"THE METAZOAN PARASITES OF THREE SPECIES OF SCOTERS (MELANITTA PERSPICILLATA (LINNAEUS, 1758), M. NIGRA (LINNAEUS, 1758) AND M. FUSCA (LINNAEUS, 1758))"

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The Metazoan parasites of
three species of scoters (*Melanitta perspicillata* (Linnaeus, 1758), *M. nigra* (Linnaeus, 1758) and *M. fusca* (Linnaeus, 1758))

by

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ABSTRACT

One hundred and seventy-five (94 surf, 36 white-winged and 45 black) scoters from four localities (British Columbia, New Brunswick, Labrador and Norway) were examined for metazoan parasites, with 91% (159 birds: 86 surf, 33 white-winged and 40 black scoters) being infected. Approximately 55 species of parasites were found (43 from the surf, 29 from the white-winged and 34 from the black), including 45 which were new host records. There were 4 new North American records, 4 new Canadian records and 1 new European record. A checklist of parasites harboured by these birds is presented.

The number and percent of birds infected, range of numbers and mean number of parasites per infected bird are given. Also for each host species the number and percent of each sex and age class infected by individual parasites is given. Parasite species are discussed individually with regard to topics such as location within host, new host records and minor variations from their original description.

The ecology of the parasites is discussed; the preferred habitat, their geographical distribution and their preference for marine or freshwater, environments are presented. A short discussion of host specificity is included and the parasites of each host are categorized. Six parasites were found to occur across the geographic area sampled, with 23 helminths cycling through the marine environment and 19 through the freshwater environment. Throughout the work the parasite burdens of each host species are contrasted. In addition the number and percent of species occurring in each geographic locale is compared and contrasted. Cluster analysis revealed that

neither individual birds of a species nor species of birds could be distinguished using parasite fauna and geographical locality as criteria.

One species of parasite, *Polymorphus botulus*, was noted to cause damage to its host but was not considered to be lethal.

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INTRODUCTION

The genus *Melanitta* Boie, 1822 contains the diving ducks commonly known as scoters. These birds are members of the Mergini, the tribe of ducks, commonly referred to as sea ducks, which spend most of their time in the marine environment only frequenting inland waters to reproduce. Palmer (1976) notes that there are three valid species in the genus namely, *M. perspicillata* (Linnaeus, 1758) the surf scoter, *M. nigra* (Linnaeus, 1758) the black scoter and *M. fusca* (Linnaeus, 1758) the white-winged scoter, with five recognized subspecies in the genus. The scoters are Holarctic in distribution, with the surf scoter being indigenous to North America and having no recognizable subspecies. This bird breeds from Alaska through the northern boreal forest to Labrador. It's wintering areas are the eastern and western coasts of North America south to Florida and California respectively.

The black scoter has two recognizable subspecies, *M. n. americana* the Nearctic and eastern Siberian race and *M. n. nigra* the western Palearctic race. *Melanitta n. americana* breeds in Alaska, Kodiak Island and the interior of the Ungava Peninsula as well as Grand Lake in Newfoundland. The wintering range of this bird is similar to that of *M. perspicillata*. *Melanitta n. nigra* breeds in Iceland, Britian, Ireland, Sweden, Finland and Western U.S.S.R. It appears that each breeding population of *M. n. nigra* moves south for the winter with wintering populations commencing around Norway and extending south to the Ivory Coast of Africa (Johnsgard, 1978: Palmer, 1976).

The white-winged scoter has three recognized subspecies, *M. f. deglandi* the American white-winged scoter, *M. f. fusca* the European white-winged scoter and *M. f. stejnegeri* the Asiatic white-winged scoter. *Melanitta f. deglandi* breeds in North America from western Ontario to British Columbia and up into Alaska. This subspecies winters from the Alaskan coast to California in the west and from Newfoundland to Florida in the east. *Melanitta f. fusca* breeds across northern Europe and Asia from Scandinavia to the Yenisei River in Western Siberia, and winters in the Atlantic Ocean from Norway to Spain and on the Caspian Sea. *Melanitta f. stejnegeri* breeds in eastern Asia from the Altai to Kamchatka Peninsula and winters on the coast of eastern Asia to Japan and China.

Prior to 1973, the black scoter was placed in the genus *Oidemia* (Flemming, 1822) because of a morphological difference between this species and the other two scoters. The black scoter has a simple syrinx, while the other two species both have a bulbous enlargement of the trachea. However, they have a similar biology and are very similar in appearance and are now placed in a single genus; a fact which is no longer a source of disagreement. If indeed the three scoters are quite similar then very little difference would be expected in the parasite burdens of birds collected from the same geographical area. With regard to the taxonomy of the genus *Melanitta* some authors consider *M. f. fusca* to be a separate species (the velvet scoter) and *M. deglandi* to be the white-winged scoter thus creating four species in the genus. However, the author chooses to follow the works of Delacour (1959) and Palmer (1976) which recognize only three valid species.

This study was initiated in 1978 to compare the parasite burdens of these three closely related species of ducks. There are many reports of parasites collected from the black and white-winged scoters but relatively few from the surf scoter (Appendix 1). However, these reports of parasites from scoters tend to be qualitative in nature rather than quantitative. Buscher (1965) compared the parasite fauna of three species of ducks along a North American migration route and found that the burden changed from the northern to southern environment. To date, no workers have looked at differences in the parasite burden of three closely related bird species along an east-west gradient. Thus, the author was curious to see if the parasite burdens did differ longitudinally, as a result of geographical distribution of the scoters.

Rhode (1964, *vide* Graham, 1966) has pointed out that just listing the hosts of a helminth tends to lump frequently parasitized hosts with those of accidental origin. Hence, when a single bird is autopsied for parasites, very little insight is obtained about the host/parasite relationships. Conversely, when a large sample of birds is surveyed, it is possible to deduce more information on the host/parasite relationships e.g. host specificity of the parasites, food relations of the host, etc.. Various workers have recognized the above (e.g. Dogiel 1964; Gallimore 1964; McDonald 1969), with the first two workers devising systems that categorized the host as main, auxillary, rare, etc.. The system devised by McDonald (1969) differs in that he lists the parasite as being accidental, rare, infrequent, frequent or common in waterfowl; but doesn't give any criteria for his grouping. Given a large sample of birds one can place parasites into McDonald's categories utilizing stated criteria for each category, this being one of the goals of the present work.

Bezubik (1956), Cornwell and Cowan (1963) and Buscher (1965) concluded that the diet of a bird is the single most important factor in determining the bird's helminth fauna. Scoters are omnivorous birds that feed predominantly on animal matter, and thus, should be more adequately described as carnivores that consume some plant material. Cottam (1939) examined the stomachs of 168 surf, 819 white-winged and 124 black scoters and found animal material to make up 88%, 94% and 90% of their diets respectively. Molluscs made up 60.8%, 75.3% and 65.2% of the animal material respectively. Moulting anatids eat predominately vegetable matter (Cornwell and Cowan, 1963; Buscher, 1965). In addition, Buscher (1965) states, "The incidence of helminths in adult ducks ... was greatly reduced when the ducks were flightless during the moulting period."

The objectives of this work are thus, to determine and quantify the parasitic burden of three closely related species of ducks along an east-west gradient, to define the status of each parasite species found in these ducks and to relate the parasites found to the ecology of the ducks.

METHODS AND MATERIALS

A total of 175 scoters (94, *M. perspicillata,* 45 *M. nigra* and 36 *M. fusca*) were collected across large parts of their respective geographical ranges, from 1973-1978. Data on the locality and date of collection of these birds is summarized in Table 1. The birds were all collected with a 12-gauge shotgun using various sizes of shot. The majority of birds were collected during their moulting season thus accounting for the large number of males (i.e. males undertake a moult migration to the sea where they congregate in large flocks while the females remain on the breeding grounds with their young).

The New Brunswick birds were obtained from the Royal Canadian Mounted Police, after they had been confiscated from hunters who were taking them illegally. As a result, no information is available on how soon they were frozen after collection. All other birds were either deep frozen or preserved in 10% formalin within six hours of their collection. The Labrador sample of birds were the only specimens collected by the author.

Birds were aged using plumage (Carney and Geis, 1964) and secondary sexual characters, and/or the presence or absence of a Bursa of Fabricius. Two age classes were recognized in this study: (1) immature (prebreeding bird) - a bird that was collected in it's first or second calendar year, that possessed

TABLE 1. COLLECTION DATES AND LOCALITIES FOR SCOTERS EXAMINED.

BIRD SPECIES	LOCAL	YEAR	JAN.	FEB.	APR./MAY	JUN.	JUL.	AUG.	SEPT.	SUMMER*	TOTAL
			MONTH								
Surf Scoter	New Brunswick -Shippegan	1973	-	-	25	-	-	-	-	-	25
	British Columbia -Roberts Bank	1974	-	-	-	-	-	-	-	11	11
	-Iona	1974	14	-	-	-	-	-	-	-	14
	-Boundary Bay	1974	-	5	-	-	9	1	-	-	15
	-'?'	1974	-	-	-	-	1	-	-	4	5
	Newfoundland -Porcupine Strand (Lab.)	1978	-	-	-	-	-	22	-	-	22
	-Porcupine Hbr. (Lab.)	1978	-	-	-	-	-	-	2	-	2

TABLE 1. CONTINUED.

BIRD SPECIES	LOCAL	YEAR	JAN.	FEB.	APR./MAY	JUN.	JUL.	AUG.	SEPT.	SUMMER*	TOTAL
			MONTH								
White-winged scoter	New Brunswick -Shippegan	1973	–	–	3	–	–	–	–	–	3
	British Columbia										
	-Roberts Bank	1974	–	–	–	–	–	–	–	4	4
	-Boundary Bay	1974	–	3	–	1	1	–	–	–	5
	-'?'	1974	–	–	–	–	–	–	–	5	5
	-Salt Spring Islands	1978	–	8	–	–	–	–	–	–	8
	Newfoundland -Porcupine Strand (Lab.)	1978	–	–	–	–	–	5	–	–	5
	Norway -Balsfjord Tromsø	1978	–	6	–	–	–	–	–	–	6

TABLE 1. CONTINUED.

BIRD SPECIES	LOCAL	YEAR	MONTH JAN.	FEB.	APR./MAY	JUN.	JUL.	AUG.	SEPT.	SUMMER*	TOTAL
Black Scoter	New Brunswick -Shippegan	1973	-	-	27	-	-	-	-	-	27
	British Columbia										
	-Roberts Bank	1974	-	-	-	-	-	-	-	10	10
	-Iona	1974	-	-	-	-	-	-	-	3	3
	Newfoundland -Porcupine Strand (Lab.)	1978	-	-	-	-	-	5	-	-	5

*No further information on date of collection is possible.

a Bursa of Fabricius and juvenille plumage; (2) adult - a bird that was two calendar years of age or older that lacked a Bursa of Fabricius and bore adult plumage. Birds were sexed using the appearance of their genital organs, when possible, and secondary sexual characteristics. Sexes and ages of the birds examined in this study are given in Table 2.

Necropsies were carried out as described by Turner (1974). In addition to necropsying the specimens the weight (g.), culmen length and depth, wing length, tail length and tarsus length was obtained (all measurements in mm.), whenever possible. Due to the birds being treated in a variety of ways by the various collectors not all birds were whole (Table 3). In addition, 27 of the British Columbia surf scoters had their food contents removed (25 had their proventriculus and gizzard emptied while 2 had their gizzard emptied). Of the British Columbia black scoters, 7 had the contents of their proventriculus and gizzard removed. Of the 1974 British Columbia white-winged scoters, 4 had their gizzard emptied and an additional 4 had their proventriculus and gizzard emptied.

The removal of food stuffs was carried out in such a way as to leave the lining of the proventriculus intact and while some parasites were undoubtedly lost, the author believes such losses were minimal. The helminth burdens recorded represent a minimum, especially in those birds that had various portions of their viscera removed.

TABLE 2

SEX AND AGE OF SCOTERS EXAMINED

BIRD	LOCALITY COLLT'D	FEMALE ADULT	FEMALE IMMATURE	MALE ADULT	MALE IMMATURE	SEX UNKNOWN	SAMPLE SIZE
Surf Scoters	New Brunswick	2	0	23	0	0	25
	British Columbia	14	1	22	8	0	45
	Labrador	0	5	11	8	0	24
	Total	16	6	56	16	0	94
White-Winged Scoters	New Brunswick	0	0	3	0	0	3
	British Columbia	2	2	16	1	1	22
	Labrador	0	0	3	2	0	5
	Norway	1	0	4	1	0	6
	Total	3	2	26	4	1	36
Black scoters	New Brunswick	7	0	20	0	0	27
	British Columbia	1	2	10	0	0	13
	Labrador	0	2	2	1	0	5
	Total	8	4	32	1	0	45

NOTE: The one bird that could not be sexed was missing its head, and its genital organs were not developed.

TABLE 3. NUMBERS OF SCOTERS LACKING VARIOUS ORGANS, DUE TO A VARIETY OF REASONS.

BIRD SPECIES	LOCAL	A	B	C	D	E	F	G	H	I	J	K	L
Surf scoter	British Columbia	-	2	7	18	12	31	32	-	-	-	-	-
	Labrador Porcupine Hbr.	2	-	-	-	-	-	-	2	2	2	2	1
Black Scoter	British Columbia	-	-	-	-	1	12	12	-	-	-	-	-
White-winged scoter	British Columbia	1	1	4	-	3	6	6	-	-	-	-	-
	Norway	-	-	-	-	-	6	6	6	6	-	6	-

A - Esophagus
B - Proventriculus
C - Gizzard
D - Liver
E - Gall bladder
F - Spleen
G - Pancreas
H - Lungs
I - Kidneys
J - Gonads
K - Cloaca
L - Bursa

Removal of ectoparasites was in accordance with Eveleigh (1974). After this procedure was completed the birds were rinsed, with a jet of water, into a sieve and any debris collected was examined for ectoparasites. Only a selected sample of each species of bird that was examined for ectoparasites was included in the results (48 surf scoters, 17 white-winged scoters and 17 black scoters), due to the fact that some birds were poorly wrapped and had almost certainly lost some of their ectoparasites.

The black scoters necropsied in this study were all *M. n. americana* and the white-winged scoters save 6 were *M. f. deglandi*, with the former being *M. f. fusca* (the Norwegian birds). Appendix 2 compares the parasites recovered from the 6 *M. f. fusca* to those recovered from the 30 *M. f. deglandi*.

The methods of fixation, preservation, staining and mounting of helminths are those set forth in Andrews (1974), while ectoparasites were treated utilizing the method outlined by Palma (1978). A scanning electron microscope was used to aid in the identification of one species of trematode, whilst it proved necessary to section another species.

Infections are recorded as prevalence (percentage of ducks infected) and intensity (average number of parasites per infected duck).

The number of schistosomes and cestodes collected refer to minimum numbers; this is a result of only searching for schistosomes until specimens were recovered i.e. presence or absence. Cestode numbers were arrived at by counting the number of scolices present and placing that number between the nearest two numbers on a five digit scale (i.e. if 42 scolices were recovered from a host, it was assumed that the bird had between 40-45 cestodes). However, due to their small size, destrobilization and digestion of the cestodes by the host on its death, some may have been overlooked. The number of *Fimbriaroides* present was arrived at by counting the number of fan shaped neck segments present. Parasites were categorized as immature or adult by meristic characters and/or presence of ova in females.

Due to taxonomic confusion within the genus *Hymenolepis* all tritesticular Hymenolepids are referred to as *Hymenolepis s.l.*. Specific determination of Hymenolepids collected in this study was not carried out due to the condition of the specimens (destrobilization, digestion and lack of rostellar hooks).

The classifications utilized in this work are of Emerson, 1972 (for lice), Yamaguti, 1961, 1963 and 1971 (for nematodes, acanthocephalans and trematodes respectively) and McDonald 1969c (for cestodes).

Data were analyzed using cluster analysis, G-tests and the Mann-Whitney U-test.

RESULTS AND DISCUSSION

A total of 37 different genera (at least 50 species) of metazoan parasites were recovered from the scoters examined in this study. Necropsies yielded 29 genera (39 species), 21 genera (28 species) and 25 genera (33 species) of parasites from the surf, white-winged and black scoters respectively.

Trematoda

The 175 scoters examined yielded 18 genera and 23 species of trematodes (surf scoters 11 genera (15 species); white-winged scoters 11 genera (14 species); black scoters 11 genera (15 species)) (Table 4). A total of 55 (58.5%) surf, 28 (77.5%) white-winged and 17 (37.8%) black scoters were infected with these parasites.

Austrobilharzia terrigalensis Johnston, 1917 was noted in 8 (8.5%) surf, 2 (5.6%) white-winged and 4 (8.9%) of the black scoters examined (Table 4). The finding of this trematode in each host constitutes a new host record. In all instances, except one, the specimens were removed from the blood vessels associated with the small intestine. The exception contained schistosomes in the blood vessels associated with the liver and gall bladder.

TABLE 4. DETAILS OF INFECTION OF SURF SCOTERS, WHITE-WINGED SCOTERS AND BLACK SCOTERS WITH TREMATODA.

DIGENEA	SURF SCOTER				WHITE-WINGED SCOTER				BLACK SCOTER			
	A	B	C	D	A	B	C	D	A	B	C	D
Austrobilharzia terrigalensis	8.5	2.5	1-5	20 17,3,0	5.6	1.5	1-2	3 3,0,0	8.9	1.0	1	4 4,0,0
Zygocotyle lunata	2.1	2.0	1-3	4	–	–	–	–	–	–	–	–
Notocotylus attenuatus	1.1	4.0	4	4	2.8	14.0	14	14 9ad. 5imm.	2.2	17.0	17	17
Catatropis verrucosa	–	–	–	–	8.3	4.7	3-8	14	–	–	–	–
Tristriata elegans	29.8	4.8	1-16	135	11.1	4.5	1-12	18	–	–	–	–
Eucotyle castenea	2.1	1.0	1	2	11.1	2.0	1-3	8	4.4	10.0	1-19	20
Gymnophallus bursicola	10.6	5.6	1-20	56	5.6	3.5	1-6	7	8.9	9.0	1-36	46

TABLE 4. CONTINUED.

DIGENEA	SURF SCOTER				WHITE-WINGED SCOTER				BLACK SCOTER			
	A	B	C	D	A	B	C	D	A	B	C	D
Gymnophallus choledocus	7.4	5.3	1-20	37	8.3	5.4	1-12	16	2.2	1.0	1	1
Gymnophallus deliciosus	14.9	4.6	1-18	64	30.6	8.8	1-26	35	8.9	6.3	1-24	69 68ad. 1imm.
Gymnophallus sp. *Type 1*	3.2	6.0	1-15	18	5.6	6	12	12	2.2	6.0	6	6
Gymnophallid sp.	1.1	2.0	2	2	-	-	-	-	2.2	2.0	2	2
Gymnophallus spp.	2.1	2.5	1-4	5	8.3	9.0	4-14	27imm.	11.1	7.0	1-26	35imm.
Echinostoma revolutum	-	-	-	-	-	-	-	-	2.2	42.0	42	42imm.
Dietziella egregia	-	-	-	-	22.2	69.8	4-240	559 328ad. 231imm.	-	-	-	-
Himasthla incisa	-	-	-	-	2.8	1.0	1	1	2.2	3.0	3	3

TABLE 4. CONTINUED.

DIGENEA	SURF SCOTER				WHITE-WINGED SCOTER				BLACK SCOTER			
	A	B	C	D	A	B	C	D	A	B	C	D
Acanthoparyphium melanittae	1.1	3.0	3	3	-	-	-	-	-	-	-	-
Psilostomum sp.	7.4	5.0	1-20	35	-	-	-	-	-	-	-	-
Ascorhytis charadriformis	3.2	10.3	1-23	31	2.8	1.0	1	1	4.4	82.5	63-102	165
Microphallus pygmaeum	-	-	-	-	-	-	-	-	2.2	8.0	8	8
Pseudospelotrema japonicum	4.3	4.8	1-13	19	16.7	5.7	1-27	34	2.2	191.0	191	191
Renicola sp.	2.1	3.0	1-5	6	2.8	1.0	1	1	-	-	-	-

TABLE 4. CONTINUED.

DIGENEA	SURF SCOTER				WHITE-WINGED SCOTER				BLACK SCOTER			
	A	B	C	D	A	B	C	D	A	B	C	D
Cotylurus strigeoides	-	-	-	-	-	-	-	-	2.2	11.0	11	11
Apatemon burti	-	-	-	-	-	-	-	-	2.2	61.0	61	61
Apatemon gracilis	1.1	19.0	19	19	-	-	-	-	-	-	-	-

A = prevalence (% of ducks infected)
B = intensity (mean no. of parasites per infected bird)
C = range of parasite numbers
D = total no. of parasites collected
no. of males, no. of females, no. of immatures
or
no. of adults, no. of immatures

McDonald (1969) listed 4 species of *Austrobilharzia* Johnston, 1917 from anatids (*A. canadensis* McLeod, 1937; *A. chapini* Price, 1929; *A. manitobensis* McLeod, 1939 and *A. variglandis* (Miller & Northup, 1926) while Farley (1971) synonymized all four species with *A. terrigalensis*.

Zygocotyle lunata (Diesing, 1836) occurred in 2 (2.1%) of the surf scoters examined. Mettrick (1959) reports this parasite as a cause of mortality in domestic ducks. The finding of this trematode in the surf scoter constitutes a new host record. Table 3 gives further details on this infection of surf scoters. The specimens recovered in this study all come from the caeca of their hosts.

Notocotylus attenuatus (Rudolphi, 1809) infected all three hosts examined in this study (Table 4). It was recovered from 1 (1.1%, 2.8%, 2.2%) of each of the surf, white-winged and black scoters examined respectively. Serafin (1957, *vide* McDonald, 1969) reports this parasite as a cause of mortality in domestic geese. The occurrence of this parasite in the surf scoter constitutes a new host record.

Catatropis verrucosa (Froelich, 1789) was recovered from the caeca of 3 (8.3%) of the white-winged scoters examined (Table 4).

Tristriata elegans Filimonova, 1971 was found in 28 (29.8%) of the surf and 4 (11.1%) of the white-winged scoters examined (Table 4). The presence of *T. elegans* in the surf scoter constitutes a new host record. The parasites were recovered from the large intestine, caeca and cloaca of their hosts.

There are presently two valid species in the genus *Tristriata* Belopol'skaia, 1953 (*T. Anatis* Belopol'skaia, 1953 and *T. elegans*) which are distinguished from other Notocotylidea by having two to four rod shaped ridges on their ventral surfaces (Yamaguti, 1971). *Tristriata elegans* is morphologically quite similar to *N. attenuatus* (Figure 1), except for the configuration of its ventral ridges. Methods of fixation alter the configuration of the aforementioned ridges in *Tristriata* which could lead to confusion with *Notocotylus*. It is consequently almost impossible to distinguish between these 2 genera after making permanent mounts of specimens. Frame (1969) states "techniques used by previous workers appear to have importantly influenced conclusions" when discussing fixation and mounting of specimens of *T. anatis*. Further, he notes that the ventral body ridges are difficult to see when methods of preparation that exert pressure on the worm, or involve excessive clearing are utilized. He also noted that the ridges were more readily visible on unstained specimens or on those stained

FIGURE 1.

Showing the similarity in the morphology of (A.) *Tristriata elegans* and (B.) *Notocotylus attenuatus.*

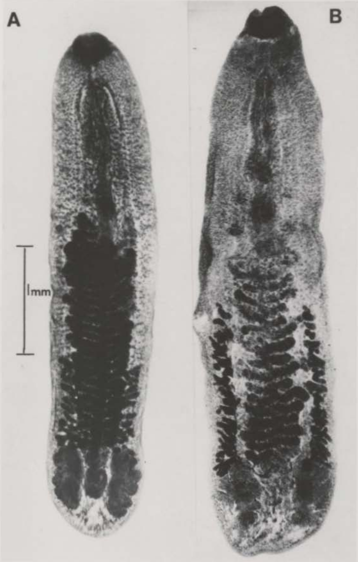

Figure 1

with Ehrlich's acid haemotoxylin. The ventral ridges of specimens obtained during this study were quite apparent upon removal from the frozen hosts. Light staining with Acid Carmine, or*Trichrome stain, and mounting in glycerine aided in microscopic examination of the specimens.

Eucotyle castenea Jensen, 1971 was recovered from 2 (2.1%) of the surf, 4 (11.1%) of the white-winged and 2 (4.4%) of the black scoters examined (Table 4). The finding of this parasite in the surf and black scoter both constitute new host records. A single specimen was recovered from the kidney of a white-winged scoter, while all other specimens were recovered from the caeca and body cavity. Jensen (1971) reports finding specimens in the intrarenal branches of ureters in *M. deglandi*. The location that they were recovered from in this study may have been due to post-mortem migration.

The family Gymnophallidae presently comprises 5 or 6 genera depending on the classification scheme one chooses to follow. Ching (1973) recognizes 6 genera: namely, *Gymnophallus* Odhner (1900), *Gymnophalloides* Fujita (1925), *Lacunovermis* Ching (1975), *Meiogymnophallus* Ching (1965), *Paragymnophallus* Ching (1973) and *Parvatrema* Cable (1953), while Yamaguti (1971) recognizes four genera in the family: namely, *Gymnophallus*, *Gymnophalloides* (synonym *Lacunovermis*), *Meiogymnophallus* and *Parvatrema* with *Paragymnophallus* being described in 1973. He

*Gomori's Trichrome

lists 10, 2, 7 and 10 species in each genus respectively, and in addition lists 12 species which cannot be placed in any genus due to inadequate descriptions. It is of interest to note that there are 8 species of *Gymnophallus* alone recorded from the black scoter. The author questions this multitude of species from a single genus occurring in a single host species. It is much more likely that the "species" described represent a "species-complex" with a number of morphological variations (possibly host induced - see Blankespoor, 1974)as suggested by Stunkard & Uzmann (1958). Due to a lack of life-cycle work the author feels that no new species should be described, unless it is an unique form, until the family is revised and augmented with life-cycle data, particularly as even the generic designations are open to interpretation. Deposition of more representative specimens in officially recognized depositories would have greatly aided this work. It is thus the opinion of the author that the family Gymnophallidae is in dire need of revision.

Members of the genus *Gymnophallus* were found in 27 (28.5%) surf, 13 (36.1%) white-winged and 10 (22.2%) of the black scoters examined.

Gymnophallus bursicola Odhner, 1900 was found to inhabit all three species of scoters examined, being recovered from 10 (10.6%) of the surf, 2 (5.6%) of the white-winged and

4 (8.9%) of the black scoters examined (Table 4). These parasites were recovered from the duodenum, caeca, Bursa of Fabricius and cloaca of their hosts.

Gymnophallus choledocus Odhner, 1900 was recovered from 7 (7.4%) surf, 3 (8.3%) white-winged and 1 (2.2%) of the black scoters examined (Table 4). The occurrence of this parasite in the surf and black scoters both constitute new host records. The sites of infection by this parasite included the gall bladder, Bursa of Fabricius and cloaca.

Gymnophallus deliciosus (Olsson, 1893) was recovered from 14 (14.9%) of the surf, 11 (30.6%) of the white-winged and 4 (8.9%) of the black scoters examined (Table 4). Prior to this study *G. deliciosus* had only been recovered from the black scoter, thus the present findings constitute new host records for the surf and white-winged scoters. These parasites were recovered from the gall bladder, small intestine (sections 1 and 3) and the Bursa of Fabricius. In a number of cases, it proved impossible to assign a specific name to some gymnophallids. The reasons for this include: (1) some specimens did not take stain very well; (2) others were immature; (3) others were too gravid; (4) some were damaged and (5) some did not fit the description of valid species well enough to warrant assigning them to a species.

Gymnophallus sp. (Type 1) was found in 3 (3.2%) surf, 2 (5.6%) white-winged and 1 (2.2%) black scoter examined (Table 4). The specimens were recovered from the caeca, bursa and cloaca of their hosts. The range of measurements for the 33 specimens recovered are shown in Table 5. These specimens most closely resemble *G. choledochus*; however, the criteria used to key other specimens of this species did not fit the aforementioned specimens well enough to assign them definitely to this species. While the specimens possessed ova, often the uterus contained less than 20 ova whereas gravid specimens may contain several hundred ova.

Gymnophallus spp. refers to damaged or immature specimens that due to their condition could not be assigned a specific name. These specimens were recovered from 2 (2.1%) surf, 3 (8.3%) white-winged and 5 (11.1%) of the black scoters examined (Table 4). Sites of infection were the ureters, gall bladder, small intestine (sections 2 and 3), large intestine, bursa and cloaca.

A gymnophallid sp. was recovered from the caeca of 1 (1.1%) surf and from the small intestine (section 3) of 1 (2.2%) black scoter (Table 4). Table 5 gives the range of measurements for the 3 specimens measured. These specimens appear to be members of the genus *Gymnophalloides*.

Table 5. Range of measurements of *Gymnophallus* sp. (Type 1) and the gymnophallid sp. found in this study.

MEASUREMENT	*Gymnophallus* sp Type 1	Gymnophallid sp.
Total Length	.650-.980	.440-.530
Total Width	.210-.480	.150
Oral Sucker Length	.100-.135	.90
Oral Sucker Width	.90-.110	.100-.105
Ventral Sucker Length	.95-.105	-
Ventral Sucker Width	.90-.105	-
Eggs	.020-.025	.020
Position of the Uterus	forebody*	hindbody

*In 2 of the 11 specimens the uterus extended to the hindbody.

Echinostoma revolutum (Froelich, 1802) a parasite that can cause disease and mortality in anatids (McDonald, 1969b), was recovered from 1 (2.2%) of the black scoters examined (Table 4). The 42 specimens recovered were located in the anterior small intestine (sections 1 and 2).

Dietziella ergregia (Dietz, 1909) was recovered from 8 (22.2%) of the white-winged scoters, thus constituting a new host record. The sites of infection were the duodenum and small intestine (sections 1 and 2). The occurrence of this parasite in waterfowl is puzzling as it has only previously been recorded from a stork (*Harpiprion caerulescens* Gibson, 1880) in Brazil. It's presence in the white-winged scoter may be considered accidental; however, it occurred in all the white-winged scoters collected in British Columbia in February, 1978. Conversely, it's occurrence in *H. caerulescens* may be accidental. The life-cycle of this parasite is unknown; however, the number of immature parasites collected (Table 4) suggests it has a marine intermediate host.

Himasthla incisa Linton, 1928 was located in the small intestine (section 3) of 1 (2.8%) white-winged and 1 (2.2%) black scoter (Table 4). Yamaguti (1958, 1971) lists this parasite as occurring in the black scoter, with McDonald (1969) calling the 1958 record erroneous.

Acanthoparyphium melanittae Yamaguti, 1939 was recovered from the duodenum of a single surf scoter (1.1%), for the first time, in this study (Table 4).

Specimens of a *Psilostomum* sp. were taken from the duodenum and small intestine (sections 1-3) of 7 (7.4%) of the surf scoters examined in this study (Table 4). The specimens recovered resemble most closely *P. magniovum* presently being described by H. L. Ching (pers. comm. H. L. Ching).

Ascorhytis charadriformis Ching, 1965 was recovered from 3 (3.2%) of the surf, 1 (2.8%) of the white-winged and 2 (4.4%) of the black scoters examined (Table 4). The occurrence of this parasite in all three hosts constitutes new host records. The sites of infection were the small intestine (sections 1-3), large intestine, cloaca and caeca of the hosts.

Microphallus pygmaeum (Levinsen, 1881), a potential pathogen of eiders (Belopol'skaia 1953 *vide* McDonald 1969), was recovered from the small intestine (section 3) of 1 (2.2%) black scoter. Yamaguti (1971) uses the generic name *Spelotrema* for this parasite (*Spelotrema pygmaeum*), reserving the generic name *Microphallus* for digenea from fishes. The author prefers to follow the more logical scheme of Deblock (1971), which bases scientific names on morphology rather than host group.

Pseudospelotrema japonicum Yamaguti, 1939 was recovered from 4 (4.3%) surf, 6 (16.7%) white-winged and 1 (2.2%) of the black scoters examined (Table 4). The presence of this parasite in the surf and black scoters constitutes new host records. The parasites were recovered from the duodenum, small intestine (section 3), large intestine and caeca of the infected birds.

Specimens of a *Renicola* sp. were recovered from the kidneys of 2 (2.1%) surf and 1 (2.8%) of the white-winged scoters examined (Table 4). The occurrence of this genus in the white-winged scoter constitutes a new host record. Yamaguti (1971) lists *R. dollfusi* Odening, 1962 as being found in the genus *Melanitta* but does not note the species of scoter, while Oshmarin (1963) lists a *Renicola* sp. from white-winged scoters. Due to the gravid uteri of the specimens recovered few measurements were obtainable. The specimens resemble *R. mollissimus* Kulachkova, 1957 most closely, when taking egg size (average 36 um for surf scoter specimens and 42.5 um for specimens recovered from white-winged scoter) and host group into consideration.

Cotylurus strigeoides Dubois, 1958 was recovered from the small intestine (sections 2 and 3) of 1 (2.2%) black scoter. This constitutes a new host record. The measurements of the

TABLE 6. Comparison of measurements of *Cotylurus strigeoides* and *Cotylurus raabei* with specimens recovered in this study.

	C. strigeoides *vide* Dubois (1968)	*C. strigeoides* present study	*C. raabei* (Bezubik, 1958) *vide* Dubois (1968)
Total length	1.9mm	2.28-2.60mm	5mm
Length of Anterior Segment	0.44-0.71mm	0.780-0.900mm	1.1-1.8mm
Length of Posterior Segment	1.03-1.19mm	1.50-1.75mm	1.7-3.2mm
Length of Anterior Segment / Length of Posterior Segment	1.5-2.3mm	1.8-2.2mm	1.46-1.85mm
Eggs	0.085-0.099mm ~ 24 eggs	0.092-0.100mm ~ 12 eggs	0.120-0.139mm numerous

specimens recovered in this study (Table 6) differ slightly from those of the only two known species of *Cotylurus* Szidat, 1928 with vitellaria in their forebody. However, accepting that egg size is the least variable character of a trematode, considering host-induced variation (Blankespoor, 1974), then the present specimens are undoubtedly *C. strigeoides*.

Apatemon burti (Miller, 1933) was located in the duodenum and small intestine (section 1) of 1 (2.2%) black scoter, for the first time.

Apatemon gracilis (Rudolphi, 1819), a parasite that can cause mortality in anatids (Zajiček 1963 , *vide* McDonald 1969), was recovered from the small intestine (sections 2 and 3) of 1 (1.1%) surf scoter (Table 4). The present finding constitutes a new host record.

Cestoda

Three genera of cestodes comprising an unknown number of species were recovered from the scoters examined in this study. A total of 56 (59.6%) of the surf, 23 (63.8%) of the white-winged and 29 (64.4%) of the black scoters were infected with Cestoda. Due to the lack of rostellar hooks and the poor condition of some of the specimens it was hard in many cases to even assign a generic name, let alone a specific one.

Hymenolepis spp. were recovered from 55 (58.5%) of the surf, 23 (63.9%) of the white-winged and 26 (57.8%) of the black scoters (Table 7). The cestodes were recovered from the duodenum, small intestine (sections 1-3), caeca and large intestine of their hosts. While the specific identification of these helminths fell outside the bounds of the present study, the author believes that approximately 10 species were present in the samples examined. The genus *Hymenolepis s. l.* is extremely large and taxonomically confused, with some 3, 26 and 24 species of *Hymenolepis s. l.* being recorded from surf, white-winged and black scoters respectively (Appendix 1).

Cloacotaenia megalops (Nitzsch, 1829) was recovered from the bursa of 1 (2.8%) of the white-winged scoters examined (Table 7). While this genus is considered by McDonald (1969) to be part of *Hymenolepis s. l.* the author diverges from him and accepts *Cloacotaenia* due to its lack of rostellar hooks.

A member of the sub-family *Fimbriariinae* was recovered from the duodenum and small intestine (sections 1 and 2) of 13 (13.8%) of the surf and 6 (13.3%) of the common scoters examined (Table 7). Due to the presence of a poorly developed pseudoscolex and internal segmentation, the author believes these specimens to belong to the genus *Fimbriarioides*.

TABLE 7. Details of infection of Surf, White-Winged and Black Scoters with Cestoda.

CESTODA	SURF SCOTER			WHITE-WINGED SCOTER			BLACK SCOTER		
	A	B	C	A	B	C	A	B	C
Hymenolepis spp.	58.5	5-10	1-5 to 50-55	63.9	25-30	1-5 to 305-310	57.8	40-45	1-5 to 670-675
Cloacotaenia megalops	-	-	-	2.8	3	3	-	-	-
Sub. family Fimbriariinae	13.8	5-10	1-5 to 25-30	-	-	-	13.3	50-55	1-5 to 140-145

A = prevalence (% of ducks infected)
B = intensity (mean no. of parasites per infected bird)
C = range of parasite numbers

Nematoda

During this study 8 genera and 14 species of Nematoda were recovered from the three species of scoters; surf scoters contained 8 genera (13 species), white-winged scoters 4 genera (8 species), black scoters 6 genera (9 species) (Table 8). A total of 77 (81.9%) surf, 22 (61.1%) white-winged and 26 (57.8%) black scoters were infected. The absence of the proventriculus and/or gizzard, and removal of food-stuffs, in some birds may have influenced the indicated incidence of all Nematoda, except the capillarids and *Sarconema* Wehr, 1939.

A single *Capillaria anatis* (Schrank, 1790) was located in the body cavity of 1 (1.1%) of the surf scoters examined (Table 8). The presence of the parasite in this host constitutes a new host record. The specimen probably migrated to the body cavity from the intestine after death of the host.

Capillaria nyrocinarium Madsen, 1945 was recovered from the small intestine (sections 1-3), Bursa of Fabricius and caeca of 20 (21.3%) surf, 12 (33.3%) white-winged and 2 (4.4%) black scoters (Table 8). The occurrence of this parasite in the first named species constitutes a new host record.

Amidostomum acutum (Lundahl, 1848) the nematode with the highest prevalence, was present in 48 (51.1%) surf, 11 (30.5%) of the white-winged and 22 (48.9%) of the black scoters examined (Table 8). The occurrence of this parasite in the surf

TABLE 8. Details of infection of surf, white-winged and black scoters with Nematoda.

PARASITE	SURF SCOTER				WHITE-WINGED SCOTER				BLACK SCOTER			
	A	B	C	D	A	B	C	D	A	B	C	D
Capillaria anatis	1.1	1	1	1 1,0,0	-	-	-	-	-	-	-	-
Capillaria nyrocinarum	21.3	2.3	1-8	46 20,18,8	33.3	2-5	1-5	30 13,14,3	4.4	5	4-6	10 3,6,1
Amidostomum acutum	51.1	6.2	1-53	307 126,174,7	30.5	4.7	1-27	52 21,31,0	48.9	4.3	1-15	94 45,46,3
Amidostomum **sp.**	5.3	1.6	1-2	8 0,0,8	-	-	-	-	-	-	-	-
Epomidiostomum uncinatum	-	-	-	-	-	-	-	-	4.4	5	5	10 5,5,0
Streptocara californica	21.3	1.9	1-6	38 14,23,1	2.8	1	1	1 1,0,0	17.8	19.5	1-90	156 36,119,1
Streptocara c. crassicauda	7.4	1.4	1-2	10 4,5,1	2.8	3.3	1-6	13 2,11,0	8.9	1	1	4 4,0,0
Streptocara formosensis	16.0	1.2	1-4	18 6,12,0	2.2	6	6	6 1,5,0	-	-	-	-
Streptocara **sp.**	2.1	1	1	2 0,0,2	-	-	-	-	-	-	-	-
Echinuria borealis	1.1	2	2	2 2,0,0	-	-	-	-	-	-	-	-
Echinuria hypognatha	22.3	8.9	1-54	186 93,61,32	-	-	-	-	15.6	2.3	1-5	16 5,4,7
Tetrameres fissispina	7.4	6.2	1-22	37 37,0,0	2.8	4	4	4 4,0,0	6.7	10.7	1-22	32 32,0,0

TABLE 8. Details of infection of surf, white-winged and black scoters with Nematoda. CONTINUED

PARASITE	SURF SCOTER				WHITE-WINGED SCOTER				BLACK SCOTER			
	A	B	C	D	A	B	C	D	A	B	C	D
Tetrameres somateriae	46.8	4.6	1-27	203 203,0,0	25.0	5.4	1-26	49 49,0,0	2.2	3	3	3 3,0,0
Tetrameres spinosa	3.1	2	1-4	6 6,0,0	2.8	1	1	1 1,0,0	2.2	1	1	1 1,0,0
Tetrameres sp.	5.3	1	1	5 0,4,1	5.6	1.5	1-2	3 3,0,0	-	-	-	-
Sarconema sp.	1.1	1	1	1 0,1,0	-	-	-	-	-	-	-	-
Nematode sp. Type 1	1.1	4	4	4 '?'	-	-	-	-	-	-	-	-

A = prevalence (percent of ducks infected)
B = intensity (mean no. of parasites per infected duck)
C = range of parasite
D = total no. of parasites collected
no. of males, no. of females, no. of immatures

scoter constitutes a new host record. If the prevalence was calculated for those missing their gizzard it would be 55.2%, 34.4% and 53.3% respectively. This parasite was characteristically found under the gizzard lining of the host, where it can cause pathological changes (Zajíček 1960, *vide* McDonald 1969). Zajíček (op. cit.) worked on *A. boschadis* which is now considered a synonym of *A. acutum* (*vide* McDonald 1969).

An *Amidostomun* sp. (*acutum?*) was located under the gizzard lining of 5 (5.3%) of the surf scoters examined (Table 8). The specimens were either immature or damaged, and hence could not be identified to the specific level. All these infections occurred in surf scoters that were infected with *A. acutum*.

Epomidiostomum uncinatum (Lundahl, 1848), a parasite which causes pathological changes in the host (Beaudette 1939, *vide* McDonald 1969) was noted under the gizzard lining of 2 (4.4%) of the black scoters examined (Table 8).

The genus *Streptocara* (Raillet, Henry et Sisoff, 1912) had a prevalence of 39.4% (37 birds), 13.9% (5 birds) and 24.4% (11 birds) in the surf, white-winged and black scoters respectively. If the prevalence is recalculated omitting those birds lacking a gizzard, (the gizzard is the preferred site of infection for members of this genus of nematode), then it is 42.5%, 16.1%, 24.4%respectively.

Streptocara californica (Gedoelst, 1919) infected 20 (21.3%), 1 (2.8%) and 8 (17.8%) of the surf, white-winged and black scoters respectively (Table 8). The preferred habitat of these worms was under the gizzard lining. If the prevalence was calculated omitting those birds that had their gizzard removed the figures were a little higher than noted above ((23.0%) for the surf scoter and (3.1%) for the white-winged scoter).

Streptocara crassicauda crassicauda (Creplin, 1829) infected 7 (7.4%) surf, 1 (2.8%) white-winged and 4 (8.9%) of the black scoters (Table 8). Garkavi (1950) reports this parasite to cause pathological conditions and death in anatids. Once again the preferred habitat of these worms was under the gizzard lining, although some parasites were removed from the proventriculus. If the prevalence is recalculated omitting the birds that had their gizzard removed, then it is 8.1% for the surf and 3.1% for the white-winged scoter.

Streptocara formosensis Sugimoto, 1930 was located under the gizzard lining and in the proventriculus of 15 (16.0%) surf scoters, and 1 (2.8%) white-winged scoter (Table 8). If the prevalence is recalculated omitting those birds that had their gizzards removed, then the result is 15.0% for the surf scoter.

Several specimens of a *Streptocara* sp. were taken from the gizzard and proventriculus of 2 (2.2%) of the surf scoters from Labrador. It seems likely that they are either *S. c. crassicauda*, *S. formosensis*, or *S. californica*.

The genus *Echinuria* (Soloviev, 1912) infected 21 (22.3%) surf and 7 (15.6%) of the black scoters examined in this study. If the prevalence is calculated omitting the birds missing their proventriculus (McDonald (1969) notes this organ to be the preferred habitat for members of this genus), then the figures are 22.8% and 15.6% for the surf and black scoters respectively.

Echinuria borealis (Mawson, 1956) was taken from the proventriculus of 1 (1.1%) surf scoter for the first time (Table 8).

Echinuria hypognatha (Wehr, 1937) infected 21 (22.3%) surf and 7 (15.6%) of the black scoters examined (Table 8), with the former constituting a new host record. The preferred site of infection for this parasite was the proventriculus with infections in the esophagus and gizzard being noted. The true prevalence (omitting birds missing their proventriculus) is 22.8% for surf and 15.6% for black scoters.

The genus *Tetrameres* was located in 44 (46.8%) surf, 11 (30.6%) white-winged and 4 (8.9%) black scoters. If the prevalence is recalculated omitting those birds missing their proventriculus, then the prevalence is 47.8%, 31.4% and 8.9% respectively.

Tetrameres fissispina (Diesing, 1861) was recovered from the esophagus or proventriculus of 7 (7.4%), 1 (2.8%) and 3 (6.7%) of the surf, white-winged and black scoters respectively (Table 8). This worm has been reported to be the cause of pathological conditions (Swales 1963a,b) and death (Bittner 1923, *vide* McDonald 1969) in anatids. This is the first record for this parsite in the surf scoter. If the prevalence is recalculated omitting birds missing their proventriculus, then 7.6%, 2.9% and 6.7% were infected respectively.

Tetrameres somateriae Ryzhikov, 1963 was taken from 44 (46.8%) surf, 9 (25.0%) white-winged and 1 (2.2%) of the black scoters, for the first time (Table 8). The major site of infection was the proventriculus, and discounting those hosts with this organ missing the prevalence was 47.8%, 25.8% and 22.2% respectively.

Tetrameres spinosa (Maplestone, 1931) was found in the esophagus and/or proventriculus of 3 (3.1%) surf, 1 (2.8%)

white-winged and 1 (2.2%) of the black scoters examined (Table 8). If birds missing their proventriculus are omitted in calculating the prevalence, then it is as follows 3.3%, 2.9% and 2.2% for the three host species respectively. The finding of *T. spinosa* in these hosts constitutes new host records.

Specimens of a *Tetrameres* sp. were recovered from 5 (5.3%) surf and 2 (5.6%) white-winged scoters. In the surf scoters all infections involved a single worm (4 female and 1 immature male), while in the white-winged scoters 3 damaged male parasites were removed from the 2 infected hosts. McDonald (1974) notes that it is not possible to key female *Tetrameres* to the species level. The 4 females recovered in this study were found in birds harbouring only *T. somateriae* males, thus it is not unreasonable to suspect that the females recovered were also *T. somateriae*. The single immature male worm was recovered from a surf scoter harbouring adult males of *T. fissispina* and *T. somateriae*. The 3 damaged male worms recovered from the 2 infected white-winged scoters were the only individuals of their genus to be recovered from these birds.

A single gravid specimen of the genus *Sarconema* was recovered from 1 (1.1%) of surf scoters examined (Table 8). This parasite was recovered from the air sacs of its host and constitutes a new host record.

An unidentifiable nematode sp designated Type 1 was recovered from the proventriculus of 1 (1.1%) of surf scoters examined (Table 8). The specimens recovered were immature, but resembled members of the genus *Paracuaria* Krishna Rao, 1951.

Acanthocephala

Acanthocephala belonging to three genera and four species were recovered in this study; Surf scoters harboured 3 genera (3 species), white-winged scoters 1 genus (1 species) and black scoters 2 genera (2 species). A total of 19 (20.2%) surf, 7 (19.4%) white-winged and 7 (15.6%) black scoters were infected with Acanthocephala.

Polymorphus botulus (Van Cleave, 1916) was found in 6 (6.25%) surf, 7 (19.4%) white-winged and 7 (15.6%) black scoters examined (Table 9). This parasite has been reported as causing pathological changes in infected animals and has been the cause of heavy mortality and epizootics in *Somateria mollissima* (Linnaeus, 1758) (Clark *et. al.* 1958, Garden *et al.* 1964). Single infections of up to 654 worms, in the latter host, were reported by Bishop (1971). In this study a single immature black scoter harboured 171 worms. Scars (referred to as **nodular** taeniasis (Harrison, 1955)) are host reactions to the embedded proboscis of this worm (Figure 2). The presence of *P. botulus* in the small and large intestines and caeca, of each species of host constitutes a new host record.

Falsifilicollis altmani (Perry, 1942) was detected in a single (1.1%) surf scoter (Table 9). Perry (1942) in the

FIGURE 2.

Showing nodular taeniasis on the intestine of a black scoter.

Figure 2

TABLE 9. Details of infection of surf, white-winged and black scoters with Acanthocephala.

PARASITE	SURF SCOTER				WHITE-WINGED SCOTER				BLACK SCOTER			
	A	B	C	D	A	B	C	D	A	B	C	D
Falsifilicollis altmani	1.1	2	2	2 2,0,0	–	–	–	–	–	–	–	
Polymorphus botulus	6.3	5.7	1–23	34 16,18,0	19.4	10.6	1–37	74 34,21,19	15.6	45.3	1–171	317 104,156,57
Corynosoma constrictum	–	–	–	–	–	–	–	–	2.2	7	7	7 6,1,0
Corynosoma sudsuche	13.8	4.2	1–14	55 25,18,12	–	–	–	–	–	–	–	–

A = prevalence (percent of birds infected with parasite)
B = intensity (mean no. of parasites per infected bird)
C = range of parasite
D = total no. of parasites collected
no. of males, no. of females, no. of immatures.

only other record of this parasite reported it as a cause of mortality in *M. f. deglandi* and *M. perspicillata*. The parasites in this study were located in the small intestine (section 2).

Seven *Corynosoma constrictum* (Van Cleave, 1918) were found in the small intestine (section 3) of 1 (2.2%) of the black scoters (Table 9).

Corynosoma sudsuche Belopol'skaia, 1959 was removed from the small and large intestines and caeca of 13 (28.9%) surf scoters (Table 9), this constituting a new host record.

Mallophaga

Four genera and 6 species of Mallophaga were recovered during this study. Surf scoters bore 4 genera (6 species), white-winged scoters 3 genera (4 species) and black scoters 3 genera (5 species) (Tables 10, 11, 12). A total of 34 (70.8%) surf, 16 (94.1%) white-winged and 16 (94.1%) black scoters were infested.

The lice collected in this study belong to the Superfamily Ischnocera (Family Philopteridae) and the Superfamily Amblycera (Family Menopondiae). The philopterid population on a bird can be divided into two basic morphological types: "On the head and neck is found a short, round-bodied type not greatly flattened dorso-ventrally and with a large head" (Clay, 1957) that is adapted to movement through and among the shorter feathers

TABLE 10. Details of Infestation of surf scoters with Mallophaga.

PARASITE	No. (%) of birds infested	NO. OF PARASITES				MEAN	RANGE
		MALE	FEMALE	NYMPH	TOTAL		
Anatoecus dentatus (males)	4(8.3%)	5	-	-	5	1.3	1-2
Anatoecus icterodes (males)	11(22.9%)	17	-	-	17	1.5	1-3
Anatoecus spp. (females and nymphs)	20(41.7%)	-	39	3	42	2.1	1-7 (females) 1 (nymphs)
Anaticola crassicornis	28(58.3%)	24	44	64	132	4.7	1-22
Holomenopon leucoxanthum	5(10.4%)	1	7	-	8	1.6	1-3
Holomenopon loomisii	3(6.3%)	-	5	-	5	1.7	1-2
Holomenopon nymphs	4(8.3%)	-	-	6	6	1.5	1-2
Trinoton querquedulae	1(2.1%)	-	-	1	1	1	1

TABLE 11. Details of infestation of white-winged scoters with Mallophaga.

PARASITE	No. (%) of birds infested	NO. OF PARASITES				MEAN	RANGE
		Male	Female	Nymph	Total		
Anatoecus dentatus (males)	4(23.5%)	15	-	-	15	3.8	1-8
Anatoecus icterodes (males)	4(23.5%)	9	-	-	9	2.3	1-4
Anatoecus spp. (females and nymphs)	5(29.4%)	-	16	5	21	4.2	1-5(female) 1(nymph)
Anaticola crassicoinis	7(41.2%)	52	43	129	224	32	1-91
Holomenopon loomisii	4(23.5%)	-	1	5	6	1.5	1-2

TABLE 12. Details of infestation of black scoters with Mallophaga.

PARASITE	No. (%) of birds infested	NO. OF PARASITES				MEAN	RANGE
		Male	Female	Nymph	Total		
Anatoecus dentatus (males)	4(23.5%)	9	-	-	9	2.3	1-5
Anatoecus icterodes (males)	7(41.2%)	16	-	-	16	1.8	1-4
Anatoecus spp. (females and nymphs)	9(53.0%)	-	32	32	64	7.1	1-9 (female) 4-16 (nymph)
Anaticola crassicornis	17(100%)	33	39	93	165	9.7	1-22
Holomenopon leucoxanthum	4(23.5%)	7	7	-	14	3.5	2-7
Holomenopon loomisii	5(29.4%)	4	11	-	15	3	1-6
Holomenopon nymphs	7(41.2%)	-	-	22	22	3.1	1-7

of the head and neck e.g. *Anatoecus* (Cummings, 1916). On the larger, broader feathers of the wings and back are found more elongate forms which have undergone severe dorso-ventral flattening to enable them to better evade preening e.g. *Anaticola* (Clay, 1936). The Amblycera, being a less specialized group seem to rely on speed to avoid the preening of their host as they have diverged little from their psocid ancestors (Clay, 1957) e.g. *Holomenopon* Eichler, 1941 and *Trinoton* Nitzsch, 1818. Amblycerans are found mainly on the breast and wings of their hosts (Bourgeois and Threlfall, 1979; Fitzpatrick and Threlfall, 1977).

The occurrence of *Anatoecus dentatus* (Scopoli, 1763), *A. icterodes* (Nitzsch, 1818), *Holomemopon leucocanthum* (Burmeister, 1838) and *H. loomisii* (Kellogg, 1896) on the surf scoter and *A. icterodes* and *H. loomisii* on the black scoter constitute new host records.

The males of *A. dentatus* and *A. icterodes* are seperated from the *Anatoecus* nymphs and females in Tables 9, 10 and 11 due to the fact that at present the females of the two species are indistinguishable, if indeed two species exist. Emerson (1972) states "whether or not *Anatoecus icterodes* is a dimorphic form of *Anatoecus dentatus* has not been settled satisfactorily." Thus to assign females or nymphs to either species could be a misinterpretation of data. Given the number of mixed infections of *A. dentatus* and *A. icterodes* males (surfs-2, white-winged-3 and black scoters-4) one cannot assume that because one type of male is absent that the females are of the other species. *Anatoceus* species were found to infest 25 (52.0%) surf, 10 (58.8%) white-winged and 13 (81.25%) of the black scoters examined.

Anaticola crassicornis (Kellogg, 1896) infested 28 (58.3%) surf, 7 (41.2%) white-winged and 17 (100%) of the black scoters examined.

Holomenopon species infested 8 (16.7%) surf, 4 (23.5%) white-winged and 9(56.3%) black scoters examined in this study. The presence of *H. loomisii* on the black scoter (Table 12) indicates that two species from this genus are found on black scoters. With neither species of *Holomenopon* being previously recorded from the surf scoter makes the assigning of either species as a straggler difficult if indeed one is. However, while collecting specimens for this study mixed moulting flocks of surf and black scoters were observed regularly. Body contact of two hosts could facilitate transfer of lice; given the close phylogenetic relationships of the hosts, it would not seem too unlikely that transferred lice could establish a population on a host. Also the possibility of shed feathers, with lice on them, coming into contact with other birds may be a more likely method of transfer in mixed moulting flocks.

Trinoton querquedulae (Linnaeus, 1758) had been recovered prior to this study, from all three scoters. However, the finding of only one female nymph on a single surf scoter is suggestive that this louse may be a straggler on scoters. A possible explanation for its low incidence may lie in the number of moulting birds examined i.e. the majority of the *Trinoton* population may have been lost with the moulted feathers.

Acarina

A single acarine, *Freyana anatina* (Koch, 1844) was located on 6 (12.5%) of the surf and 6 (35.3%) of the black scoters examined. No data is available on intensity of infestation as only presence or absence was noted. A possible explanation for its low prevalence concerns its primary habitat i.e. the primary and secondary feathers of the wing. The fact that many birds were in heavy moult may have reduced its prevalence.

GENERAL DISCUSSION

A total of 16 (9.1%) of the 175 scoters examined were helminth free (8(8.5%) of the surf, 3(8.3%) of the white-winged and 5(11.1%) of the black scoters).

Surf scoters had the highest prevalence of nematodes and acanthocephalans, while white-winged scoters had the highest prevalence of trematodes and black scoters had the highest prevalence of cestodes. The Labrador sample of birds showed the highest prevalence for most helminths in all three host species. However, this latter fact may be misleading due to the small sample size. Table 13 details the infection of scoters by the major parasite groups and by sample area. In all cases, except two, Western Atlantic birds contained more species than the other sample areas (Table 14).

PARASITE DISTRIBUTION

"Parasitologists have known for a long time that individual species of parasites are found only in restricted, specific sites (or microhabitats) within their hosts, that the microhabitats occupied by some species are more restricted than those of others" (Holmes, 1973). It is well known that each organ and sometimes even different tissues may be regarded as unique environments for helminths due to morphological, biochemical and physiological differences. Further "site selection is predominately an active process on the part of the parasite; for some parasites at least, site selection is a continuing process, which may result in para-

TABLE 13. DETAILS OF INFECTION OF SCOTERS AND INDIVIDUAL SAMPLE AREAS BY THE MAJOR HELMINTH GROUPS.

PARASITE GROUP	ALL SCOTERS	SURF SCOTERS				WHITE-WINGED SCOTERS					BLACK SCOTERS			
	A	A	B	C	D	A	B	C	D	E	A	B	C	D
Trematoda	100(57.1)	55 (58.5)	3 (12.0)	29 (64.4)	23 (95.8)	28 (97.8)	1 (33.3)	17 (77.3)	5 (100.0)	5 (83.3)	17 (37.8)	7 (25.9)	5 (38.5)	5 (100.0)
Cestoda	108(61.7)	56 (59.6)	11 (44.0)	25 (55.6)	21 (87.5)	23 (63.8)	-	15 (68.2)	5 (100.0)	3 (50.0)	29 (64.4)	18 (66.7)	6 (46.2)	5 (100.0)
Nematoda	125(71.4)	77 (81.9)	10 (40.0)	44 (97.8)	23 (95.8)	22 (61.1)	1 (33.3)	12 (54.5)	5 (100.0)	4 (66.7)	26 (57.8)	10 (37.0)	13 (100.0)	3 (60.0)
Acanthocephala	33(18.9)	19 (20.2)	-	18 (40.0)	1 (4.2)	7 (19.4)	-	6 (27.3)	-	1 (16.7)	7 (15.6)	-	6 (46.2)	1 (20.0)

A = No. (%) infected
B = No. (%) of New Brunswick sample infected
C = No. (%) of British Columbia sample infected
D = No. (%) of Labrador sample infected
E = No. (%) of Norway sample infected

Table 14. Number of species of each major helminth group in birds from different sample areas.

PARASITE GROUP	SURF SCOTER		WHITE-WINGED SCOTER			BLACK SCOTER	
	A	B	A	B	C	A	B
Trematoda	11	10	8	9	3	5	12
Cestoda	1	2	2	1	1	2	2
Nematoda	10	11	5	6	2	7	8
Acanthocephala	2	2	1	0	1	1	2

A = Pacific sample
B = Western Atlantic sample (New Brunswick & Labrador samples combined)
C = Eastern Atlantic

NOTE: *Gymnophallus* spp. are excluded from this Table.
Also the no. of cestode species is a minimum.

sites alternating between different microhabitats; and the presence of other parasites may modify the microhabitat selected by a parasite." (Holmes, 1973). Thus, it is not too surprising to find a parasite in more than one area within a host or hosts.

Many authors list the area(s) parasites are recovered from but few list together all the parasites found in a given area. This is deceiving in that it masks the fact that parasites are found in communities. It is not a goal of this thesis to discuss the various communities that can occur in scoters but merely to give an idea that parasites are not solitary organisms, as they are often depicted. Therefore, the parasites will be listed with their respective environments to give an idea of the possible parasite communities as well as to indicate the areas in which they occurred and the preferred area/s if any (Table 15).

A further interesting aspect of this work relates to the geographical distribution of the parasites found. Not all parasites are evenly distributed throughout the geographical range of a host. The reasons for this include (1) absence of one or more intermediate hosts and (2) biotic factors e.g. water pH, temperature, water salinity, etc..

In this study, (see Table 16) 2 trematodes (*G. choledocus* and *G. deliciosus*), 1 genus of cestodes (*Hymenolepis*), 2 nematodes (*A. acutum* and *T. somateriae*) and 1 acanthocephalan (*P. botulus*) occurred across the geographical range of the hosts sampled. Four trematodes, 1 cestode and 2 nematodes were recovered only from the Pacific sample. Eight trematodes, 4 nematodes and 2 acanthocephalans were harboured only by Western Atlantic hosts. A single trematode *C. verrucosa* was the only parasite restricted to the Eastern

TABLE 15. DETAILS OF PARASITE LOCATIONS AND PARASITE COMMUNITIES POSSIBLE IN SCOTERS EXAMINED IN THIS STUDY.

	Esophagus	Proventriculus	Gizzard	Duodenum	SI_1	SI_2	SI_3	Caecum	Large Intestine	Cloaca	Bursa	Gall Bladder	Kidney	Body Cavity	Ureter
A. terrigalensis	-	-	-	1(7.7)	2(15.4)	1(7.7)	2(15.4)	-	3(23.0)	-	-	2(15.4)	-	3(23.1)	-
Z. lunata	-	-	-	-	-	-	-	3(100)	-	-	-	-	-	-	-
N. attenuatus	-	-	-	-	-	-	-	4(100)	-	-	-	-	-	-	-
C. verrucosa	-	-	-	-	-	-	-	3(100)	-	-	-	-	-	-	-
T. aloysiae	-	-	-	-	-	-	-	27(81.8)	4(12.1)	1(3.0)	-	-	-	1(3.0)	-
E. obtenua	-	-	-	-	-	-	-	2(28.6)	-	-	-	-	1(14.3)	4(57.1)	-
G. bursicola	-	-	-	1(4.8)	-	-	-	4(19.0)	-	5(23.8)	10(47.6)	-	-	1(4.8)	-
G. choledochus	-	-	-	-	-	-	-	-	-	4(33.3)	7(58.3)	1(8.3)	-	-	-
G. deliciosus	-	-	-	1(3.6)	-	-	1(3.6)	-	-	-	1(3.6)	24(85.7)	-	1(3.6)	-
Gymnophallus sp. Type 1	-	-	-	-	-	-	-	6(66.7)	-	1(11.1)	2(22.2)	-	-	-	-
Gymnophallus spp.	-	-	-	-	-	1(10.0)	1(10.0)	-	1(10.0)	1(10.0)	4(40.0)	1(10.0)	-	-	1(10.0)
Gymnophallid sp.	-	-	-	-	-	-	1(50.0)	1(50.0)	-	-	-	-	-	-	-
E. revolutum	-	-	-	-	1(50.0)	1(50.0)	-	-	-	-	-	-	-	-	-
D. agregia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
[illegible]	-	-	-	-	-	-	2(100)	-	-	-	-	-	-	-	-
A. melanittae	-	-	-	1(100.0)	-	-	-	-	-	-	-	-	-	-	-
Psilostomum sp.	-	-	-	1(11.1)	1(11.1)	3(33.3)	4(44.4)	-	-	-	-	-	-	-	-
A. charadriiformis	-	-	-	-	1(7.1)	4(28.6)	1(7.1)	5(35.7)	2(14.3)	1(7.1)	-	-	-	-	-
M. pygmaeus	-	-	-	-	-	-	1(100.0)	-	-	-	-	-	-	-	-
P. japonicus	-	-	-	1(7.1)	-	-	1(7.1)	8(57.1)	2(14.3)	-	-	2(14.3)	-	-	-
Renicola sp.	-	-	-	-	-	-	-	-	-	-	-	-	3(100.0)	-	-
C. strigeoides	-	-	-	-	-	1(50.0)	1(50.0)	-	-	-	-	-	-	-	-
A. burti	-	-	-	1(50.0)	1(50.0)	-	-	-	-	-	-	-	-	-	-
A. gracilis	-	-	-	-	-	1(50.0)	1(50.0)	-	-	-	-	-	-	-	-
Hymenolepis spp.	-	-	-	16(8.8)	64(35.4)	53(29.3)	27(14.9)	14(7.7)	2(1.1)	-	1(0.6)	-	-	4(2.2)	-
C. megalops	-	-	-	-	-	-	-	-	-	-	1(100.0)	-	-	-	-
Fimbriariinae	-	-	-	12(46.2)	7(26.9)	5(19.2)	-	-	-	-	-	-	-	2(7.7)	-
C. mustis	-	-	-	-	-	-	-	26(96.3)	-	-	-	-	-	1(100.0)	-
U. nyrocinarum	-	-	-	-	2(5.3)	4(10.5)	4(10.5)	-	-	-	1(2.6)	-	-	1(2.6)	-
A. acutum	1(1.3)	6(7.9)	66(86.8)	-	-	-	1(1.3)	-	-	-	-	-	-	2(2.6)	-
Amidostomum sp.	-	-	6(85.7)	-	-	-	-	-	-	-	-	-	-	1(14.3)	-
E. uncinatum	-	-	2(100.0)	-	-	-	-	-	-	-	-	-	-	-	-
S. californica	-	1(3.4)	28(96.6)	-	-	-	-	-	-	-	-	-	-	-	-
S. c. crassicauda	-	1(7.7)	11(84.6)	-	-	-	1(7.7)	1(1.6)	-	-	-	-	-	-	-
S. formosensis	-	1(6.3)	15(93.7)	-	-	-	-	-	-	-	-	-	-	-	-
Streptocara sp.	-	1(50.0)	1(50.0)	-	-	-	-	-	-	-	-	-	-	-	-
E. borealis	-	1(100.0)	-	-	-	-	-	-	-	-	-	-	-	-	-
E. hypognatha	1(3.3)	25(83.3)	4(13.3)	-	-	-	-	-	-	-	-	-	-	-	-
T. fissispina	1(10.0)	9(90.0)	-	-	-	-	-	-	-	-	-	-	-	-	-
T. americana	6(9.8)	45(73.8)	8(13.1)	1(1.6)	-	-	-	-	-	-	-	-	-	1(1.6)	-
T. spinosa	1(20.0)	4(80.0)	-	-	-	-	-	-	-	-	-	-	-	-	-
Tetrameres sp.	1(14.3)	5(71.4)	1(14.3)	-	-	-	-	-	-	-	-	-	-	-	-
Sarconema sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	1(100.0)	-
Nematode sp. (Type 1)	-	1(100.0)	-	-	-	-	-	-	-	-	-	-	-	-	-
P. altmani	-	-	-	-	-	1(100.0)	-	-	-	-	-	-	-	-	-
P. botulus	-	-	-	-	6(15.4)	15(38.5)	13(33.3)	-	-	-	-	-	-	1(2.6)	-
C. constrictum	-	-	-	-	-	-	1(100.0)	-	-	-	-	-	-	-	-
C. mobilis	-	-	-	-	1(5.9)	3(17.6)	11(64.7)	1(5.9)	1(5.9)	-	-	-	-	-	-

TABLE 15. DETAILS OF PARASITE LOCATIONS AND PARASITE COMMUNITIES POSSIBLE IN SCOTERS EXAMINED IN THIS ST

	Esophagus	Proventriculus	Gizzard	Duodenum	SI_1	SI_2	SI_3	Caecae	I
A. terrigalensis	-	-	-	1(7.7)	2(15.4)	1(7.7)	2(15.4)	-	3
Z. lunata	-	-	-	-	-	-	-	2(100)	
N. attenuatus	-	-	-	-	-	-	-	4(100)	
C. verrocusa	-	-	-	-	-	-	-	3(100)	
T. elegans	-	-	-	-	-	-	-	27(81.8)	4
E. castenea	-	-	-	-	-	-	-	2(28.6)	
G. bursicola	-	-	-	1(4.8)	-	-	-	4(19.0)	
G. choledocus	-	-	-	-	-	-	-	-	
G. delicuous	-	-	-	1(3.6)	-	-	1(3.6)	-	
Gymnophallus sp. Type 1	-	-	-	-	-	-	-	6(66.7)	
Gymnophallus spp.	-	-	-	-	-	1(10.0)	1(10.0)	-	1
Gymnophallid sp.	-	-	-	-	-	-	1(50.0)	1(50.0)	
E. revolutum	-	-	-	-	1(50.0)	1(50.0)	-	-	
D. egregia	-	-	-	-	-	-	-	-	
H. incisa	-	-	-	-	-	-	2(100)	-	
A. melanittae	-	-	-	1(100.0)	-	-	-	-	
Psilostomum sp.	-	-	-	1(11.1)	1(11.1)	3(33.3)	4(44.4)	-	
A. charadiformis	-	-	-	-	1(7.1)	4(28.6)	1(7.1)	5(35.7)	2
M. pygmaeum	-	-	-	-	-	-	1(100.0)	-	
P. japonicum	-	-	-	1(7.1)	-	-	1(7.1)	8(57.1)	2
Renicola sp.	-	-	-	-	-	-	-	-	
C. strigeiodes	-	-	-	-	-	1(50.0)	1(50.0)	-	
A. burti	-	-	-	1(50.0)	1(50.0)	-	-	-	
A. gracilis	-	-	-	-	-	1(50.0)	1(50.0)	-	
Hymenolepis spp.	-	-	-	16(8.8)	64(35.4)	53(29.3)	27(14.9)	14(7.7)	2
C. megalops	-	-	-	-	-	-	-	-	
Frimbriariinae	-	-	-	12(46.2)	7(26.9)	5(19.2)	-	-	
O. anatis	-	-	-	-	-	-	-	26(88.4)	
C. nyrocinarium	-	-	-	-	2(5.3)	4(10.5)	4(10.5)	-	
A. acutum	1(1.3)	5(7.9)	6(86.8)	-	-	-	1(1.3)	-	
Amidostium sp.	-	-	(85.7)	-	-	-	-	-	
E. uncinatum	-	-	(100.0)	-	-	-	-	-	
S. californica	-	1(3.4)	8(96.6)	-	-	-	-	-	
S. c. crassicauda	-	1(7.7)	1(84.6)	-	-	-	1(7.7)	1(1.6)	
S. formosensis	-	1(6.3)	5(93.7)	-	-	-	-	-	
St[illegible]	-	1(50.0)	(50.0)	-	-	-	-	-	

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... POSSIBLE IN SCOTERS EXAMINED IN THIS STUDY.

...num	SI_1	SI_2	SI_3	Caecae	Large Intestines	Cloaca	Bursa	Gall Bladder	Kidney	Body Cavity	Ureter
7)	2(15.4)	1(7.7)	2(15.4)	-	3(23.0)	-	-	2(15.4)	-	3(23.1)	-
	-	-	-	2(100)	-	-	-	-	-	-	-
	-	-	-	4(100)	-	-	-	-	-	-	-
	-	-	-	3(100)	-	-	-	-	-	-	-
	-	-	-	27(81.8)	4(12.1)	1(3.0)	-	-	-	1(3.0)	-
	-	-	-	2(28.6)	-	-	-	-	1(14.3)	4(57.1)	-
3)	-	-	-	4(19.0)	-	4(23.8)	10(47.6)	-	-	1(4.8)	-
	-	-	-	-	-	4(33.3)	7(58.3)	1(3.0)	-	-	-
5)	-	-	1(3.6)	-	-	-	1(3.6)	24(85.7)	-	1(3.6)	-
	-	-	-	6(66.7)	-	1(11.1)	2(22.2)	-	-	-	-
	-	1(10.0)	1(10.0)	-	1(10.0)	1(10.0)	4(40.0)	1(10.0)	-	-	1(10.0)
	-	-	1(50.0)	1(50.0)	-	-	-	-	-	-	-
	1(50.0)	1(50.0)	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-
	-	-	2(100)	-	-	-	-	-	-	-	-
.0)	-	-	-	-	-	-	-	-	-	-	-
.1)	1(11.1)	3(33.3)	4(44.4)	-	-	-	-	-	-	-	-
	1(7.1)	4(28.6)	1(7.1)	5(35.7)	2(14.3)	1(7.1)	-	-	-	-	-
	-	-	1(100.0)	-	-	-	-	-	-	-	-
1)	-	-	1(7.1)	8(57.1)	2(14.3)	-	-	2(14.3)	-	-	-
	-	-	-	-	-	-	-	-	3(100.0)	-	-
	-	1(50.0)	1(50.0)	-	-	-	-	-	-	-	-
.0)	1(50.0)	-	-	-	-	-	-	-	-	-	-
	-	1(50.0)	1(50.0)	-	-	-	-	-	-	-	-
.8)	64(35.4)	53(29.3)	27(14.9)	14(7.7)	2(1.1)	-	1(0.6)	-	-	4(2.2)	-
	-	-	-	-	-	-	1(100.0)	-	-	-	-
.2)	7(26.9)	5(19.2)	-	-	-	-	-	-	-	2(7.7)	-
	-	-	-	26(88.4)	-	-	-	-	-	1(100.0	-
	2(5.3)	4(10.5)	4(10.5)	-	-	-	1(2.6)	-	-	1(2.6)	-
	-	-	1(1.3)	-	-	-	-	-	-	2(2.6)	-
	-	-	-	-	-	-	-	-	-	1(14.3)	-
	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-
	-	-	1(7.7)	1(1.6)	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-

G. choledocus	-	-	-	-	-	-			
G. delicuous	-	-	-	1(3.6)	-	I	1(3.6)	-	
Gymnophallus sp. Type 1	-	-	-	-	-	-	-	6(66.7)	
Gymnophallus spp.	-	-	-	-	-	1(10.0)	1(10.0)	-	1(
Gymnophallid sp.	-	-	-	-	-	-	1(50.0)	1(50.0)	
E. revolutum	-	-	-	-	1(50.0)	1(50.0)	-	-	
D. egregia	-	-	-	-	-	-	-	-	
H. incisa	-	-	-	-	-	-	2(100)	-	
A. melanittae	-	-	-	1(100.0)	-	-	-	-	
Psilostomum sp.	-	-	-	1(11.1)	1(11.1)	3(33.3)	4(44.4)	-	
A. charadriformis	-	-	-	-	1(7.1)	4(28.6)	1(7.1)	5(35.7)	2(
M. pygmaeum	-	-	-	-	-	-	1(100.0)	-	
P. japonicum	-	-	-	1(7.1)	-	-	1(7.1)	8(57.1)	2(
Renicola sp.	-	-	-	-	-	-	-	-	
C. strigeiodes	-	-	-	-	-	1(50.0)	1(50.0)	-	
A. burti	-	-	-	1(50.0)	1(50.0)	-	-	-	
A. gracilis	-	-	-	-	-	1(50.0)	1(50.0)	-	
Hymenolepis spp.	-	-	-	16(8.8)	64(35.4)	53(29.3)	27(14.9)	14(7.7)	2
C. megalope	-	-	-	-	-	-	-	-	
Frimbriariinae	-	-	-	12(46.2)	7(26.9)	5(19.2)	-	-	
C. anatis	-	-	-	-	-	-	-	26(88.4)	
C. nyrocinarium	-	-	-	-	2(5.3)	4(10.5)	4(10.5)	-	
A. acutum	1(1.3)	6(7.9)	66(86.8)	-	-	-	1(1.3)	-	
Amidostium sp.	-	-	6(85.7)	-	-	-	-	-	
E. uncinatum	-	-	2(100.0)	-	-	-	-	-	
S. californica	-	1(3.4)	28(96.6)	-	-	-	-	-	
S. c. crassicauda	-	1(7.7)	11(84.6)	-	-	-	1(7.7)	1(1.6)	
S. formosensis	-	1(6.3)	15(93.7)	-	-	-	-	-	
Streptocara sp.	-	1(50.0)	1(50.0)	-	-	-	-	-	
E. borealis	-	1(100.0)	-	-	-	-	-	-	
E. hypognatha	1(3.3)	25(83.3)	4(13.3)	-	-	-	-	-	
T. fissispina	1(10.0)	9(90.0)	-	-	-	-	-	-	
T. somateriae	6(9.8)	45(73.8)	8(13.1)	1(1.6)	-	-	-	-	
T. spinosa	1(20.0)	4(80.0)	-	-	-	-	-	-	
Tetrameres sp.	1(14.3)	5(71.4)	1(14.3)	-	-	-	-	-	
Sarconema sp.	-	-	-	-	-	-	-	-	
Nematode sp. (Type 1)	-	1(100.0)	-	-	-	-	-	-	
F. altmani	-	-	-	-	-	1(100.0)	-	-	
P. botulus	-	-	-	-	6(15.4)	15(38.5)	13(33.3)	-	
C. constrictum	-	-	-	-	-	-	1(100.0)	-	
C. sudsuche	-	-	-	-	1(5.9)	3(17.6)	11(64.7)	1(5.9)	

3of

-	-	-	-	-	-	[illegible]	[illegible]	[illegible]	-	-	-
.6)	-	-	1(3.6)	-	-	-	1(3.6)	24(85.7)	-	1(3.6)	-
-	-	-	-	6(66.7)	-	1(11.1)	2(22.2)	-	-	-	-
	-	1(10.0)	1(10.0)	-	1(10.0)	(10.0)	4(40.0)	1(10.0)	-	-	1(10.0)
-	-	-	1(50.0)	1(50.0)	-	-	-	-	-	-	-
-	1(50.0)	1(50.0)	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-
-	-	-	2(100)	-	-	-	-	-	-	-	-
0.0)	-	-	-	-	-	-	-	-	-	-	-
.1)	1(11.1)	3(33.3)	4(44.4)	-	-	-	-	-	-	-	-
	1(7.1)	4(28.6)	1(7.1)	5(35.7)	2(14.3)	(7.1)	-	-	-	-	-
	-	-	1(100.0)	-	-	-	-	-	-	-	-
.1)	-	-	1(7.1)	8(57.1)	2(14.3)	-	-	2(14.3)	-	-	-
	-	-	-	-	-	-	-	-	3(100.0)	-	-
-	-	1(50.0)	1(50.0)	-	-	-	-	-	-	-	-
.0)	1(50.0)	-	-	-	-	-	-	-	-	-	-
	-	1(50.0)	1(50.0)	-	-	-	-	-	-	-	-
.8)	64(35.4)	53(29.3	27(14.9)	14(7.7)	2(1.1)	-	1(0.6)	-	-	4(2.2)	-
	-	-	-	-	-	-	1(100.0)	-	-	-	-
6.2)	7(26.9)	5(19.2)	-	-	-	-	-	-	-	2(7.7)	-
	-	-	-	26(88.4)	-	-	-	-	-	1(100.0)	-
	2(5.3)	4(10.5)	4(10.5)	-	-	-	1(2.6)	-	-	1(2.6)	-
-	-	-	1(1.3)	-	-	-	-	-	-	2(2.6)	-
	-	-	-	-	-	-	-	-	-	1(14.3)	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	1(7.7)	1(1.6)	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
6)	-	-	-	-	-	-	-	-	-	1(1.6)	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	1(100.0)	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	1(100.0)	-	-	-	-	-	-	-	-	-
-	6(15.4)	15(38.5)	13(33.3)	-	-	-	-	-	-	1(2.6)	-
-	-	-	1(100.0)	-	-	-	-	-	-	-	-
-	1(5.9)	3(17.6)	11(64.7)	1(5.9)	1(5.9)	-	-	-	-	-	-

4 of 4

TABLE 16. GEOGRAPHICAL DISTRIBUTION OF HELMINTH PARASITES RECOVERED FROM SCOTERS IN THIS STUDY.

PARASITE	A	B	C
A. terrigalensis	-	+	-
Z. lunata	+	-	-
N. attenuatus	+	+	-
C. verrucosa	-	-	+
T. elegans	+	+	-
E. castenea	+	+	-
G. bursicola	+	+	-
G. choledocus	+	+	+
G. deliciosus	+	+	+
Gymnophallus sp. Type 1	-	+	-
Gymnophallid sp.	-	+	-
Gymnophallus spp.	+	-	-
E. revolutum	-	+	-
D. ergregia	+	-	-
H. incisa	-	+	-
A. melanittae	+	-	-
Psilostomum sp.	+	-	-
A. charadriformis	+	-	-
M. pygmaeum	-	+	-
P. japonicum	+	-	-
Renicola sp.	+	+	-
C. strigeoides	-	+	-
A. burti	-	+	-
A. gracilis	-	+	-
Hymenolepis spp.	+	+	+
C. megalops	+	-	-
Fimbriariinae	+	+	-
C. anatis	-	+	-
C. nyrocinarum	+	+	-

TABLE 16. CONTINUED

PARASITE	A	B	C
A. acutum	+	+	+
Amidostomum sp.	+	+	–
E. uncinatum	+	+	–
S. californica	+	–	–
S. c. crassicadua	+	+	–
S. formosensis	+	+	–
Streptocara sp.	+	–	–
E. borealis	+	–	–
E. hypognatha	+	+	–
T. fissispina	+	+	–
T. somateriae	+	+	+
T. spinosa	+	+	–
Tetrameres sp.	+	–	+
Sarconema sp.	–	+	–
Nematode sp. Type 1	–	+	–
P. altmani	–	+	–
P. botulus	+	+	+
C. constrictum	–	+	–
C. sudsuche	+	+	–

A = Pacific sample
B = Eastern Atlantic sample
C = Western Atlantic sample

Atlantic hosts. It is apparent from Table 16 that the hosts in the Western Atlantic carried the greatest number of species.

A number of new host records were established during the course of this work (Table 17). *Tristriata elegans*, *D. ergregia*, *P. japonicium* and *C. sudsuche* are reported from North America for the first time. In addition, 4 parasites were recorded from Canada for the first time; namely, *C. strigeiodes*, *A. burti*, *C. constrictum* and *F. altmani*. *Tetrameres somateriae* were recorded from Europe for the first time.

To further address parasite distribution cluster analysis was performed on the data to determine if birds from a certain locality were more similar to birds from the same locality with respect to their parasite fauna than to birds from other localities. This would tell the author whether or not a bird or a sample of birds could be separated from birds in other sample areas examined on the basis of their helminth fauna. Due to the fact that Hymenolepids and some specimens of *Gymnophallus* were not identified to the species level these groups of parasites were omitted from the analysis. It is unfortunate that the hymenolepids were not identified to the species level as it is likely that the different geographical areas sampled would have yielded different species within the genus. If this hypothesis is true then the hymenolepids would have caused birds from different geographical areas to be more similar to other birds from their area than to birds from any of the other areas sampled.

TABLE 17. NEW HOST RECORDS NOTED IN THIS STUDY.

SURF SCOTER	WHITE-WINGED SCOTER	BLACK SCOTER
A. terrigalensis	*A. terrigalensis*	*A. terrigalensis*
Z. lunata	*G. deliciosus*	*E. castenea*
N. attenuatus	*D. ergregia*	*G. choledocus*
T. elegans	*A. charadriformis*	*A. charadriformis*
E. castenea	*Renicola* sp.	*P. japonicum*
G. choledocus	*T. somateriae*	*C. strigeoides*
G. deliciosus	*T. spinosa*	*A. burti*
A. melanittae	*P. botulus*	*T. somateriae*
A. charadriformis		*T. spinosa*
P. japonicum		*P. botulus*
A. gracilis		*A. icterodes*
C. nyrocinarum		*H. loomisii*
A. acutum		
E. borealis		
E. hypognatha		
T. fissispina		
T. somateriae		
T. spinosa		
Sarconema sp.		
P. botulus		
C. sudsuche		
A. dentatus		
A. icterodes		
H. leuxocanthum		
H. loomisii		

"Cluster analysis is a multivariate approach to sorting data into groups so that members of any particular group are more similar to each other than to non members" (Bush, 1980). In this study, the average linkage method was employed with Jaccard's coefficient (see Wishart, 1978). Cluster analysis, in this study, is used as a technique to reduce data with the resulting dendrogram depicting the similarity of individual birds based on presence of helminth species.

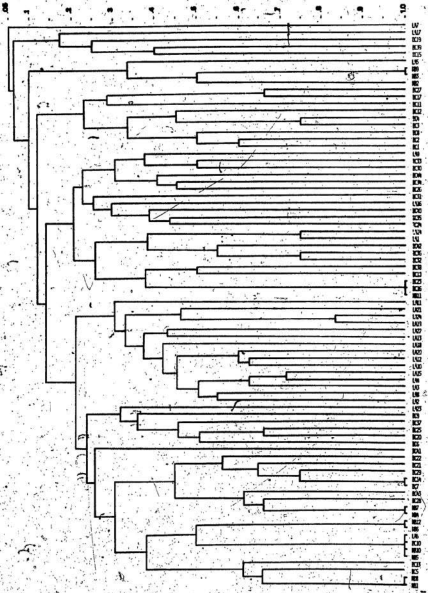
Cluster analysis was performed individually on each of the three bird species and on the three bird species as a group. The reason for the latter was to see if the three species of birds could be seperated on the basis of presence of specified helminths in their parasite faunas.

Figures 3, 4 and 5 depict the result of cluster analysis on surf, white-winged and black scoters respectively. Due to the very low levels of similarity displayed in each dendrogram, it is, therefore, not possible to separate birds of either species on the basis of presence of helminths in their parasite faunas by geographical areas. This, however, is not to say that certain individual birds would not be able to be separated by a certain parasite e.g. the presence of *Psilostomum* sp. would strongly suggest that the bird came from British Columbia. Overall, one can state that due to the high levels of similarity that the parasite fauna of scoters, for the most part, is independent of geography.

The cluster analysis performed on all three species of birds together did not allow the author to separate either of the three

FIGURE 3.

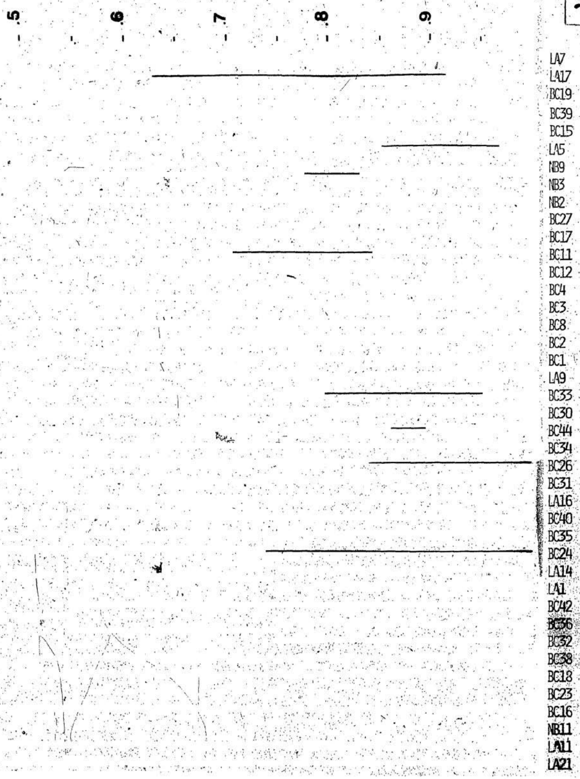
Cluster analysis comparing individual surf scoters with respect to presence of helminth species.



.05 .1 .2 .3 .4 .5 .6

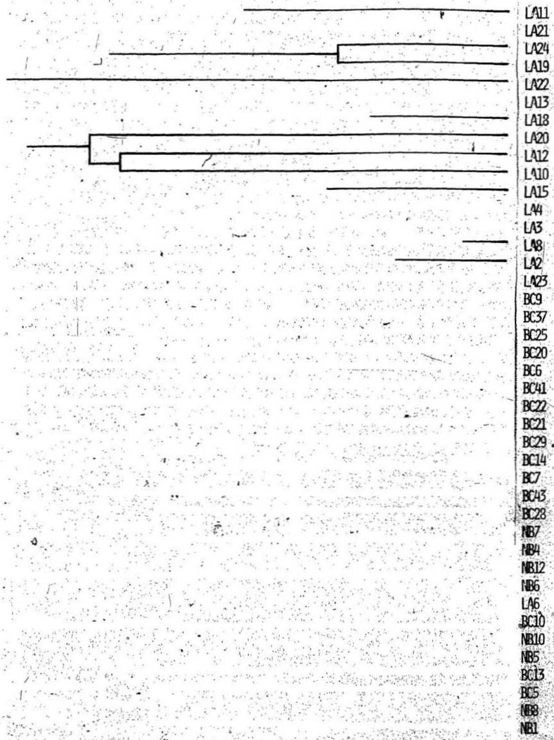
1of

2 of



5
6
7
8
9
LA7
LA17
BC19
BC39
BC15
LA5
NB9
NB3
NB2
BC27
BC17
BC11
BC12
BC4
BC3
BC8
BC2
BC1
LA9
BC33
BC30
BC44
BC34
BC26
BC31
LA16
BC40
BC35
BC24
LA14
LA1
BC42
BC36
BC32
BC38
BC18
BC23
BC16
NB11
LA11
LA21

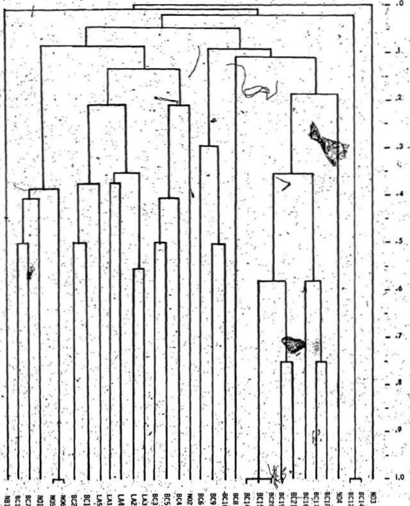
3of


LA11
LA21
LA24
LA19
LA22
LA13
LA18
LA20
LA12
LA10
LA15
LA4
LA3
LA8
LA2
LA23
BC9
BC37
BC25
BC20
BC6
BC41
BC22
BC21
BC29
BC14
BC7
BC43
BC28
NB7
NB4
NB12
NB6
LA6
BC10
NB10
NB5
BC13
BC5
NB8
NB1

4 of 4

FIGURE 4.

Cluster analysis comparing individual white-winged scoters with respect to presence of helminth species.


.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
NB1
BC1
BC7
NO1
NO5
NO6
BC2
BC11
LA5
LA1
LA4
LA2
LA3
BC3
BC5
BC4
NO2
BC6
BC9
BC10
BC8
BC14
BC15
BC20
BC19
BC21
BC16
BC17
BC18
NO4
BC12
BC14
NO3

1of

2 of 2

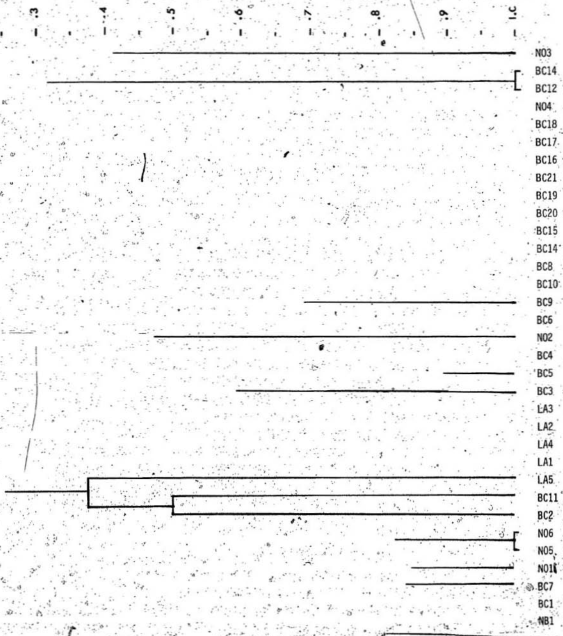
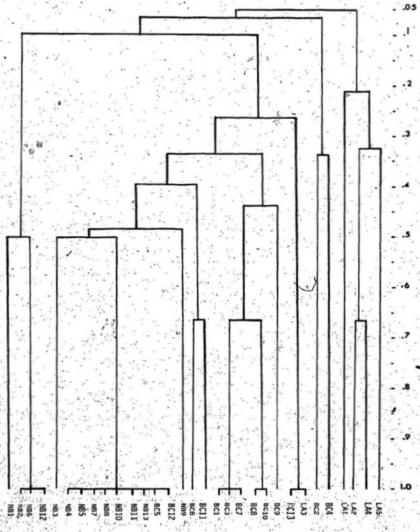

.3
.4
.5
.6
.7
.8
.9
1.0
NO3
BC14
BC12
NO4
BC18
BC17
BC16
BC21
BC19
BC20
BC15
BC14
BC8
BC10
BC9
BC6
NO2
BC4
BC5
BC3
LA3
LA2
LA4
LA1
LA5
BC11
BC2
NO6
NO5
NO1
BC7
BC1
NB1

FIGURE 5.

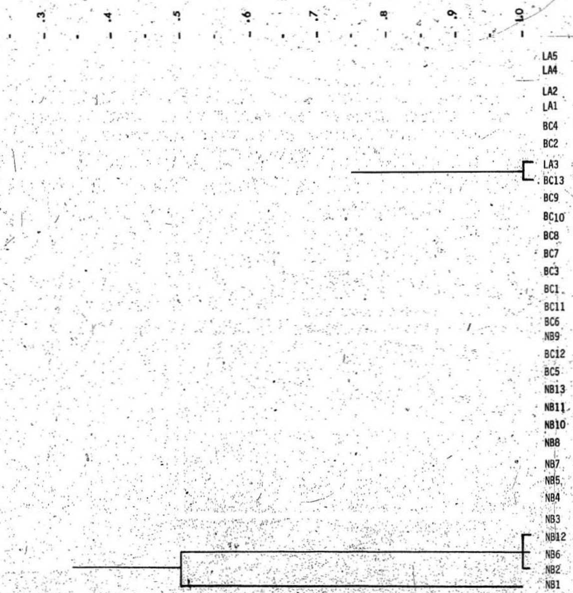
Cluster analysis comparing individual black scoters with respect to presence of helminth species.


.05
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
NB1
NB2
NB6
NB12
NB3
NB4
NB5
NB7
NB8
NB10
NB11
NB13
BC5
BC12
NB9
BC6
BC11
BC1
BC3
BC7
BC8
BC10
BC9
BC13
LA3
BC2
BC4
LA1
LA2
LA4
LA5

1of

.05 .1 .2 .3 .4 .5 .6 .7 .8 .9

2 of 2


.3
.4
.5
.6
.7
.8
.9
1.0
LA5
LA4
LA2
LA1
BC4
BC2
LA3
BC13
BC9
BC10
BC8
BC7
BC3
BC1
BC11
BC6
NB9
BC12
BC5
NB13
NB11
NB10
NB8
NB7
NB5
NB4
NB3
NB12
NB6
NB2
NB1

host species by presence of helminths in their parasite faune. This is what one might expect when one considers the close phylogenetic relationship of the three hosts. While they do occupy different niches and their diets differ (see Cottam, 1939), they have very similar parasite faunas, which can be used as further evidence for the supression of the genus *Oidemia* as discussed in the Introduction.

HOST SPECIFICITY

Researchers have long recognized two basic types of parasite-host specificity i.e. phylogenetic and ecological specificity. Phylogenetic specificity deals with those parasites that have evolved with their hosts and form a very close relationship. Often this relationship is so intimate that the parasite can only develop in its "natural host". Ecological specificity refers to parasites that develop in many hosts (their host requirements are not stringent) with the limiting factor most often being the chance of a host consuming the right intermediate host. Ryšavý (1966) states "The composition of the fauna of cestodes, parasitizing birds of various orders or families, does not only depend on their phylogenetic relations but also on the way of living and the composition of their food." Therefore, the biology of the host is as important as or more important in ecological specificity than the diet of the host.

In addition, an animal that is a member of a large group of closely related animals (eg. an anatid) has the possibility of more potential parasites than does an animal that belongs to a small group. In ecological specificity the possibility of infection rests largely on a host organism eating an infected intermediate host which in turn depends largely on the number of parasites seeding an area. Most animal species have a primary food item with their diet being supplemented by secondary and tertiary food items. These secondary and tertiary food items in the diet of one anatid may be the primary food item in the diet of another anatid, thus, making it possible for a parasite to have many natural hosts, with certain hosts having a higher prevalence of certain parasites.

This leads to the problem of trying to classify the parasites of a host. Given the present knowledge of the life-cycles and ecology of many parasites, it is probably easier to classify a parasite as an inhabitant of a higher taxon rather than a species. A modification of the system devised by McDonald (1969b) that categorizes parasites as accidental, rare, infrequent, frequent, common or very common will be employed in this work. A scheme such as this is much more accurate as it can take many studies into account. As in this study, the classifications of a parasite that was only recovered from a single host is questionable.

Table 18 lists the category that each parasite falls into and compares it to McDonald's (1969b) scheme. The status of some parasites (as given in this study) may change as further work is done. In addition to categorizing the parasites for each host species, they are also classified according to geographical origin, as their status changes with the environment.

TABLE 18. CATEGORIZATION OF PARASITES RECOVERED IN THIS STUDY.

PARASITE	SURF SCOTER			WHITE-WINGED SCOTER				BLACK SCOTER			McDONALD'S CATEGORIZATION FOR WATERFOWL
	A	B	D	A	B	C	D	A	B	D	
A. terrigalensis	-	freq	inf.	-	freq	-	inf.	-	inf.	inf.	rare
Z. lunata	rare	-	rare	-	-	-	-	-	-	-	comm. (char.)
N. attenuatus	-	rare	rare	rare	-	-	rare	-	rare	rare	V. comm. (char.)
C. verrucosa	-	-	-	-	-	comm	inf.	-	-	-	-
T. elegans	freq	comm	freq	-	comm	-	inf.	-	-	-	-
E. castenea	rare	rare	rare	inf.	inf.	-	inf.	inf.	rare	rare	-
G. bursicola	freq	inf.	inf.	rare	inf.	-	inf.	freq	rare	inf.	inf.
G. choledocus	rare	inf.	inf.	rare	inf.	freq	inf.	rare	-	rare	freq.
G. deliciosus	rare	freq	inf.	freq	comm	comm	comm	-	freq	inf.	inf.
Gymnophallus sp. Type1	-	inf.	rare	-	comm	-	inf.	-	freq	rare	-
gymnophallid	-	rare	rare	-	-	-	-	-	freq	rare	-
E. revolutum	-	-	-	-	-	-	-	-	rare	rare	V. comm. (char.)
D. egregia	-	-	-	comm	-	-	freq	-	-	-	-
H. incisa	-	-	-	-	inf.	-	rare	-	rare	rare	rare
A. melanittae	rare	-	rare	-	-	-	-	-	-	-	rare
Psilostomum sp.	freq	-	inf.	-	-	-	-	-	-	-	-
A. charadriformis	inf.	-	rare	rare	-	-	rare	freq	-	rare	acc.
M. pygmaeum	-	-	-	-	-	-	-	-	rare	rare	comm.

TABLE 18. CONTINUED.

PARASITES	SURF SCOTER			WHITE-WINGED SCOTER				BLACK SCOTER			McDONALD'S CATEGORIZATION FOR WATERFOWL
	A	B	D	A	B	C	D	A	B	D	
P. japonicum	inf.	-	rare	freq	-	-	inf.	inf.	-	rare	-
Renicola sp.	inf.	-	rare	freq	-	-	rare	-	-	-	-
C. strigeoides	-	-	-	-	-	-	-	-	rare	rare	rare
A. burti	-	-	-	-	-	-	-	-	rare	rare	rare
A. gracilis	-	rare	rare	-	-	-	-	-	-	-	V. comm. (char.)
C. megalops	-	-	-	rare	-	-	rare	-	-	-	V. comm. (char.)
Fimbriariinae	-	freq	inf.	-	-	-	-	rare	freq	inf.	freq.
C. anatis	-	rare	rare	-	-	-	-	-	-	-	V. comm. (char.)
C. nyrocinarum	inf.	rare	inf.	comm	v.comm	-	comm	inf.	rare	rare	probably freq.
A. acutum	comm	comm	comm	freq	comm.	comm	comm	v.comm	comm	comm	V. comm. (char.)
E. uncinatum	-	-	-	-	-	-	-	inf.	rare	rare	V. comm. (char.)
S. californica	comm	-	freq	rare	-	-	rare	v.comm	-	freq	inf.
S. c. crassicauda	inf.	rare	inf.	-	inf.	-	rare	freq.	rare	inf.	V. comm. (char.)
S. formosensis	inf.	inf.	inf.	-	inf.	-	rare	-	-	-	inf.
E. borealis	rare	-	rare	-	-	-	-	-	-	-	rare
E. hypognatha	comm	inf.	freq	-	-	-	-	comm.	inf.	freq	inf.

TABLE 18. CONTINUED

PARASITE	SURF SCOTER			WHITE-WINGED SCOTER				BLACK SCOTER			McDONALD'S CATEGORIZATION FOR WATERFOWL
	A	B	D	A	B	C	D	A	B	D	
T. fissispina	inf.	inf.	inf.	rare	-	-	rare	inf.	inf.	inf.	V. comm. (char.)
T. somateriae	comm	comm	comm	freq	comm.	comm	freq	-	rare	rare	inf.
T. spinosa	rare	rare	rare	-	inf.	-	rare	-	rare	rare	comm. in Athyini in N.A.
Sarconema sp.	-	rare	rare	-	-	-	-	-	-	-	-
Nematode sp. Type 1	-	rare	rare	-	-	-	-	-	-	-	-
F. altmani	-	rare	rare	-	-	-	-	-	-	-	rare
P. botulus	inf.	-	inf.	freq	-	freq	freq	comm.	rare	freq	freq.
C. constrictum	-	-	-	-	-	-	-	-	rare	rare	inf.
C. sudsuche	freq	rare	inf.	-	-	-	-	-	-	-	-

V. comm. - Very Common 60%
Comm. - Common 30% 60%
freq. - frequent 15% 30%
inf. - infrequent 5% 15%
rare - rare 5%
acc. - accidental (Parasite does not mature in host)
char. - characteristic for waterfowl

A - Pacific
B - Western Atlantic
C - Eastern Atlantic
D - Overall

NOTE: *Gymnophallus* spp. and *Hymenolepis* spp. are omitted.

LIFE-CYCLES

The genus *Melanitta*, Tribe Mergini, are known to breed in a freshwater environment and inhabit the marine environment for their non-breeding season. The males of the genus spend very little time in the freshwater environment as they depart from the breeding grounds after the nest is built whence they undergo a migration to the sea to moult.

Our lack of knowledge of the life-cycle of many anatid parasites makes it difficult to assess the percentage of scoter parasites that carry out their larval life-cycle in the marine or freshwater environment; although it is possible, in many cases to predict with some degree of accuracy the most likely environment in which the parasite completes its life-cycle. Table 19 details the environment in which certain known life-cycles are completed and gives speculations on others. The life-cycle is presently known for 22 of the parasites recovered in this study; of these 22, 13 (59.0%) can complete their life-cycle in the marine environment and the same number in the freshwater environments (Note: 4 (18.0%) can complete their life-cycle in either environment). Thus, the scoters examined harboured more parasites which cycle through the marine environment than the freshwater environment. Of the 15 parasites believed to have freshwater life-cycles, 5 (*E. revolutum*, *C. strigeiodes*, *A. burti*, *E. borealis* and *C. constrictum*) were only located in immature females and 2 (*A. gracilis* and *C. megalops*) only in immature males. This means that adult males harboured 8 (53.0%)

TABLE 19. ENVIRONMENT IN WHICH PARASITE LIFE-CYCLES ARE COMPLETED.

			UNKNOWN but probably	
MARINE	FRESHWATER	BOTH	MARINE	FRESHWATER
Trematoda:	Trematoda:	Nematoda:	Trematoda:	Trematoda:
A. terrigalensis	*Z. lunata*	*C. anatis*	*T. elegans*	*C. strigeoides*
G. bursicola	*N. attenuatus*	*S. c. crassicauda*	*D. ergregia*	*A. burti*
G. choledocus	*E. revolutum*	*S. formosensis*	*Psilostomum* sp.	
G. deliciosus	*A. gracilis*	*T. fissispina*	*H. incisa*	Cestoda:
A. melanittae	*C. verrucosa*		*Renicola* sp.	*Hymenolepis s.l.*
A. charadriformis				
M. pygmaeum	Cestoda:		Nematoda:	Nematoda:
Gymnophallus sp. Type 1	*C. megalops*		*C. nyrocinarum*	*E. hypognatha*
Gymnophallid sp.	Fimbriariinae		*S. californica*	*E. borealis*
			T. somateriae	*E. uncinatum*
	Nematoda:			
	T. spinosa		Acanthocephala:	
			F. altmani	
	Acanthocephala:		*C. sudsuche*	
	C. constrictum			

Life-cycle unknown:
Trematoda:
- *E. castenea*
- *P. japonicum*

Nematoda:
- *Sarconema* sp. utilizes a dipteran vector
- Nematode sp. (Type 1)

of the freshwater species of parasites while males in general harboured 10(66.7%) and females 13(87.0%). Of the marine parasites males contained 21 (91.0%) and females 19 (83.0%). This is possibly the result of the male moult migration which causes them to spend more time in the sea.

THE INFLUENCE OF AGE & SEX OF THE HOST ON PARASITE BURDEN

Büscher (1965) stated that "the extensity and intensity of invasion of parasites is greater in juvenile ducks then in adults." The reason for this was believed to be that young ducks probably did not acquire an age immunity to parasite infection for some time after hatching (within their first year of life). The immature birds necropsied in this study were prebreeding birds (as stated in the Introduction), however, they all contained a Bursa of Fabricius. In the strictest sense the results of Buscher (1965) and other workers in this area do not apply to the immature birds in this study. However, the author feels that it is important that this theory be checked utilizing two recognizable age classes; namely, prebreeding (bursate) and breeding adult birds.

Bychovskaja-Pavlovskaja (1962, *vide* Graham, 1966) stated that "the trematode fauna is more diverse in adults then in immatures", with Graham (1966) noting that this fact can be extended to include the total helminth fauna.

Table 20 lists the parasites found only in immature and adult birds respectively. A total of 43 species of helminths were re-

TABLE 20. Parasites found to occur in only immature or adult birds.

IMMATURE BIRDS	ADULT BIRDS
	A. terrigalensis
E. revolutum	*D. ergregia*
G. choledocus	*H. incisa*
C. strigeoides	*A. melanittae*
A. burti	*Psilostomun* sp.
A. gracialis	*C. verracusa*
C. anatis	
E. borealis	
Nematode sp. I	
Sarconema sp.	
F. altmani	
C. constrictum	
C. megalops	

covered in this study with immatures harbouring 37 species and adults 30 species. This contradicts both Bychovskaia-Pavlovskaia (1962) and Graham (1966) as the trematode fauna of immature birds was as diverse as that of adults and immature birds had a more diverse nematode, cestode and acanthocephalan fauna than adult birds.

To further address the question of age and sex influences on parasite G-tests (see Sokal and Rohlf, 1969) were performed on the data in Appendix 3 (i.e. the number of infected and uninfected adult males was run against the number of infected and uninfected females for each age class by individual parasites). The same procedure was carried out for total adults versus total immatures, total males versus total females and total immature males versus total immature females.

The result of this would tell if a parasite occurred in significantly more adult male than adult female birds, more immature male than immature female birds, more adult than immature birds or more male than female birds. All the aforementioned tests were carried out for the surf scoters with only the total immature male versus total immature not being performed on the black scoter and total adult male versus total adult female and total immature female versus total immature male not being performed on the white-winged scoters. The reason for these tests not being performed on the white-winged and black scoters was that the sample size of birds was less than 5.

The following parasites infected significantly (G 3.814 with 1 degree of freedom at the .05 level) more immature surf scoters than adult scoters; *G. choledocus*, *G. bursicola*, *Hymenolepis* spp., Frimbriariinae, *S. c. crassicauda*, *S. formosensis*, *E. hypognatha*, *C. nyrocinarum*, *T. fissispina* and *T. somateriae*. *Hymenolepis* spp. also preferred immature males to immature females. *Gymnophallus choledocus* preferred immature white-winged scoters to adult white-winged scoters and Frimbriariinae and *C. nyrocinarum* preferred immature black scoters to adult black scoters, while *S. californica* preferred female black scoters to male black scoters. In no instance did any parasite infect significantly more adult than immature birds. These data indicate that the extensity of invasion for immature birds was greater than that of adults for the forementioned parasites and species.

The reasons for this include the following possibilities: (1) immature (prebreeding) birds have not yet acquired the level of immunity to parasites that adult birds have (as yet there has been no physiological study to prove or disporve this statement). (2) that their diets differ from breeding birds - different ecological habitats i.e. breeding birds tend to spend more time on the breeding grounds which restricts their foraging range or (3) differences in their biology.

Since there was a significant difference in the extensity of invasion of certain parasites in certain host species of given age and sex, the author used a Mann-Whitney U-test (see Sokal and Rohlf, 1969) to determine if there was a significant difference in the intensity of helminth infection between immatures and adults. The results of these tests all proved to be insignificant. This suggests that the observed significant differences in extensity of invasion of certain species and sexes may more likely be due to dietary differences.

SUMMARY

1. One hundred and seventy-five scoters from 4 locations (British Columbia, New Brunswick, Labrador and Norway) were necropsied for metazoan parasites. A total of 94 surf, 36 white-winged and 45 black scoters were examined.

2. Ninety-one percent (86 surf, 33 white-winged and 40 black scoters) of the specimens examined contained parasites.

3. A total of 37 genera and approximately 50 species of metazoan parasites were recovered. More specifically, Necropsies yielded 29 genera (39 species), 21 genera (28 species) and 25 genera (33 species) of parasites from the surf, white-winged and black scoters respectively.

4. Parasite species are considered individually and their prevalence and intensity of infection is noted for each host species.

5. The locations in which parasites were found are discussed and are presented in tabular form with the number and percent of times a parasite occurred in a given area.

6. The geographical distribution of helminth parasites found in this study is presented in tabular form.

7. Cluster analysis revealed that species of hosts nor individuals of a species of a certain host could not be separated geographically based on the degree of similarity in their parasite faunas.

8. A total of 45 new host records (25 for the surf, 8 for the white-winged and 12 for the black scoter) were noted as well as 4 North American, 4 Canadian and 1 European Record.

9. The helminth parasites were categorized for each host and this categorization was compared to that of McDonald's (1969) categorization for waterfowl.

10. It was shown that there was no difference in the intensity of helminth infection in immature versus adult scoters.

11. Finally, a checklist of parasites which have been recovered from these hosts was compiled and included as an appendix to this manuscript.

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Appendix 1. Checklist, compiled from original papers and other checklists, of Metazoan parasites recovered from the Surf Scoter, White-Winged Scoter and Black Scoter (excluding Acarina).

SURF SCOTER	
PARASITE	REFERENCE
Anaticola crassicornis constrictus (Kellogg, 1896)	Emerson, 1972
Trinoton querquedulae (Linnaeus, 1758)	Emerson, 1972
Tristriata anatis Belopol'skaia, 1953	Frame, 1969
Gymnophallus bursicola Odhner, 1900	Yamaguti, 1939
Gymnophallus somateriae Ching, 1973	Ching, 1973
Meiogymnophallus multigemulus Ching, 1975	Ching, 1975
Parvatrema lintoni James, 1964	Linton, 1928
Myxolepis collaris (Batsch, 1786)	McDonald, 1969
Dicranotaenia (H.) coronula (Dujardin, 1845)	Spasskaia, 1966
Fimbriaria fasciolaris (Pallas, 1781)	McDonald, 1969
Fimbriarioides lintoni (Webster, 1943)	Linton, 1927
Hymenolepis tenuirostris (Rudolphi, 1819)	Linton, 1927

Appendix 1. Continued

SURF SCOTER	
PARASITE	REFERENCE
Streptocara californica (Gedoelst, 1919)	Gibson, 1968
Streptocara crassicauda crassicauda (Creplin, 1829)	Gibson, 1968
Streptocara formosensis Sugimoto, 1930	Gibson, 1968
Streptocara recta (Linstow, 1879)	Gibson, 1968
Paracuaria tridentata (Linstow, 1877)	Gibson, 1968
Falsifilicollis altmani (Perry, 1942)	Perry, 1942

Appendix 1. Continued

WHITE-WINGED SCOTER	
PARASITE	REFERENCE
Anaticola crassicornis constrictus (Kellogg, 1896)	Emerson, 1972
Anaticola crassicornis punctalatus (Rudow, 1869)	Emerson, 1972
Anatoecus dentatus (Eichler, 1946)	Zlotoryzcka, 1970
Anatoecus icterodes (Nitzsch, 1818)	Zlotoryzcka, 1970
Holomenopon loomisii (Kellogg, 1896)	Price, 1971
Trinoton querquedulae (Linnaeus, 1758)	Emerson, 1972
Notocotylus attenuatus (Rudolphi, 1809)	Ryzhikov, 1963a
Notocotylus sp. Diesing, 1839	Xuan, 1962
Catatropis verrucosa (Froelich, 1789)	Ryzhikov, 1963a
Paramonostomum alveatum (Mehlis in Creplin, 1846)	McDonald, 1969
Tristriata elegans Filimonova, 1971	Filimonova, 1971
Cyclocoelum mutabile (Zeder, 1800)	McDonald, 1969
Hyptiasmus arcuatus (Brandes, 1892)	McDonald, 1969

Appendix 1. Continued

WHITE-WINGED SCOTER	
PARASITE	REFERENCE
Hyptiasmus laevigatus Kossack, 1911	Kossack, 1911
Hyptiasmus theodori Witenberg, 1928	Ryzhikov, 1963a
Typhlocoelum cucumerinum (Rud., 1809)	Mehlis, 1831
Tracheophilus sisowi Skrjabin, 1913	McDonald, 1969
Eucotyle castenea Jensen, 1971	Jensen, 1971
Eucotyle cohni Skrjabin, 1924	Ryzhikov, 1963a
Eucotyle popowi Skrjabin & Euranova, 1942	Ryzhikov, 1963a
Eucotyle zakharowi Skrjabin, 1920	McDonald, 1969b
Gymnophallus bursicola Odhner, 1900	Yamaguti, 1939
Gymnophallus gibberosus Loos-Frank, 1971	Loos-Frank, 1971
Meiogymnophallus macroporus (Jameson & Nicoll, 1913)	Bykhovskaia-Pavlovskaia, 1962
Echinostoma revolutum (Froelich, 1802)	McDonald, 1969b
Echinostoma sp. (Rudolphi, 1809)	Ryzhikov, 1963a
Echinoparyphium baculus (Diesing, 1850)	McDonald, 1969c

Appendix 1. Continued

WHITE-WINGED SCOTER	
PARASITE	REFERENCE
Echinoparyphium recurvatum (Linstow, 1873)	Odening, 1963
Himasthala incisa (Linton, 1928)	McDonald, 1969
Acanthoparyphium marilae Yamaguti, 1934	McDonald, 1969
Acanthoparyphium melanittae Yamaguti, 1939	McDonald, 1969
Acanthoparyphium tyrosenese Yamaguti, 1939	McDonald, 1969
Psilostomum brevicolle (Creplin, 1829)	Loos-Frank, 1968
Prosthogonimus cuneatus (Rudolphi, 1803)	McDonald, 1969
Prosthogonimus pellucidus (Linstow, 1873)	Ryzhikov, 1963a
Schistogonimus rarus (Braun, 1901)	McDonald, 1969
Orchipedum tracheicola Braun, 1901	Cheatum, 1938
Bulbovitellus fusiformis (Reimer, 1963)	Reimer, 1963
Levinseniella brachysoma (Creplin, 1837)	Reimer, 1963
Microphallus fusiformis Reimer, 1963	Reimer, 1963
Microphallus papillorobustum (Rankin, 1940)	Reimer, 1963
Microphallus pirum (Afanas'ev, 1941)	Ching, 1965b

Appendix 1. Continued

WHITE-WINGED SCOTER	
PARASITE	REFERENCE
Microphallus pygmaeum (Levinsen, 1881)	Belopol'skaia, 1952
Maritrema japonicum (Yamaguti, 1939)	McDonald, 1969
Maritrema subdolum Jagerskiold, 1908	Reimer, 1963
Odhneria odhneri Travassos, 1921	Sinclair, 1971
Pseudospelotrema japonicum Yamaguti, 1939	Yamaguti, 1939
Renicola sp. Cohn, 1904	Oshmarin, 1963
Cyathocotyle melanittae Yamaguti, 1934	Yamaguti, 1934
Cyathocotyle prussica Muhling, 1896	Yamaguti, 1971
Cotylurus erraticus (Rudolphi, 1809)	McDonald, 1969
Cotylurus japonicus Ischii, 1932	Ryzhikov, 1963
Apatemon canadensis Dubois et Rausch, 1950	Dubois, 1967
Apatemon fuligulae Yamaguti, 1933	Ryzhikov, 1963
Apatemon gracilis (Rudolphi, 1819)	Ryzhikov, 1963
Apatemon somateriae fischeri Dubois, 1968	Dubois, 1968

Appendix 1. Continued

WHITE-WINGED SCOTER	
PARASITE	REFERENCE
Australapatemon skrjabini Ryzhikov et al, 1964	Ryzhikov et *al.*, 1964
Plagiorchis nanus (Rudolphi, 1802)	McDonald, 1969
Plagiorchis potanini (Skrjabin, 1928)	McDonald, 1969
Anomotaenia ciliata Fuhrmann, 1913	McDonald, 1969
Anomotaenia citrus (Krabbe, 1869)	McDonald, 1969
Lateriporus biuterinus Fuhrmann, 1908	McDonald, 1969
Lateriporus mathevossianae Ryzhikov & Gubanov, 1962	Denny, 1969
Lateriporus skrjabini Matevosian, 1946	Tolkacheva, 1966
Lateriporus teres (Krabbe, 1869)	McDonald, 1969
Gastrotaenia dogieli (Gieneksinskaia, 1944)	Spasskaia, 1966
Fimbriaria fasciolaris (Pallas, 1781)	Czapliński, 1956
Fimbriariella falciformis (Linton, 1927)	Webster, 1943
Fimbriarioides intermedia (Fuhrmann, 1913)	Spasskaia, 1966
Fimbriarioides lintoni Webster, 1943	McDonald, 1969

Appendix 1. Continued

WHITE-WINGED SCOTER	
PARASITE	REFERENCE
Aploparaksis furcigera (Nitzch, 1819)	Spasskaia, 1966
Diorchis bulbodes Mayhew, 1929	Spasskaia, 1966
Diorchis ransomi Johri, 1939	Spasskaia, 1966
Microsomacanthus (H.) abortiva (Linstow, 1904)	Tolkacheva, 1966
Drepanidolepis (H.) anatina (Krabbe, 1869)	Spasskaia, 1966
Monosaccanthes (H.) andrejewoi (Matevosian, 1945)	Spasskaia, 1966
Wardium (H.) arctica (Schiller, 1955)	Spasskaia, 1966
Microsomocanthus (H.) arcuata (Kowalewski, 1904)	Spasskaia, 1966
Myxolepis (H.) collaris (Batsch, 1786)	McDonald, 1969
Microsomacanthus (H.) compressa (Linton, 1892)	Tolkacheva, 1966
Dicranataenia (H.) coronula (Dujardin, 1845)	Spasskaia, 1966
Dicranataenia (H.) deglandi Skrjabin & Matevosian, 1942	McDonald, 1969
Microsomacanthus (H.) fausti (Shentseng, 1932)	Ryzhikov, 1963
Microsomacanthus (H.) formosoides Spasskaia & Spasskii, 1961	Tolkacheva, 1966

Appendix 1. Continued

WHITE-WINGED SCOTER	
PARASITE	REFERENCE
Soboleviccanthus kenaiensis (Schiller, 1952)	Czapliński, 1973
Microsomacanthus (H.) hystix Spasskaia & Spasskii, 1961	Tolkacheva, 1966
Microsomacanthus (H.) jaegerskioeldi (Fuhrmann, 1913)	Fuhrmann, 1913
Sobolevicanthus (H.) krabbeella (Hughes, 1940)	Tolkacheva, 1966
Tschertkovilepis (H.) krabbei (Kowalewski, 1895)	McDonald, 1969
Cloacataenia megalops (Nitzsch, 1829)	McDonald, 1969
Microsomacanthus (H.) melanittae Ryzhikov, 1962	Ryzhikov, 1962
Microsomacanthus (H.) microskrjabini Spasskii & Iurpalova, 1964	Tolkacheva, 1966
Microsomacanthus (H.) microsoma (Creplin, 1829)	Fuhrmann, 1913
Microsomacanthus (H.) mirabilis Spasskii & Iurpalova, 1964	Spasskii, 1966
Wardium nyrocae Ryzhikov & Gubanov, 1959	McDonald, 1969
Sobolevicanthus (H.) octacanthoides Fuhrmann, 1906	McDonald, 1969
Microsomacanthus (H.) pachycephla (Linstow, 1872)	Ryzhikov, 1963
Echinatrium skrjabini Spasskaia & Iurpalova, 1965	Spasskaia, 1966

Appendix 1. Continued

WHITE-WINGED SCOTER	
PARASITE	REFERENCE
Hamatolepis (H.) teresoides (Fuhrmann, 1906)	Czaplinski, 1962
Hymenolepis turiensis Podestra and Holmes, 1970	Podesta & Holmes, 1970
Capillaria nyrocinarum Madsen, 1945	Madsen, 1945
Capillaria mergi Madsen, 1945	Czaplinski, 1962
Capillaria s. l. sp. Zeder, 1800	Ryzhikov, 1963b
Amidostomum acutum (Lundahl, 1848)	Czaplinski, 1962
Amidostomum anseris (Zeder, 1800)	Czaplinski, 1962
Epomidostium orispinum (Molin, 1861)	Czaplinski, 1962
Epomidostium uncinatum (Lundahl, 1848)	McDonald, 1969
Streptocara californica (Gedoelst, 1919)	Gibson, 1964
Streptocara crassicauda crassicauda (Creplin, 1829)	Gibson, 1968
Streptocara formosensis Sugimoto, 1930	Gibson, 1968
Paracuaria somateriae (Ryzhikov, 1960)	McDonald, 1969

Appendix 1. Continued

WHITE-WINGED SCOTER	
PARASITE	REFERENCE
Echinuria hypognatha Wehr, 1937	McDonald, 1969
Tetrameres fissispina (Diesing, 1861)	Ryzhikov, 1963b
Trichostrongylus tenuis (Mehlis, 1846)	Czaplinski, 1962
Fillicolis anatis (Schrank, 1788)	Czaplinski, 1962
Polymorphus altmani (Perry, 1942)	Perry, 1942
Polymorphus diploinflatus Lundstrom, 1942	McDonald, 1969
Polymorphus kostylewi Petrochenko, 1949	Petrochenko, 1949
Polymorphus magnus Skrjabin, 1913	Schmidt, 1965a
Polymorphus marilis Van Cleave, 1939	Schmidt, 1965a
Polymorphus mathevossianae Petrochenko, 1949	Petrochenko, 1949
Polymorphus minutus (Goeze, 1782)	Petrochenko, 1949
Polymorphus strumosoides Lundstrom, 1942	Petrochenko, 1949
Polymorphus trochus Van Cleave, 1945	Petrochenko, 1949
Polymorphus paradoxus Conell & Corner, 1957	Denny, 1969
Corynosoma constrictum Van Cleave, 1945	Schmidt, 1965b

Appendix 1. Continued

BLACK SCOTER	
PARASITE	REFERENCE
Anaticola crassicornis angustolimbatus (Giebel, 1866)	Emerson, 1972
Anatoecus dentatus (Eichler, 1946)	Zlotorzycka, 1970
Holomenopon leucoxanthum (Burmeister, 1838)	Price, 1976
Trinoton querquedulae (Linnaeus, 1758)	Emerson, 1972
Notocotylus attenuatus (Rudolphi, 1809)	Ryzhikov, 1963
Notocotylus dafilae Harwood, 1939	Leonov *et al.*, 1963
Notocotylus gibbus (Mehlis in Creplin, 1846)	Leonov *et al.*, 1963
Catatropis verrucosa (Froelich, 1789)	McDonald, 1969
Paramonostomum alveatum (Mehlis in Creplin, 1846)	McDonald, 1969
Cyclocoelum mutabile (Zeder, 1800)	McDonald, 1969
Hyptiasmus arcuatus (Brandes, 1892)	McDonald, 1969
Hyptiasmus laevigatus Kossack, 1911	Kossack, 1911
Eucotyle cohni Skrjabin, 1924	Ryzhikov, 1963
Gymnophallus affinis James & Nicoll, 1913	Jameson & Nicoll, 1913

Appendix 1. Continued

BLACK SCOTER	
PARASITE	REFERENCE
Gymnophallus bursicola Odhner, 1900	Jameson & Nicoll, 1913
Gymnophallus choledocus Odhner, 1900	Loos-Frank, 1968
Gymnophallus dapsilis Nicoll, 1907	Jameson & Nicoll, 1913
Gymnophallus deliciosus (Olsson, 1893)	Loos-Frank, 1969
Gymnophallus ceratostomus Tsimbaliuk & Leonov, 1963	Tsimbaliuk & Leonov, 1963
Gymnophallus gibberosus Loos-Frank, 1971	Loos-Frank, 1971
Gymnophallus somateriae Ching, 1973	Ching, 1973
Gymnophalloides conspicuus (Ching, 1965)	Ching, 1965a
Meiogymnophallus jamesoni Bowers, 1966	Bowers, 1966
Meiogymnophallus macroporus (Jameson & Nicoll, 1913)	Jameson & Nicoll, 1913
Meiogymnophallus macrostoma (Yamaguti, 1939)	Yamaguti, 1971
Meiogymnophallus minutus (Cobbold, 1859)	Bowers & James, 1967
Meiogymnophallus multigemmulus Ching, 1965	Ching, 1965
Parvatrema ovoplenum (Jameson & Nicoll, 1913)	Yamaguti, 1971

Appendix 1. Continued

BLACK SCOTER	
PARASITE	REFERENCE
Echinostoma revolutum (Froelich, 1802)	McDonald, 1969
Echinoparyphium aconiatum Dietz, 1909	Ryzhikov, 1963
Echinoparyphium flexum (Linton, 1892)	McDonald, 1969
Echinoparyphium recurvatum (Linstow, 1873)	McDonald, 1969b
Stephanoprora denticulata (Baer, 1959)	McDonald, 1969b
Himasthla incisa Linton, 1928	Linton, 1928
Acanthoparyphium kurogamo Yamaguti, 1939	Yamaguti, 1939
Acanthoparyphium marilae Yamaguti, 1934	Yamaguti, 1934
Acanthoparyphium tyrosenense Yamaguti, 1939	Yamaguti, 1939
Psilostomum brevicolle (Creplin, 1829)	Loos-Frank, 1968
Psilochasmus oxyurus (Creplin, 1825)	McDonald, 1969b
Psilotrema oligoon (V. Linstow, 1887)	McDonald, 1969b
Psilotrema spiculigerum (Muhl, 1898)	Ryzhikov, 1963
Prosthogonimus pellucidus (v. Linstow, 1887)	Ryzhikov, 1963

Appendix 1. Continued

BLACK SCOTER	
PARASITE	REFERENCE
Wetzelitrema melanittae Rayski & Fahmy, 1962	Rayski & Fahmy, 1962
Levinseniella brachysomum (Creplin, 1837)	Reimer, 1963
Microphallus excellens (Nicoll, 1907)	McDonald, 1969
Microphallus primas (Jagerskiold, 1908)	Reimer, 1963a
Microphallus pygmaeum (Levinsen, 1881)	Deblock & Tran Van Ky, 1966a
Maritrema gratiosum Nicoll, 1907	Deblock & Tran Van Ky, 1966a
Maritrema subdolum (Jagerskiold, 1908)	Reimer, 1963a
Cryptocotyle concava (Creplin, 1825)	McDonald, 1969b
Cotylurus cornutus (Rudolphi, 1808)	Ryzhikov, 1963
Apatemon gracilis (Rudolphi, 1819)	Ryzhikov, 1963
Australapatemon skrjabini Ryzhikov *et al.*, 1964	Ryzhikov *et al.*, 1964
Plagiorchis laricola Skrjabin, 1924	Leonov *et al.*, 1963
Plagiorchis obtusus Shtrom, 1940	Leonov *et al.*, 1963
Metorchis xanthosomus (Creplin, 1846)	McDonald, 1969b

Appendix 1. Continued

BLACK SCOTER	
PARASITE	REFERENCE
Anomotaenia ciliata Fuhrmann, 1913	McDonald, 1969
Lateriporus teres (Krabbe, 1869)	McDonald, 1969
Lateriporus skrjabini Matevosian, 1946	Tolkacheva, 1966
Paricterotaenia borealis (Linstow, 1905)	McDonald, 1969
Gastrotaenia dogieli (Ginetsinskaia, 1944)	Spasskaia, 1966
Diploposthe laevis (Bloch, 1872)	Spasskaia, 1966
Fimbriaria fasciolaris (Pallas, 1781)	Czaplinski, 1962
Fimbriarioides intermedia (Fuhrmann, 1913)	Spasskaia, 1966
Diorchis stefanskii Czaplinski, 1956	McDonald, 1969
Microsomacanthus (H.) abortiva (Linstow, 1904)	Tolkacheva, 1966
Microsomacanthus (H.) acus Spasskii & Iurpalova, 1965	Spasskaia, 1966
Microsomacanthus (H.) compressa (Linton, 1892)	Spasskaia, 1966
Dicranotaenia (H.) coronula (Dujardin, 1845)	McDonald, 1969
Microsomacanthus (H.) formosa (Dubinia, 1954)	Tolkacheva, 1966

Appendix 1. Continued

BLACK SCOTER	
PARASITE	REFERENCE
Retinometra (H.) macracanthus (Linstow, 1877)	Tolkacheva, 1966
Echinatrium mellitae Tolkacheva, 1966	Tolkacheva, 1966
Hymenolepis micrancristrota (Wedl, 1855)	McDonald, 1969
Microsomacanthus microskrjabina Spasskii & Iurpalova	Tolkacheva, 1966
Microsomacanthus (H.) microsoma (Creplin, 1829)	Bowers, 1966
Microsomacanthus mirabilis Spasskii & Iurpalova, 1964	Tolkacheva, 1966
Wardoides (H.) nyrocae (Yamaguti, 1935)	McDonald, 1969
Microsomacanthus oidemiae Spasskii & Iurpalova, 1964	Spasskaia, 1966
Wardoides oidemiae Spasskii, 1966	Spasskaia, 1966
Microsomacanthus (H.) pachycephala (Linstow, 1872)	Tolkacheva, 1966
Microsomacanthus (H.) paracompressa (Czapliński, 1956)	Tolkacheva, 1966
Microsomacanthus (H.) paramicrosoma (Gasowska, 1931)	Tolkacheva, 1966
Amphipetrovia (H.) retracta (Linstow, 1905)	Tolkacheva, 1966
Echinatrium skrjabini Spasskii, 1965	Spasskaia, 1966

Appendix 1. Continued

BLACK SCOTER	
PARASITE	REFERENCE
Microsomacanthus (H.) jaegerskioeldi (Fuhrmann, 1913)	Spasskaîa, 1966
Microsomacanthus spasskii Tolkacheva, 1965	Tolkacheva, 1966
Sobolevicanthus kenaiensis (Schiller, 1952)	McDonald, 1969
Anatinella spinulosa (Dubinina, 1954)	Tolkacheva, 1966
Microsomacanthus tuvensis Spasskaîa & Spasskii, 1961	McDonald, 1969
Capillaria nyrocinarum Madsen, 1945	Madsen, 1945
Amidostomum acutum (Lundahl, 1845)	Ryzhikov, 1963b
Amidostomum anseris (Zeder, 1800)	Czaplinski, 1962
Epomidostium orispinum (Molin, 1861)	Czaplinski, 1962
Epomidostium uncinatum (Lundahl, 1848)	Czaplinski, 1962
Streptocara californica (Gedoelst, 1919)	Gibson, 1964
Streptocara crassicauda crassicauda (Creplin, 1829)	Gibson, 1968
Streptocara formosensis Sugimoto, 1930	Gibson, 1968

Appendix 1. Continued

BLACK SCOTER	
PARASITE	REFERENCE
Streptocara dogieli Belopol'skaîa, 1952	Ryzhikov, 1963b
Echinuria borealis asiatica Ryzhikov, 1962	Ryzhikov, 1963b
Echinuria hypognatha Wehr, 1937	Ryzhikov, 1963b
Tetrameres fissipina (Diesing, 1861)	Ryzhikov, 1963b
Fillicolis anatis (Schrank, 1788)	McDonald, 1969
Polymorphus diploinflatus Lundstrom, 1942	McDonald, 1969
Polymorphus magnus Skrjabin, 1913	McDonald, 1969
Polymorphus minutus (Goeze, 1782)	McDonald, 1969
Polymorphus strumosoides Lundstrom, 1942	McDonald, 1969
Polymorphus trochus Van Cleave, 1945	McDonald, 1969
Corynosoma constrictum Van Cleave, 1945	McDonald, 1969

APPENDIX 2. Comparison of the helminths recovered from 6 *M. f. fusca* to those recovered from the 30 *M. f. deglandi*.

PARASITE	*M. f. deglandi*	*M. f. fusca*
Austrobilharzia terrigalensis	✓	-
Notocotylus attenuatus	✓	-
Tristriata elegans	✓	-
Catatropis verrucosa	-	✓
Eucotyle castenea	✓	-
Gymnophallus busicola	✓	-
Gymnophallus choledocus	✓	✓
Gymnophallus deliciosus	✓	✓
Gymnophallus sp. Type III	✓	-
Dietziella egregia	✓	-
Himasthala incisa	✓	-
Ascorhytis charadriformis	✓	-
Pseudospelotrema japonicum	✓	-
Renicola sp.	✓	-
Capillaria nyrocinarum	✓	✓
Amidostomum acutum	✓	✓

APPENDIX 2. CONTINUED

PARASITE	*M. f. deglandi*	*M. f. fusca*
Streptocara californica	✓	-
Streptocara c. crassicauda	✓	-
Streptocara formosensis	✓	-
Tetrameres fissispina	✓	-
Tetrameres somateriae	✓	✓
Tetrameres spinosa	✓	-
Tetrameres sp.	✓	✓
Hymenolepis sp.	✓	✓
Cloacotaenia megalops	✓	-
Polymorphus botulus	✓	✓

Details of Infection of Scoters with helminths bt age and sex.

APPENDIX 3. Details of infection of surf scoters with Trematoda by age and sex.

PARASITE	ADULTS			IMMATURES			TOTAL	TOTAL
	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALES	FEMALES
A. terrigalensis	8(14.3)	-	8(11.1)	-	-	-	8(11.1)	-
Z. lunata	1(1.8)	-	1(1.4)	1(6.3)	-	1(4.5)	2(2.8)	-
N. attenuatus	-	-	-	1(6.3)	-	1(4.5)	1(1.4)	-
T. elegans	15(26.8)	5(31.3)	20(27.8)	3(18.8)	3(50.0)	6(27.3)	18(25.0)	8(36.4)
E. castenea	-	1(6.3)	1(1.4)	1(6.3)	-	1(4.5)	1(1.4)	1(4.5)
G. bursicola	2(3.6)	1(6.3)	3(4.2)	6(37.5)	1(16.7)	7(31.8)	8(11.1)	2(9.1)
G. choledocus	-	-	-	6(37.5)	1(16.7)	7(31.8)	6(8.3)	1(4.5)
G. delicupus	5(8.9)	1(6.3)	6(8.3)	4(25.0)	4(66.7)	8(36.4)	9(12.5)	5(22.7)
Gymnophallus sp. Type 1	1(1.8)	-	1(1.4)	1(6.3)	1(16.7)	3(13.6)	2(2.8)	1(4.5)
Gymnophallus spp.	1(1.8)	-	1(1.4)	1(6.3)	-	1(4.5)	2(2.8)	-
Gymnophallid sp.	-	-	-	1(6.3)	-	1(4.5)	1(1.4)	-
A. melanittae	1(1.8)	-	1(1.4)	-	-	-	1(1.4)	-
Psilostomum sp.	5(8.9)	2(12.5)	7(9.7)	-	-	-	5(6.9)	2(9.1)
A. charadiformis	1(1.8)	1(6.3)	2(2.8)	1(6.3)	-	1(4.5)	2(2.8)	2(9.1)
P. japonicum	1(1.8)	1(6.3)	2(2.8)	2(12.5)	-	2(9.1)	3(4.2)	1(4.5)
Renicola sp.	1(1.8)	-	1(1.4)	1(6.3)	-	1(4.5)	2(2.8)	-
A. gracilis	-	-	-	1(6.3)	-	1(4.5)	1(1.2)	-

NOTE: The first figure represents the no. of birds of that class infected and the no. in brackets represents the percentage of that class infected.

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Details of infection of white-winged scoters with Trematoda by age and sex.

PARASITE	ADULTS MALE	ADULTS FEMALE	ADULTS TOTAL	IMMATURES MALE	IMMATURES FEMALE	IMMATURES TOTAL	TOTAL MALE	TOTAL FEMALE
A. terrigalensis	2(7.7)	-	2(6.9)	-	-	-	2(6.7)	-
N. attenuatus	1(3.8)	-	1(3.4)	-	-	-	1(3.3)	-
C. verrucosa	2(7.7)	1(33.3)	3(10.3)	-	-	-	2(6.7)	1(20.0)
T. elegans	3(11.5)	-	3(10.3)	1(25.0)	-	1(16.6)	4(13.3)	-
E. castenea	4(15.4)	-	4(13.8)	-	-	-	4(13.3)	-
G. bursicola	1(3.8)	-	1(3.4)	-	1(50.0)	1(16.6)	1(3.3)	1(20.0)
G. choledocus	-	-	-	2(50.0)	1(50.0)	3(50.0)	2(6.7)	1(20.0)
G. deliciosus	7(26.9)	1(33.3)	8(27.6)	2(50.0)	-	2(6.7)	9(30.0)	1(20.0)
Gymnophallus spp.	2(7.7)	-	2(6.9)	1(25.0)	-	1(16.6)	3(10.0)	-
Gymnophallus sp. 1	1(3.8)	-	1(3.4)	1(25.0)	-	1(16.6)	2(6.7)	-
D. ergregia *	6(23.1)	1(33.3)	7(24.1)	-	-	-	6(20.0)	1(20.0)
H. incisa	1(3.8)	-	1(3.4)	-	-	-	1(3.3)	-
A. charadiformis	1(3.8)	-	1(3.4)	-	-	-	1(3.3)	-
P. japonicum	4(15.4)	1(33.3)	5(17.2)	1(25.0)	-	1(16.6)	5(16.7)	1(20.0)
Renicola sp.	1(3.8)	-	1(3.4)	-	-	-	1(3.3)	-

**D. ergregia* infected 1 white-winged scoter that could not be aged or sexed.

Details of infection of black scoters with Trematoda by age and sex.

PARASITE	ADULTS			IMMATURES			TOTAL	TOTAL
	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE
A. terrigalensis	2(6.3)	2(25.0)	4(10.0)	-	-	-	2(6.1)	2(16.7)
N. attenuatus	-	-	-	-	1(25.0)	1(20.0)	-	1(8.3)
E. castenea	2(6.3)	-	2(5.0)	-	-	-	2(6.1)	-
G. bursicola	2(6.3)	-	2(5.0)	-	2(50.0)	2(40.0)	2(6.1)	2(16.7)
G. choledocus	-	-	-	1(100.0)	-	1(20.0)	1(3.0)	-
G. deliciosus	2(6.3)	-	2(5.0)	-	2(50.0)	2(40.0)	2(6.1)	2(16.7)
Gymnophallus sp. Type 1	-	-	-	1(100.0)	-	1(20.0)	1(3.0)	-
Gymnophallus spp.	4(13.0)	-	4(10.0)	-	1(25.0)	1(20.0)	4(12.2)	1(8.3)
Gymnophallid sp.	1(3.1)	-	1(2.5)	-	-	-	1(3.0)	-
E. revoulutum	-	-	-	-	1(25.0)	1(20.00)	-	1(8.3)
H. incisa	1(3.1)	-	1(2.5)	-	-	-	1(3.0)	-
A. charadiformis	1(3.1)	-	1(2.5)	-	1(25.0)	1(20.0)	1(3.0)	1(8.3)
M. pygmaeum	-	-	-	-	1(25.0)	1(20.0)	-	1(8.3)
P. japonicum	-	-	-	-	1(25.0)	1(20.0)	-	1(8.3)
C. strigeoides	-	-	-	-	1(25.0)	1(20.0)	-	1(8.3)
A. burti	-	-	-	-	1(25.0)	1(20.0)	-	1(8.3)

Details of infection of scoters with Cestoda by age and sex.

HOST	PARASITE	ADULTS			IMMATURES			TOTAL	TOTAL
		MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE
M. perspicillata	*Hymenolepis* spp.	26(46.4)	10(62.5)	36(38.3)	16(100.0)	3(50.0)	19(86.4)	42(58.3)	13(59.1)
	Frimbriariinae	6(10.7)	-	6(8.3)	5(31.3)	2(33.3)	7(31.8)	11(15.3)	2(9.1)
M. fusca	**Hymenolepis* spp.	16(61.5)	2(66.6)	18(62.1)	2(50.0)	2(100.0)	4(66.7)	18(60.0)	4(80.0)
	C. megalops	-	-	-	1(25.0)	-	1(16.7)	1(3.3)	-
M. nigra	*Hymenolepis* spp.	18(56.3)	5(62.5)	23(57.5)	1(100.0)	2(50.0)	3(60.0)	19(57.6)	7(58.3)
	Frimbriariinae	3(9.4)	-	3(7.5)	1(100.0)	2(50.0)	3(60.0)	4(12.1)	2(16.7)

**Hymenolepis* spp. infected 1 *M. fusca* that could not be aged or sexed.

Details of infection of surf scoters with Nematoda by age and sex.

PARASITE	ADULTS			IMMATURES			TOTAL	TOTAL
	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE
C. anatis	-	-	-	-	1(16.7)	1(4.5)	-	1(4.5)
C. nyrocinarum	5(8.9)	1(6.3)	6(8.3)	10(62.5)	4(66.7)	14(63.6)	15(20.8)	5(22.7)
A. acutum	28(50.0)	8(50.0)	36(50.0)	9(56.3)	3(50.0)	12(54.5)	37(51.4)	11(50.0)
S. californica	10(17.9)	6(37.5)	16(22.2)	3(18.8)	1(16.7)	4(18.2)	13(18.1)	7(31.8)
S. c. crassicauda	-	2(12.5)	2(2.8)	5(31.3)	-	5(22.7)	5(6.9)	2(9.1)
S. formosensis	4(7.1)	1(6.3)	5(6.9)	5(31.3)	3(50.0)	8(36.4)	9(12.5)	4(18.2)
E. borealis	-	-	-	-	1(16.7)	1(4.5)	-	1(4.5)
E. hypognatha	7(12.5)	5(31.3)	12(16.7)	8(50.0)	1(16.7)	9(40.9)	15(20.8)	6(27.3)
T. fissispina	1(1.8)	-	1(1.4)	5(31.3)	1(16.7)	6(27.3)	6(8.3)	1(4.5)
T. somateriae	20(35.7)	8(50.0)	28(38.9)	13(81.3)	3(50.0)	16(72.7)	33(45.8)	11(50.0)
T. spinosa	-	1(6.3)	1(1.4)	2(12.5)	-	2(9.1)	2(2.8)	1(4.5)
Amidostomum sp.	4(7.1)	1(6.3)	5(6.9)	-	-	-	4(5.6)	1(4.5)
Streptocara sp.	2(3.6)	-	2(2.8)	-	-	-	2(2.8)	-
Tetrameres sp.	1(1.8)	-	1(1.4)	1(6.3)	3(50.0)	4(18.2)	2(2.8)	3
Sarconema sp.	1(1.8)	-	1(1.4)	-	-	-	1(1.4)	-
Nematode sp. II	-	-	-	-	1(16.7)	1(4.5)	-	1(4.5)

Details of infection of white-winged scoters with Nematoda by age and sex.

PARASITE	ADULTS			IMMATURES			TOTAL	TOTAL
	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE
C. nyrocinarum	10(38.5)	1(33.3)	11(37.9)	-	1(50.0)	1(16.7)	10(33.3)	2(40.0)
A. acutum	8(30.7)	-	8(27.6)	1(25.0)	2(100.0)	3(50.0)	9(30.0)	2(40.0)
S. californica	1(2.7)	-	1(3.4)	-	-	-	1(3.3)	-
S. c. crassicauda	1(2.7)	-	1(3.4)	-	-	-	1(3.3)	-
S. formosensis	1(2.7)	-	1(3.4)	-	-	-	1(3.3)	-
T. fissispina	-	-	-	-	1(50.0)	1(16.7)	-	1(20.0)
T. somateriae	7(26.9)	-	7(24.1)	1(25.0)	1(50.0)	2(33.3)	8(26.7)	1(20.0)
T. spinosa	1(2.7)	-	1(3.4)	-	-	-	1(3.3)	-
Tetrameres sp.	2(7.7)	-	2(6.9)	-	-	-	2(6.7)	-

Details of infection of black scoters with Nematoda by age and sex.

PARASITE	ADULTS			IMMATURES			TOTAL	TOTAL
	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE
C. nyrocinarum	-	-	-	-	2(50.0)	2(40.0)	-	2(16.7)
A. acutum	17(53.1)	4(50.0)	21(52.5)	1(100.0)	2(50.0)	3(60.0)	18(54.5)	6(50.0)
E. uncinatum	1(3.1)	-	1(2.5)	-	1(25.0)	1(20.0)	1(3.0)	1(8.3)
S. californica	5(15.6)	1(12.5)	6(15.0)	-	2(50.0)	2(40.0)	5(15.2)	8(66.7)
S. c. crassicauda	3(9.4)	-	3(7.5)	-	1(25.0)	1(20.0)	3(9.1)	1(8.3)
E. hypognatha	4(12.5)	1(12.5)	5(12.5)	-	2(50.0)	2(40.0)	4(12.1)	3(25.0)
T. fissispina	1(3.1)	-	1(2.5)	-	2(50.0)	2(40.0)	1(3.1)	2(16.7)
T. somateriae	-	-	-	-	1(25.0)	1(20.0)	-	1(8.3)
T. spinosa	-	-	-	1(100.0)	-	1(20.0)	1(3.0)	-

Details of infection of scoters with Acanthocephala by age and sex.

HOST	PARASITE	ADULTS			IMMATURES			TOTAL	TOTAL
		MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE
M. perspicillata	*F. altmani*	–	–	–	1(6.3)	–	1(4.5)	1(1.4)	–
	P. botulus	4(7.1)	1(6.3)	5(6.9)	1(6.3)	–	1(4.5)	5(6.9)	1(4.5)
	C. sudsuche	6(10.7)	2(12.5)	8(11.1)	5(31.3)	–	5(22.7)	11(15.3)	2(9.1)
M. fusca	*P. botulus*	3(11.5)	1(33.3)	4(13.8)	2(50.0)	1(50.0)	3(50.0)	5(16.7)	2(40.0)
M. nigra	*P. botulus*	4(12.5)	1(12.5)	5(12.5)	–	2(50.0)	2(40.0)	4(12.1)	3(25.0)
	C. constriotum	–	–	–	–	1(25.0)	1(20.0)	–	1(8.3)