on Cestodes of the Genus Andrya Railliet, 1883, with the Description of A. ondatrae n. sp. (Cestoda: Anoplocephalidae). Trans. Amer. Microsc. Soc. 67: 187-191.

Rausch, R. and J.D. Tiner. 1949. Studies on the Parasitic Helminths of the North Central States. II. Helminths of Voles (Microtus sp.). Preliminary Report. Amer. Midl. Nat. 41 (3): 665-694.

_____and L. Margolis. 1969. Plicobothrium globicephalae gen. et sp. nov. (Cestoda: Diphyllobothriidae) from the Pilot Whale, Globicephala melaena Traill, in Newfoundland Waters. Can. J. Zool. 47 (5): 745-750.

Rayment, A.F. Canada Department Agriculture Research Station, St. John's, Newfoundland. Personal Communication.

_____and Nicholson, J.W.O. 1965. Interesting Results From Research Projects. Animal Science Newsletter, 10 (1):6-7.

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

Schantz, P.M. and Biagi, F. 1968. Coexistence of Toxocara and Toxascaris in dogs in Mexico City. J. Parasit. 54 (1): 185-186.

Severs, D. Department of Health, Newfoundland Government. Personal Communication.

Siegmund, O.H. (ed.) 1967. The Merck Veterinary Manual. Merck & Company, Inc. Chicago. 1686 pp.

Simpson, G.G. 1945. The Principles of Classification and a Classification of Mammals. Bull. Amer. Mus. Nat. Hist. Volume 85. 350 pp.

Skrjabin, I.I., N.P. Shikhobalova and R.S. Shul'ts. 1954. Osnovy nematodolgii. Trikhostrongilidy zhivotnykh i cheloveka (Trichostrongylids of Animals and Man.) Akad. Nauk SSSR, Moscow. (Israel Program for Scientific Translations, 1960).

Smith, A. St. John's Veterinarian. Personal Communication.

Smith H.A. and T.C. Jones. 1966. Veterinary Pathology 3rd ed. Lea and Febiger, Philadelphia. 1192 pp.

Soulsby, E.J.L. 1968. Helminths, Arthropods and Protozoa of Domesticated Animals. (6th. ed.) Bailliere, Tindall and Cassell, London. 824 pp.

Spaskii, A.A. 1951. Osnovy tsestodologii, Anoplotsefalyaty, lentochnye gel'minty domashiniki i dikikh z hivotnykh. (Essentials of Cestodology, Anoplocephalate Tapeworms of Domestic and Wild Animals.) Akad. Nauk SSSR, Moscow. (Israel Program for Scientific Translations, 1961.).

Spedding, C.R.W. 1956. Worm Infestation in Sheep. Outlook on Agriculture 1 (3): 101-110.

Spurlock, G.M. 1943. Observations on Host-Parasite Relations between Laboratory Mice and Nematospiroides dubius Baylis. J. Parasit. 29 (5): 303-311.

Styles, T.J. 1967. Incidence of Toxocara canis and other Helminth Parasites of Dogs in Mexico City. J. Parasit. 53 (4): 822-823.

Tetley, J.T. 1959. The Extent to Which Self-Augmentation of Nematode Parasitism Occurs in Lambs. J. Helminthol. 33 (4): 293-300.

Threlfall, W. 1967. Parasites of Moose (Alces alces) in Newfoundland. J. Mammal. 48 (4): 668-669.

_____. 1968. Studies on the Helminth Parasites of the American Herring Gull (Larus argentatus Pont.) in Newfoundland. Can. J. Zool. 46 (6): 1119-1126.

_____. 1969. Further Records of Helminths From Newfoundland Mammals. Can. J. Zool. 47 (2): 197-201.

_____. and Hanek, G. Department of Biology, Memorial University of Newfoundland. Personal Communication.

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

Yamaguti, S. 1951. Studies on the Helminth Fauna of Japan. Part 46. Nematodes of Marine Mammals. Arbeiten aus der Medizinischen Fakultat Okayama, 7 (4): 295-306.

_____. 1958. Systema Helminthum Vol. I. The Digenetic Trematodes of Vertebrates. Interscience Publishers Inc. New York and London. 1575 pp.

_____. 1959. Systema Helminthum Vol. II. The Cestodes of Vertebrates. Interscience Publishers Inc. New York and London. 860 pp.

_____. 1961. Systema Helminthum Vol. III. The Nematodes of Vertebrates. Interscience Publishers Inc. New York and London. 1261 pp.

_____. 1963. Systema Helminthum Vol. V. Acanthocephala. Interscience Publichers, Inc. New York and London. 423 pp.

APPENDIX I

Preliminary list of the helminths found in Newfoundland mammals as reported in the literature.

Snowshoe Hare (*Lepus americanus struthopus* Bangs)

Dicrocoelium dendriticum (Rudolphi)	Dodds & Mackiewicz 1966
Mosgovoyia pectinata (Goeze)	"
Taenia pisiformis larvae (Bloch)	"
Hydatigera taeniaeformis (Batsch)	"
Multiceps sp.	"
Obeliscoides cuniculi (Graybill)	"
Trichostrongylus axei (Cobbold)	"

Beaver (*Castor canadensis* Kuhl)

Castorstrongylus castoris Chapin	Choquette & Pimlott, 1956 Threlfall, 1969
Travassosius americanus Chapin	Choquette & Pimlott, 1956
Stichorchis subtriguetrus (Rudolphi)	"

House mouse (*Mus musculus* Linnaeus)

Syphacia obvelata (Rudolphi)	Threlfall, 1969

Domestic dog (*Canis familiaris* Linnaeus)

Cryptocotyle lingua (Creplin)	Cameron, 1940
Taenia pisiformis (Bloch)	Threlfall, 1969
Taenia hydatigena, Pallas	"

Taenia sp.	Threlfall, 1969
Dipylidium caninum (Linnaeus)	"
Diphyllobothrium latum (Linnaeus)	"
Diphyllobothrium sp.	"
Uncinaria stenocephala (Railliet)	Cameron, 1940 Threlfall, 1969
Ancylostoma caninum (Ercolani)	Threlfall, 1969
Toxocara canis (Werner)	"
Toxascaris leonina (Linstow)	"
Trichuris sp. (vulpis (Froelich, 1789)?)	"

Red fox (Vulpes fulva (Linnaeus))

Uncinaria stenocephala (Railliet)	"
Crenosoma vulpis (Dujardin)	"

Domestic cat (Felis catus Linnaeus)

Diphyllobothrium dendriticum (Nitzsch)	"
Dipylidium caninum (Linnaeus)	"
Toxocara mystax (Zeder)	"
Toxascaris leonina (Linstow)	"

Domestic Cats and Dogs.

Cryptocotyle lingua (Creplin)	Becklund, 1964
Metorchis conjunctus (Cobbold)	"

Canada lynx (Lynx canadensis Kerr)

Taenia laticollis Rudolphi	Threlfall, 1969
Toxascaris leonina (Linstow)	"
Cylicospirura subaequalis (Molin)	"

Harbour Seal (*Phoca vitulina* Linnaeus)	
Phocascaris netsiki Lyster	Lyster, 1940
Contracaecum osculatum (Rudolphi)	"
Ringed Seal (*Phoca hispida* Schreber)	
Contracaecum osculatum (Rudolphi)	"
Phocascaris netsiki Lyster	"
Corynosoma strumosum Rudolphi	"
Harp or Greenland Seal (*Phoca groenlandica* Erxleben)	
Diphyllobothrium sp.	Lyster, 1940
Porrocaecum decipiens Baylis	"
Bearded Seal (*Erignathus barbatus* (Erxleben))	
Diphyllobothrium sp.	"
Porrocaecum decipiens Baylis	"
Corynosoma strumosum Rudolphi	"
C. semerme Forssell	"
Domestic Horse (*Equus caballus* Linnaeus)	
Oxyuris equi (Schrank)	Threlfall, 1969
Oesophagodontus robustus (Giles)	"
Cyathostoma sp.	"
Strongyle eggs	"
Moose (*Alces alces* (Linnaeus))	
Paramphistomum cervi (Zeder)	Threlfall, 1967
Cysticercus tenuicollis (Pallas)	Threlfall, 1969

Nematodirella longispeculata York & Maplestone	Threlfall, 1967
Dictyocaulus viviparus (Bloch)	"
Dictyocaulus hadweni Chapin	Threlfall, 1969

Caribou (Rangifer caribou terraenovae Bangs)

Paramphistomid flukes	Peters & King, 1958
Dictyocaulus eckerti Skrjabin	"
Ostertagia gruhneri Skrjabin	"
Elaphostrongylus sp.	"

Domestic cattle (Bos taurus Linnaeus)

Moniezia sp.	Rayment, pers. comm.
Ostertagia ostertagi (Stiles)	Rayment & Nicholson 1965
Trichostrongylus axei (Cobbold)	Rayment, pers. comm.
Cooperia oncophora (Railliet)	"
Bunostomum phlebotomum (Railliet)	"
Oesophagostomum radiatum (Rudolphi)	Rayment & Nicholson 1965
Nematodirus sp.	Rayment, pers. comm.
Trichuris sp.	"

White whale (Delphinapterus leucas (Pallas))

Anisakis simplex Rudolphi	Lyster, 1940
Anisakis sp. inq.	"
Corynosoma strumosum Rudolphi	"

Pilot whale, Pothead whale (*Globicephala melaena* (Traill))

Orthosplanchus arcticus Odhner	Cowan, 1967
Phyllobothrium sp.	"
Trigonocotyle lintoni Guiart	"
Diphyllobothrium sp.	"
Stenurus globicephalus Baylis & Daubney	"
Anisakis sp.	"
Bolbosoma capitatum (Linstow)	"

APPENDIX II

The following is a list of stains and chemicals used in the preparation of helminths for identification.

Semichon's Acid Carmine

Glacial Acetic Acid ..... 500 ml.

Distilled Water ..... 500 ml.

Carmine in excess

Combine and heat to boiling for 15 minutes. Cool rapidly and allow excess carmine to settle. Filter. Stain can be diluted with 70% alcohol.

Permount - Fisher Chemical Co.

A 60% solution of synthetic resin materials.

Chemically stable - fast drying.

Lacto-phenol

Melted Phenol crystals .....100 ml.

Lactic Acid .....100 ml.

Glycerine .....200 ml.

Distilled Water .....100 ml.

Use heated in a water bath.

Rubin's Fluid

Dissolve 15 gm. polyvinyl alcohol in 100 ml. distilled water at 80°C.

Polyvinyl alcohol (stock)	56 ml.
Lactic acid	22 ml.
Phenol crystals	22 ml.

This is to be kept in a dark glass bottle.

Glycerol Jelly

Gelatine	10 gm.
Distilled Water	60 ml.
Pure glycerol	70 ml.
Phenol crystals	0.25 gm.

Dissolve the gelatine in the water in a beaker in a water bath. When the gelatine has dissolved, add the glycerol, and, finally the phenol.