HELMINTH PARASITES OF THE COMMON EIDER DUCK (SOMATERIA MOLLISSIMA L.) IN NEWFOUNDLAND AND LABRADOR

CLAUDE ALBERT BISHOP

Helminth parasites of the common eider duck (*Somateria mollissima* L.) in Newfoundland and Labrador.

by

Claude Albert Bishop.

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

Department of Biology,
Memorial University of Newfoundland,
St. John's, Newfoundland, Canada.

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Abstract

A total of 110 common eider ducks from six localities in Newfoundland and Labrador were examined for parasites. Twenty-seven species of parasites were recovered, eight being new host records and eighteen new host records for the common eider in North America. Ninety-five percent of the ducks were infected.

The percentage of infection, range of numbers, and mean number of parasites is given for each age group and each sex of bird examined. Parasite species are discussed individually with regard to topics such as location within the host, other host records, the authority used in specific determination, minor variations, if any, from the original description, and comparison of results obtained by other authors who recorded the same species from common eiders.

Two species of parasites were observed to cause damage to the host but none were lethal.

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Introduction

The common eider duck (Somateria mollissima(L.))is the commonest marine duck in Newfoundland coastal waters, inhabiting the littoral zone and occuring most abundantly during the winter months. It is found throughout the northern hemisphere in North America, Europe and Asia (Dement'ev and Gladkov, 1967). These authors list four valid subspecies, three of which occur in North America. They include the northern eider, S.m. borealis (Brehm); the American eider, S.m. dresseri Sharpe; and the Pacific eider, S.m. v-nigra Bonaparte. Both the northern and American eiders are found in Newfoundland and Labrador. The northern eider breeds in Greenland, the eastern Canadian arctic, and in Labrador south to Hamilton Inlet. It winters from southern Greenland, Labrador, south to Nova Scotia, occasionally to Maine and rarely to Massachusetts and Connecticut (A.O.U. Checklist, 1957). The American eider breeds from Hamilton Inlet south in Labrador and Quebec to Nova Scotia and Maine, with a small breeding population (approximately 200 pairs: D. Gillespie, pers. comm.) being found in insular Newfoundland (Notre Dame Bay, Hare Bay, St. John Bay). It winters from Newfoundland and the Gulf of St. Lawrence, south to Massachusetts and New York, rarely to New Jersey and Delaware (A.O.U. Checklist, 1957).

Many aspects of the biology of the common eider have been studied (Table 1) throughout the whole of its range. Little work, however, has been done on its parasites. In North America some of the more recent works on the helminthofauna of common eiders are those of Clark, et al. (1958), Schiller (1955), Stunkard (1960-67), Stunkard and Uzmann

(1958), and Van Cleave and Rausch (1951), while in the U.S.S.R. Belopolskaya (1952), Kulachkova (1953-1960) and Ryzhikov (1960-1965) worked on this host.

The purpose of the present study was to determine the nature of the helminth burden of common eider ducks in Newfoundland, if any. This is the first time that this species of bird from the eastern seaboard has been so surveyed.

Table 1

A selected checklist of papers concerned with the biology of the common eider duck (*Somateria mollissima* L.).

Subject	Author	Date	Locality
A. General Biology	Belopol'skii	1957	U.S.S.R. (East Murman)
	Bent	1951	N.A.
	Dement'ev and Gladkov	1967	U.S.S.R.
	Flint	1955	U.S.S.R.
	Gerasimova and Baranova	1960	U.S.S.R.
	Godfrey	1966	N.A. (Canada)
	Gross	1938, 1944	N.A. (U.S.A.)
	Gudmundsson	1932	Iceland
	Kortright	1942	N.A.
	Millais	1913	Britain
	Peters and Burleigh	1951	N.A. (Nfld.)
	Pettingill	1959	Iceland
	Portenko	1952	U.S.S.R.
	Sutton and Parmalee	1955	N.A. (Canada)
	Thompson and Person	1963	N.A. (Alaska)
B. Food	Campbell	1947	Britain
	Cottam	1939	N.A.
	Evans	1909	Britain
	Halkett	1905	N.A. (Britain)
	Hartley and Fisher	1936	Spitzbergen
	Kumlien	1879	N.A.
	Mackay	1890	N.A. (U.S.A.)
	Madsen	1954	Europe (Denmark)
	Paludán	1962	Europe (Denmark)
	Preetsov and Flint	1963	U.S.S.R.
	Rathburn	1930	N.A.

Table 1 (continued)

Subject	Author	Date	Locality
C. Breeding	Cooch	1962	N.A. (Canada)
	Choate	1966, 1967	N.A. (U.S.A.)
	Guignion	1968	N.A. (Canada)
	Lewis	1939	N.A. (Canada)
	Paynter	1951	N.A. (Canada)
D. Taxonomy	Humphrey	1958	N.A.
	Johnsgard	1961	N.A.
E. Behavior	Johnsgard	1964	N.A.
	McKinney	1961	N.A. and Europe
F. Mortality and native use	Barry	1968	N.A. (Alaska)

Materials and Methods

A total of 110 common eiders, including both subspecies, were examined during the period November 1968 - July 1969 (Table 2). When aging females it was not possible to distinguish age groups other than chicks, juveniles (1st winter), and adults. The head and viscera of two females of indeterminate age are also included. On the basis of plumage the males could be separated into juvenile (1st winter), 2nd and 3rd winter, 2nd, 3rd and 4th summer, and adult. As there were few representatives of age classes between juvenile and adult these were placed together in the category "subadult". All the chicks were downy young (measurements in Appendix 1). The chicks could not be aged on the basis of measurements taken as little information is available in the literature on measurements of "known age" birds (Appendix 1). The sex of the chicks was determined by examining the syrinx which differs in shape in the two sexes (Figure 1).

The majority of the specimens were collected at six localities (Figure 2) using a 12 gauge shotgun and shot size #2. Chicks were normally caught in a large dipnet. All winter specimens were collected near Witless Bay (Area 1) or in Notre Dame Bay (Area 2), while summer specimens were collected in N.D. Bay and north to southern Labrador (Areas 3, 4, 5, and 6). All birds were weighed and measured as part of a wider study (Appendix 2).

Most of the specimens collected during the winter months were deep frozen prior to examination. Some birds were eviscerated in the field,

Table 2

Age composition of a sample of 110 common eiders (S. mollissima L.) examined for helminth parasites and details of infection.

	Number examined	Number infected	Percentage infected
Females - Adult	44	44	100
Juvenile	11	11	100
Chick	4	2	50
Unknown	2	2	100
Subtotal	61	59	97
Males - Adult	3	3	100
Subadult	23	23	100
Juvenile	10	10	100
Chick	13	9	69
Subtotal	49	45	92
Total	110	104	95

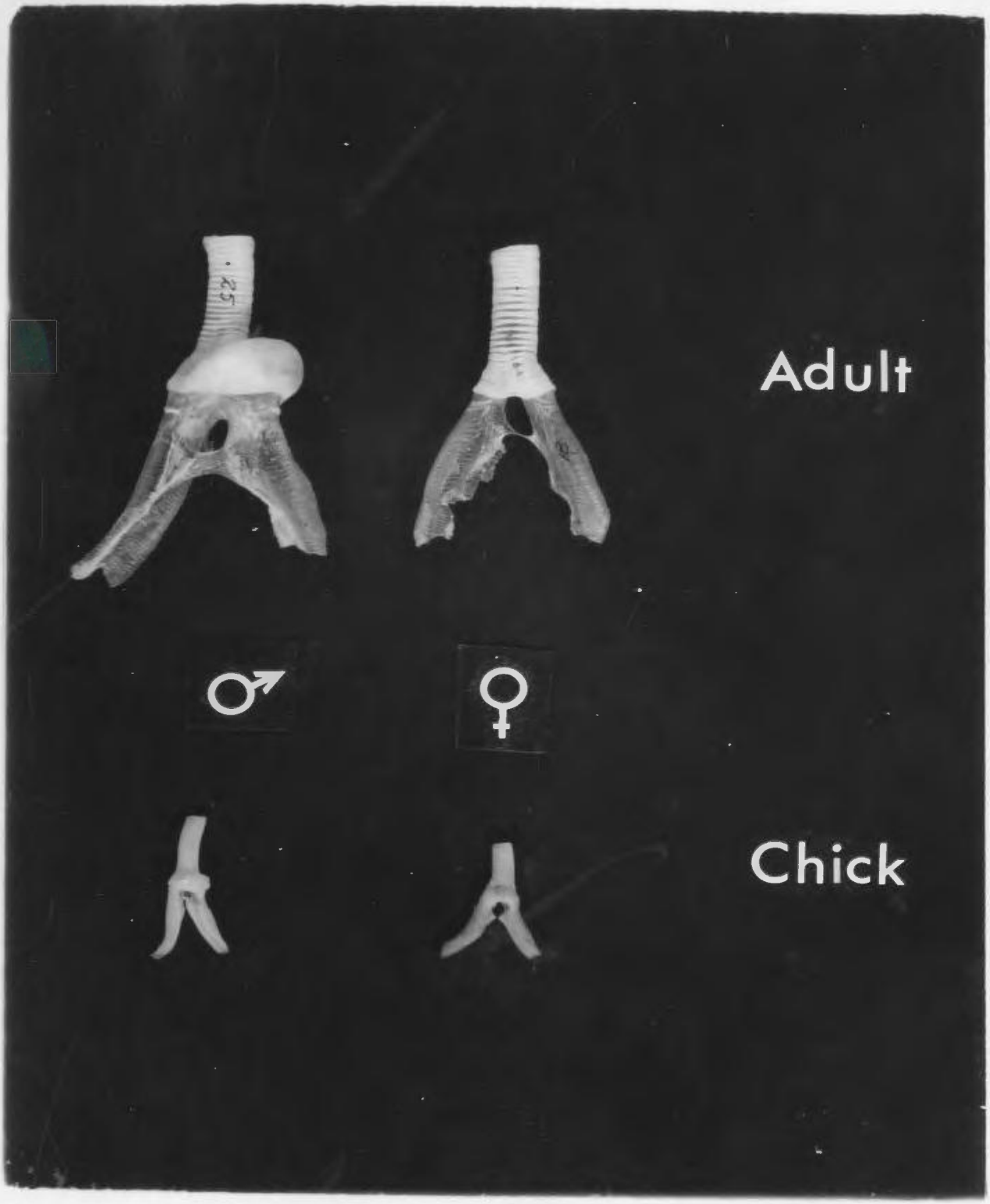
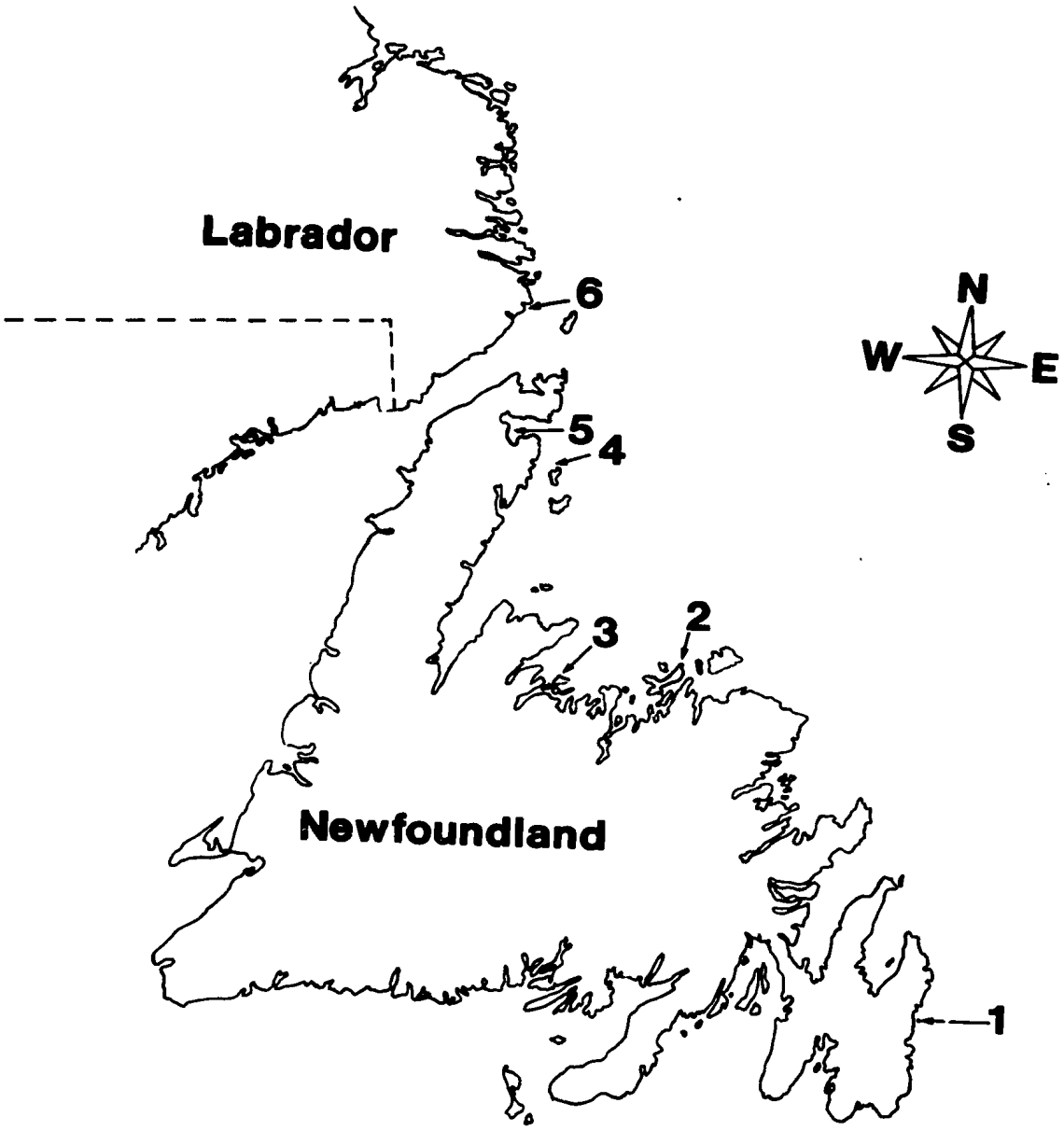

Adult
♂
♀
Chick

Figure 2.

Sampling areas.


Labrador
Newfoundland
N
W
E
S
1
2
3
4
5
6

the viscera being preserved immediately in 10% formalin, as freezing facilities were not available. All specimens, whether frozen or fresh, were examined for external parasites. The entire skin of each specimen was retained for future use as an aid in aging and separation of subspecies. Blood smears were taken from both fresh and frozen specimens. No attempts were made to determine the presence of other protozoan parasites. Ten nests were collected during the summer of 1969 from Areas 5 and 6 (Figure 2). Down and plant material, sealed in plastic bags were brought back to the laboratory and left in a warm place to facilitate hatching of any eggs or emergence of adults from pupae present. Parasites were collected using a modified Berlese funnel technique in which the nest contents were placed in a large funnel approximately 6 inches below a heat source (40 watt light bulb). The parasites were collected in a vial of 70% alcohol as they fell through the bottom of the funnel.

Portions of the viscera examined for parasites included the following: the entire digestive tract, trachea, lungs, heart, liver, gall bladder, spleen, kidneys, ureters, oviduct and Bursa of Fabricius. Air sacs were also examined when the birds were eviscerated. The digestive tract was separated into esophagus, proventriculus, gizzard, duodenum (1st loop of small intestine), small intestine, large intestine, caeca, and cloaca. The small intestine section was further divided into four equal sections (approximately 40 cm. each and designated S_1, S_2, S_3, S_4) to determine whether there was any difference in the linear distribution of helminths in this region of the digestive tract. All parts of the

viscera were teased apart or in the case of the digestive tract, the contents were washed into a fine sieve (149 u. mesh) after the longitudinal incision had been made in the section in question. Any material collected in the sieve was washed into a petri dish and examined under a low power (10-40x) binocular microscope. The horny, keratinous lining of the gizzard was removed to reveal any nematodes buried in the underlying tissue. All sections of the gut were scraped with a scalpel to remove any attached or embedded worms.

Parasites recovered were stored in 5% formalin or 70% alcohol. At a later date some were stained, cleared and mounted, to aid identification, using standard techniques. Stains used included Semichon's acid carmine (trematodes, cestodes and acanthocephala), Grenacher's borax carmine (cestodes, acanthocephala) and celestin blue (cestodes). Various stains were used on a particular group when it was found necessary to demonstrate characteristics that are important in identification and which could not clearly be shown utilizing one stain. Specimens were mounted in Canada balsam. Nematodes and ectoparasites were cleared and mounted in Rubin's fluid.

In all instances where parasites were found an attempt was made to determine the numbers of each species present. Total counts were made when the number of helminths found did not exceed approximately one hundred individuals. However, in most cases the numbers of trematodes and cestodes found were high and an aliquot sampling technique was used to estimate the numbers present. Tucker, et al. (1970) commented on the accuracy of aliquot sampling in estimating total roundworm burdens.

Food items found in the digestive tract of the ducks were retained for future study.

Results and Discussion

A total of 27 species of parasites were recovered during the study (10 trematodes, 5 cestodes, 8 nematodes, 1 acanthocephalan,1 siphonapteran, 1 mallophagan and 1 haematozoan). Eight new host records and 18 new records for the common eider in North America are reported. Twenty-two of these parasite species are recorded for the first time from Newfoundland. One hundred and four birds (95%) were found to be infected (Table 2), the number of parasite species per infected bird ranging from 1 - 13 (mean 8). All measurements given are in microns unless otherwise stated.

Trematoda:

Ten species of trematodes, belonging to 7 genera, were recovered (Table 3). The number of species found per bird ranged from 1 to 8 (mean 4).

Himasthla compacta Stunkard, 1960

This species was found in 18 (16%) birds, with numbers per bird ranging from 1 to 146. The majority of the helminths were recovered from the duodenum and the first section of the small intestine (S_1), smaller numbers being found in the second and third regions of the small intestine (S_2, S_3). The species was first described from laboratory reared herring gulls (Larus argentatus Pont.) which had been fed soft shelled clams (Mya arenaria L.) containing echinostome metacercariae (Stunkard, 1960(b). Attempts to infect laboratory-reared eider ducks failed. The species has been reported from herring gulls in Newfoundland (Threlfall, 1968(b)). Measurements from specimens in the present study agreed with those of

Table 3

Details of infection of 110 common eiders (S. mollissima) with Trematodes.

	No. of birds	Percent infection	Himasthla compacta			Cryptocotyle lingua			Microphallus primas			Microphallus pygmaeum		
			a	b	c	a	b	c	a	b	c	a	b	c
Males														
Adult	3	100	-	-	-	-	-	-	-	-	-	100	(1- 1039)	531
Subadult	23	96	26	(6-72)	22	4	(1)	1	4	(6)	6	96	(8-28213)	5147
Juvenile	10	100	-	-	-	-	-	-	10	(6)	6	100	(20-36942)	12656
Chick	13	69	23	(11-17)	9	-	-	-	-	-	-	62	(6- 4169)	658
Subtotal	49	90	18	(6-72)	18	2	(1)	1	4	(6)	6	88	(1-36942)	5736
Females														
Adult	44	98	18	(<6-145)	49	5	(3)	3	7	(1-492)	174	77	(1-26406)	4271
Juvenile	11	91	-	-	-	-	-	-	-	-	-	91	(21-67140)	18486
Chick	4	50	25	(17)	17	-	-	-	-	-	-	50	(913- 2671)	1792
Unknown	2	100	-	-	-	-	-	-	-	-	-	50	(12)	12
Subtotal	61	93	15	(<6-145)	46	3	(3)	3	3	(1-492)	174	77	(1-67140)	6952
Total	110	92	16	(<6-145)	32	3	(1-3)	2	5	(1-492)	107	82	(1-67140)	6377
Status				*			* *			* *			* * *	

a - present infection; b - range of numbers per infected bird; c - mean number per infected bird.

Status: * - new host record; ** - new records for common eider in N. America; *** - new records for Nfld.

Table 3 (Continued)

	Maritrema subdolum			Gymnophallus bursicola			Gymnophallus choledochus			Gymnophallus minor			Renicola sp.			Notocotylus attenuatus		
	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Males																		
Adult	-	-	-	-	-	-	67	(1)	1	33	(44)	44	33	(550)	550	33	(1)	1
Subadult	-	-	-	83	(1-157)	52	65	(1-12)	4	96	(1- 860)	89	43	(2-283)	60	83	(1- 47	9
Juvenile	-	-	-	100	(3-512)	178	80	(2-10)	4	100	(22-1044)	310	60	(2- 50)	17	80	(1- 8)	4
Chick	8	(1)	1	-	-	-	-	-	-	-	-	-	-	-	-	62	(2-125)	20
Subtotal	2	(1)	1	59	(1-512)	96	53	(1-12)	4	67	(1-1044)	155	35	(2-550	73	73	(1-125)	10
Females																		
Adult	2	(1)	1	64	(2-635)	65	41	(1- 9)	3	70	(1-1316)	142	25	(1-333)	61	86	(1-261)	22
Juvenile	-	-	-	82	(9-322)	112	82	(1- 9)	5	91	(3-3035)	364	64	(6-349)	106	82	(2- 22)	10
Chick	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	50	(22- 23)	22
Unknown	-	-	-	-	-	-	-	-	-	100	(1- 7)	4	-	-	-	50	(7)	7
Subtotal	2	(1)	1	61	(2-635)	77	44	(1- 9)	4	70	(1-3035)	187	30	(1-349)	79	82	(1-261)	19
Total	2	(1)	1	60	(1-635)	85	47	(1-12)	4	69	(1-3035)	173	31	(1-550)	76	79	(1-261)	13
Status	* *			* * *			* * *			* *			* *			* *		

a - present infection; b - range of numbers per infected bird; c - mean number per infected bird.

Status: * - new host record; ** - new records for common eider in N. America; *** - new records for Nfld.

Stunkard (1960) with a few exceptions. The body length, length and width of lineal spines, and length and width of testes were found to be smaller in the present study. These variations could possibly be explained by differences in technique, state of maturity (most immature), or host influence. The worms were found in all age groups except adult and juvenile males and juvenile females.

All the birds infected with this species were collected from the same locality, namely Hare Bay, Newfoundland (Area 5, Figure 1). The birds from this area considered separately gave the following degrees of infection: adult female - 47%; chicks (male and female) - 40%; and subadult males - 86%. A statistical test comparing incidence of this species in birds from the various sampling areas showed a highly significant difference ($p < .001$) in incidence between the various areas. The incidence in only one area could possibly be explained by differences in feeding habits or the presence of suitable intermediate hosts in the area. One other species of the genus, H. militaris (Rudolphi, 1803), has been recorded from the common eider (Kulachkova, 1958).

Cryptocotyle lingua (Creplin, 1825).

Seven representatives of this species were found in 3% of the birds (1 subadult male and 2 adult females), three worms per bird being the highest infection. Worms were found in all parts of the small intestine (duodenum, S_1, S_2, S_3, S_4). This species has been described previously from the common eider (Belopolskaya, 1952; Kulachkova, 1958; vide McDonald, 1969(a)(b)).Infection is acquired through ingestion of a fish intermediate host (Stunkard, 1930). Although fish is an uncommon

item in the eiders' diet (Cottam, 1939; Pretsov and Flint, 1963), fish scales, vertebrae, muscle, and eggs were observed in the gut on several occasions in the present study. C. lingua metacercariae are extremely common on local marine fish (Sekhar and Threlfall (1970); Threlfall, pers. comm.). Two other species of this genus, C. concava (Creplin, 1825) and C. jejuna (Nicoll, 1907) have been found in common eiders (vide McDonald, 1969 (b)).

Microphallus primas (Jagerskiold, 1908)

Representatives of this species were found in 5 birds (5%), (number per infected bird 1 - 492, mean 107, Table 3). Worms were found in sections S_2, S_3, S_4 of the small intestine, the large intestine, and the caeca, the highest numbers being found in sections S_3 and S_4. This species has been recorded previously from common eiders in Europe (Dawes, 1946; vide McDonald, 1969 (b)), and other waterfowl in North America (vide McDonald 1969 (b)). The present report constitutes a new North American host record. Measurements of specimens obtained during the present study agree with those of Dawes (1946) and Deblock and Pearson (1969). The measurements of two mature specimens (mean (range)) are as follows: body length 855 (840 - 870); width 229 (218 - 240); oral sucker, length 40 (38 - 43), width 77 (70 - 84); ventral sucker, length 69 (68-70), width 64 (64 - 65); prepharynx 44 (30 - 58); pharynx, length 48 (45 - 50), width 46 (43 - 48); esophagus, 192; male papilla, length 76 (68 - 85) width 70 (67 - 73); ovary, length 72 (65 - 78), width 52 (50 - 55); seminal vesicle, length 74 (73 - 75), width 36 (30 - 43); eggs, length 22 (19 - 24), width 10 (10 - 12).

Microphallus pygmaeum (Levinsen, 1881)

This species was found in 90 (82%) of the birds examined, numbers per infected bird varying from 1 to 67,140 (mean 6,377). While infections were greatest in sections S_3 and S_4 of the small intestine other specimens were found associated with the duodenum, S_1, S_2, large intestine, caeca, cloaca, Bursa of Fabricius, kidneys, ureters, and gizzard. Some of the latter locations may not have been the normal sites of infection as a gut punctured by lead shot, sometimes allowed worms to migrate into regions where they would not normally be found. As a general rule, the heavier the infection the more widespread was the distribution. This species has been found in the common eider in Europe (vide McDonald 1969 (b)) and North America (Levinsen, 1881). Kulachkova (1958) and Belopolskaya (1952) found this species in common eiders in the U.S.S.R. Kulachkova (1958) found that 78.6% of adult eiders and 84.5% of the chicks she examined from the Kandalaksha Gulf were infected. The average intensity of infection of adult birds was 15,433 (chicks, 92,000) with a maximum intensity of 135,870 (chicks, 640,000). Belopolskaya (1952) found that 76% of the adults and 91.7% of the chicks she examined from the East Murman area were infected, with the maximum intensity of infection reaching 24,000. In the present study this species was the most frequently encountered parasite and the one that occurred in greatest numbers (Table 3). The heaviest infections were noted in the adult, subadult and juvenile age classes. No difference was noted in the percentage of male and female birds infected (88:77% respectively). The species has also been found in the harlequin duck, Histrionicus histrionicus (L.), (Ching, 1961) in Canada, and the sea otter, Enhydra lutris (L.),

(Rausch and Locker, 1951) in Alaska.

Maritrema subdolum Jagerskiold, 1908

Only two specimens were found in 2% of the birds (a male chick, and an adult female). Both worms were found in the first section (S_1) of the small intestine. This species has been recorded previously from common eiders in Europe (Kulachkova, 1958) but not from this host in North America. Kulachkova, (1958) noted that only chicks up to the age of 2 weeks were infected giving an infection rate of 15.6%, an average intensity of between 8 and 15 worms, with a maximum of 43. She found worms most often in the small intestine, some occurring in the caeca. Measurements of the specimens from the present study fell within the range given by Deblock and Capron (1960). Both infected birds were collected from the same locality, namely Hare Bay, Newfoundland (Area 5, Figure 1).

Gymnophallus spp.

Based on existing descriptions of species of the genus Gymnophallus, three species were found in the present study. Stunkard and Uzmann (1958) gave an historical review of the genus and described three adult forms, two from natural infections and one from an experimental infection. They reached the conclusion that the classification of the group was somewhat confused and questioned the validity of some of the species. They stated (p. 285) ".... but the species are not clearly distinguished and the validity of some of them is doubtful," and went so far as to say (p. 287) ".... specific determination on the basis of existing descriptions is virtually impossible." In classifying the

three adult forms found they said (p. 298), "Specific identification is so uncertain that we prefer to list the worms by host and location rather than propose names that might further confuse the taxonomic situation." Consequently they referred to the worms found as Adults I, II, and III, and gave a lengthy description of each.

To date six species of Gymnophallus have been described from common eiders (vide McDonald, 1969 (b)). The three adult forms described from the present study were identified using the descriptions of James (1964), Odhner (1900), and Stunkard and Uzmann (1958).

Gymnophallus bursicola Odhner, 1900

This species was found in 66 (60%) of the birds studied, numbers ranging from 1 to 635 (mean 85). Sites of infection were the cloaca and Bursa of Fabricius. The Bursa of Fabricius, a somewhat transitory lymphoid structure, is largest in juvenile birds and small or non-existent in adults (Ward and Middleton, 1971). In the present study it was found in only 65% of the birds examined. The parasite was found in the cloaca of 56% of the birds and in the Bursa of Fabricius of 71% (Table 4). Infections were limited to juvenile males and females, subadult males, and adult females. On analysing data with regard to degree of infection for the Bursa of Fabricius, only those birds which possessed a bursa were considered. There was little difference in the percentage of birds infected in each of the various age groups nor was any difference noted between the sexes, although there was a difference in intensity of infection.

This species has been recorded previously from the common

Table 4

Details of infection of the Bursa of Fabricius (72 birds) and cloaca (109 birds) with Gymnophallus bursicola Odhner, 1900.

Sex	Age	% infected		mean/infected bird		range nos./ infected bird	
		cloaca	B. of F.	cloaca	B. of F.	cloaca	B. of F.
Males	Juvenile	90	90	42	136	7-185	3-327
	Subadult	78	93	12	38	1-104	3-113
Females	Juvenile	73	90	30	68	1-205	9-231
	Subadult	54	90	7	82	1-102	2-533
Total		56	71	13	59	(1-205)	(2-533)

eider duck from Sweden (Odhner,1900), the U.S.S.R. (Bykhovskaya - Pavlovskaya, 1962; Kulachkova (1958), and the U.S.A. (Stunkard and Uzmann, 1958). Kulachkova (1958) found this species in the Bursa of Fabricius (range of numbers 1 to 1150) of 14.6% of adult common eiders and 24.7% of chicks. The same worker also reported single specimens from the caeca, cloaca, and large intestine. The Gymnophallus sp. described as Adult I by Stunkard and Uzmann (1958) was also found in the Bursa of Fabricius of common eiders in Maine and is considered by James (1964) to be G. bursicola.

Measurements of six specimens (average (range)) are as follows: body length 1000 (800 - 1300); body width 529 (316 - 675); oral sucker, length 150 (108 - 170), width 170 (127 - 192); ventral sucker, length 124 (101 - 139), width 125 (108 - 144); pharynx, length 69 (55 - 79), width 74 (60 - 91); distance from oral to ventral sucker 334 (216 - 465); testes, length 117 (84 - 161), width 89 (39 - 125); ovary, length 112 (72 - 144), width 74 (50 - 101); eggs, length 24 (22 - 28), width 17 (14 - 19). The uterus coils usually occurred throughout most of the body while the vitellaria were situated at the level of the ventral sucker.

G. choledochus Odhner, 1900

This species was found to infect the gall bladder of 52 (47%) of the birds examined (Table 3). The highest degree of infection and greatest intensity was seen in juvenile birds, while no chicks were infected. The species has been recorded previously from the common eider in Sweden and Greenland (Odhner, 1900), the U.S.S.R. (Belopolskaya, 1952;

Bykhovskaya - Pavlovskaya, 1962: Kulachkova, 1958) and Iceland (Brinkman, 1956). Belopolskaya (1952) working on common eiders from the Barents Sea found 30% of adults and 16.7% of "young birds" examined to be infected. Kulachkova (1958) found the helminth in a sample of adult and chick (26.2%:16.5% infected respectively) common eiders from the Kandalaksha Gulf in the U.S.S.R. She found nestlings to be infected at an early age, 2-week-old birds being infected with 1 to 4 worms, while fledglings contained from 75 to 86 worms. The maximum number recorded in adults was 32.

The measurements of five specimens (mean (range)) obtained during the present study are as follows: body length 1300 (1100-1700); body width 488 (405-543); oral sucker, length 167(151-192), width 180 (156-197); ventral sucker, length 143 (125-154), width 141 (120-159); pharynx, length 52 (46-62), width 59 (53-67); distance from oral to ventral sucker 223 (79-396); testes, length 98 (72-120), width 66 (53-89); ovary, length 79 (72-96), width 69 (55-77); eggs, length 26 (23-31), width 18 (14-22). The uterus coils usually occupied a position anterior to the vitellaria and either occupied the whole anterior region or spread to a point just posterior to the pharynx. The vitellaria were situated behind the ventral sucker while the caeca extended to the region of the ventral sucker.

Gymnophallus minor Ryzhikov, 1963.

Representatives of this species were found in 76 (69%) of the birds examined (Table 3) numbers per infected bird ranging from 1 to 3035 (mean 173). Highest infections were noted in the small intestine (S_4), the large intestine, and caeca while lesser numbers were found in the duodenum, S_1, S_2, and S_3.

As stated previously the classification of this genus is in a

state of confusion. Several species of Gymnophallus, namely G. minor Ryzhikov, 1963; G. skrjabini Ryzhikov, 1963; G. somateriae (Levinsen, 1881), have been described from the intestine of common eiders. These helminths are very similar in appearance and size and they may well not be specifically distinct.

Stunkard and Uzmann (1958) commented on the confusing situation and posed several questions, one of which concerned the validity of classifying worms from the gall bladder, intestine, caeca, and Bursa of Fabricius as different species. They state, "the extent of morphological variation that may result from development in different hosts or different locations is quite unknown." In spite of the uncertain state of the classification of this group, on the basis of existing descriptions, the specimens found in this study were identified as G. minor Ryzhikov, 1963 (Table 3). There was little variation in size or proportions amongst specimens from different parts of the gut and hence all were placed in the same species. A comparison of measurements obtained from specimens in the present study with those of G. minor and G. somateriae may be seen in Table 5, which also reveals that the description of G. somateriae is somewhat lacking in detail. G. minor has previously been found in common eiders from Chukotka in the eastern U.S.S.R. (Ryzhikov, 1963a). The present report however constitutes a new host record for North America and greatly extends the known range of the parasite.

Renicola sp.

Specimens of the genus Renicola were found in the renal tubules of 35 (31%) of the birds studied (Table 3). The heaviest infection rate

Table 5

Measurements of Gymnophallus minor obtained during the present study compared with those of Ryzhikov (1963) and with those of G. somateriae (Levinsen, 1881).

Characteristics	Gymnophallus minor Ryzhikov (1963a)	G. minor (Present study)	G. somateriae* Levinsen, (1881)
	Holotype (Paratypes)	Mean (Range)	
Body, length	384 (368-480)	459 (316-633)	500-600
width	195 (190-256)	217 (168-256)	250-300
Oral sucker, length	75 (73-116)	84 (67-113)	130
width	83 (83-112)	95 (74-139)	-
Ventral sucker, length	63 (50- 70)	62 (54- 70)	70
width	-	62 (53- 74)	-
Pharynx, length	50 (36- 59)	36 (31- 53)	-
width	56 (45- 59)	41 (35- 52)	-
Esophagus	-	60 (48- 72)	-
Distance from oral to ventral sucker	224 (200-314)	165 (65-277)	-
Testes, length	33 (30- 50)	48 (43- 58)	-
width	66 (59- 80)	33 (25- 41)	-
Ovary, length	40 (36- 50)	53 (36- 65)	-
width	-	35 (24- 41)	-
Eggs, length	20- 26	20 (16- 24)	17- 20
width	12- 17	13 (11- 17)	13
Uterus coils	between the ventral and oral suckers	between suckers, ventral sucker to posterior and sometimes throughout the body	in hind body
Vitellaria	-	in region of ventral sucker	-

* Measurements obtained from Levinsen (1881), Odhner (1900, 1905).

was seen among juvenile birds, no chicks being infected. The numbers of helminths found gives some indication of the relative abundance of this species and reflects the total numbers present. However in the case of worms such as these, which lie in the tubules of the kidneys, it is not possible to extract all specimens. Consistency in technique does, however, give some idea of relative numbers in the total examined sample.

Two species of Renicola have previously been recorded from the common eider in the U.S.S.R., namely, R. somateriae Belopolskaya, 1952 and R. mollissima Kulachkova, 1957. Kulachkova (1958) reported R. mollissima as occurring in pairs in the tubules, a condition also observed in some instances in this study. R. brantae McIntosh and Farr, 1952, has been recorded from the Canada goose (Branta canadensis (L.)) in the U.S.A. It may be seen in Table 6 that the measurements of specimens of Renicola sp. in the present study do not compare closely with either of these species. It may well be that the present specimens are R. somateriae, a description of which was unavailable.

Notocotylus attenuatus (Rudolphi, 1809)

This species was found in 86 (79%) of all birds examined (Table 3), numbers ranging from 1 to 261 (mean 13). Sites of infection were the small intestine (S_4), large intestine, cloaca and caeca. The latter region was the most heavily infected area. N. attenuatus has been reported from the common eider in Europe (Gower, 1939) and from the common eider and many other species of waterfowl in many parts of the world (vide McDonald, 1969 (b)). No record could be found of its

Table 6

Measurements of Renicola sp. obtained during the present study compared with those of R. mollissima Kulachkova, 1958 and R. brantae McIntosh and Farr, 1952.

	Renicola sp. Present study	R. mollissima Kulachkova, 1958	R. brantae McIntosh & Farr, 1952
	Mean (Range)		
Body length (mm.)	1.0 (.6-1.5)	1.32- 3.2	1.16-2.15
width	500 (287-811)	850-1800	500-1150
Oral sucker, length	232 (208-250)	326- 407	250-325
width	237 (144-326)	218- 390	275-380
Pharynx, length	63 (55- 79)	82- 95	80
width	68 (48- 96)	73- 85	
Ventral sucker, length	92 (55-146)	116	
width	97 (60-144)	149	
Testes, length	74 (65- 84)	109- 140	
width	64 (48- 78)	93- 115	
Ovary, length	101	115- 260	
width	72	124- 155	
Eggs, length	30 (24- 34)	30- 52	25- 29
width	20 (14- 26)	17- 19	13- 15
Body hooks	12- 14	22	present.

occurrence in the common eider in North America. Specimens obtained during the present study agreed most closely with the description and range of measurements given by Dubois (1951), with a few exceptions. The number of previtelline uterine loops was found to be highly variable numbering from 2 to 13 (2 to 5 in Dubois), while the oral sucker had a mean diameter of 247 (132-445). Those measured by Dubois (op. cit.) ranged from 100-260. No apparent difference was noted in the degree of infection of male and female (75%:80% respectively), although adult females carried the highest individual burdens (up to 261 per bird). The relatively high percentage infection in chicks would seem to indicate that the worms are acquired at an early age.

Cestoda

Five species of cestodes, belonging to three genera, were recovered (Table 7).

Lateriporus teres (Krabbe, 1869)

This species was found in 13 (12%) of the birds examined (Table 7) with numbers per infected bird ranging from 1 to 45 (mean 13). The site of infection included the entire small intestine (duodenum, S_1, S_2, S_3, S_4), greatest numbers occurring in the most posterior region, S_4. L. teres has been recorded from the common eider in Greenland (Krabbe, 1869), Iceland (Baer, 1962; Fuhrman, 1907); the U.S.S.R. (Baylis, 1919; Belopolskaya, 1952; Kulachkova, 1958), Spitzbergen and Norway (Zschokke, 1903) and North America (Cooper, 1921; Schiller, 1955; Threlfall, 1968(a)). Kulachkova (1958) found one adult and two "fledglings" to be infected

Table 7

Details of infection of 110 common eiders (S. mollissima L.) with cestodes.

	No. of birds	% infection	Lateriporus teres			Hymenolepis (Microsomacanthus) sp.†			Fimbriarioides intermedia		
			a	b	c	a	b	c	a	b	c
Males, adult	3	100	-	-	-	100	(2- 216)	77	67	(15-189)	102
subadult	23	96	13	(7-31)	16	91	(46- 9016)	2068	70	(6-161)	50
juvenile	10	100	30	(5-27)	12	100	(650-15416)	5588	20	(6- 11)	8
chick	13	69	-	-	-	69	(33- 1739)	689	-	-	-
Subtotal	49	88	12	(5-31)	14	88	(2-15416)	2459	41	(6-189)	51
Females, adult	44	86	11	(1-45)	19	82	(1-19116)	1694	43	(1-133)	24
juvenile	11	91	9	(25)	25	91	(522-23084)	6788	9	(6)	6
chick	4	50	-	-	-	50	(15- 1172)	1024	-	-	-
unknown	2	100	50	(3)	3	100	(15- 165)	90	50	(5)	5
Subtotal	61	85	11	(1-45)	18	82	(1-23084)	2622	34	(1-133)	22
Total	110	86	12	(1-45)	13	85	(1-23084)	2547	37	(1-189)	37
Status											* * *

a - percent infection; b - range of numbers per infected bird; c - mean no. per infected bird.

Status: * new host record; ** new record for common eiders in N.A.; *** new record for Nfld.

† - 3 species[(H. (M.) formosoides *; H. (M.) microskrjabini *; H. (M.) somateriae **] discussed individually in text.

with this helminth. Threlfall(1968(a))reported its presence in two adult common eiders from Newfoundland. Specimens in the present study agreed with the description and measurements given by Schiller(1955).

Hymenolepis (Microsomacanthus) spp.

An extensive literature search revealed that 14 species of Hymenolepis (Microsomacanthus) have been recorded from common eiders throughout the birds' range, including five from North America (Schiller, 1955). In the present study three species were found, 94 (87%) birds being infected (Table 7), with numbers ranging from 1 to 23,084 (mean 2547).

As a group it was virtually impossible to distinguish between the species of Hymenolepis (Microsomacanthus) present when counting specimens, unless they were stained and mounted. The helminths were found in the gizzard, duodenum, all sections of the small intestine, the large intestine and caeca. The percentage distribution per section of the gut based on the total number of worms found is as follows: duodenum - 38.4%; S_1 - 42.5%; S_2 - 16.3%; S_3 - 2.2%; (S_4, large intestine, gizzard, caeca) each $<$.5%. The gizzard infection was most likely caused by movement from the duodenum following death of the bird.

An attempt was made to obtain an indication of the number of species present and the relative abundance of each per bird and per section of the gut. This was accomplished by using rostellar hook length as a preliminary aid in species separation. A sample of 50 scolices (when available) was taken from each section of infected gut, and mounted in Rubin's fluid. The scolices were squashed so that the hooks separated

and could be measured accurately. Using this method, 24 birds were examined in detail, measurements being taken on 2797 scolices or a mean of 117 per bird. Hook sizes were found to range from 31 to 66 (Figure 3), and fell into three main groups with peaks at 35-36; 43-48; and 57-62. It would seem reasonable to assume that the three peaks indicated the presence of three species. Intermediate measurements,e.g. between 37-42 and 49-56, may be produced by overlap of hook size in the various species or by the presence of more than three species.

Further analysis of the material, with regard to the proportions of each major group in each section of the gut, indicated that there was a difference in the linear distribution of the three groups (Figure 4). The ratios of different sizes of hooks in the duodenum and S_1 sections were much the same. In S_2 there was an increase in the proportion of smallest and middle size hooks while in section S_3 the hooks occupying the middle range predominated. In addition to the detailed study of the 24 birds, samples of scolices were taken (10 per section, per bird) from other infected birds in an effort to determine the presence or absence of hooks not falling within the established ranges. None were found.

Using the works of Hughes (1941), Ryzhikov (1965), and Tolkacheva (1966) it was possible to demonstrate the presence of 3 species of hymenolepids in the common eiders examined.

Hymenolepis (Microsomacanthus) formosoides Spasskaja and Spassky, 1961

This species (Figure 5) was first recorded from the golden eye (Bucephala clangula (L.)) in Tuva, eastern U.S.S.R. and subsequently from the scoter (Melanitta fusca (L.)) in Chukotka and Tamyr, eastern U.S.S.R.

Figure 3.

Frequency distribution of rostellar hook lengths from a sample of 2797 hymenolepid scolices.

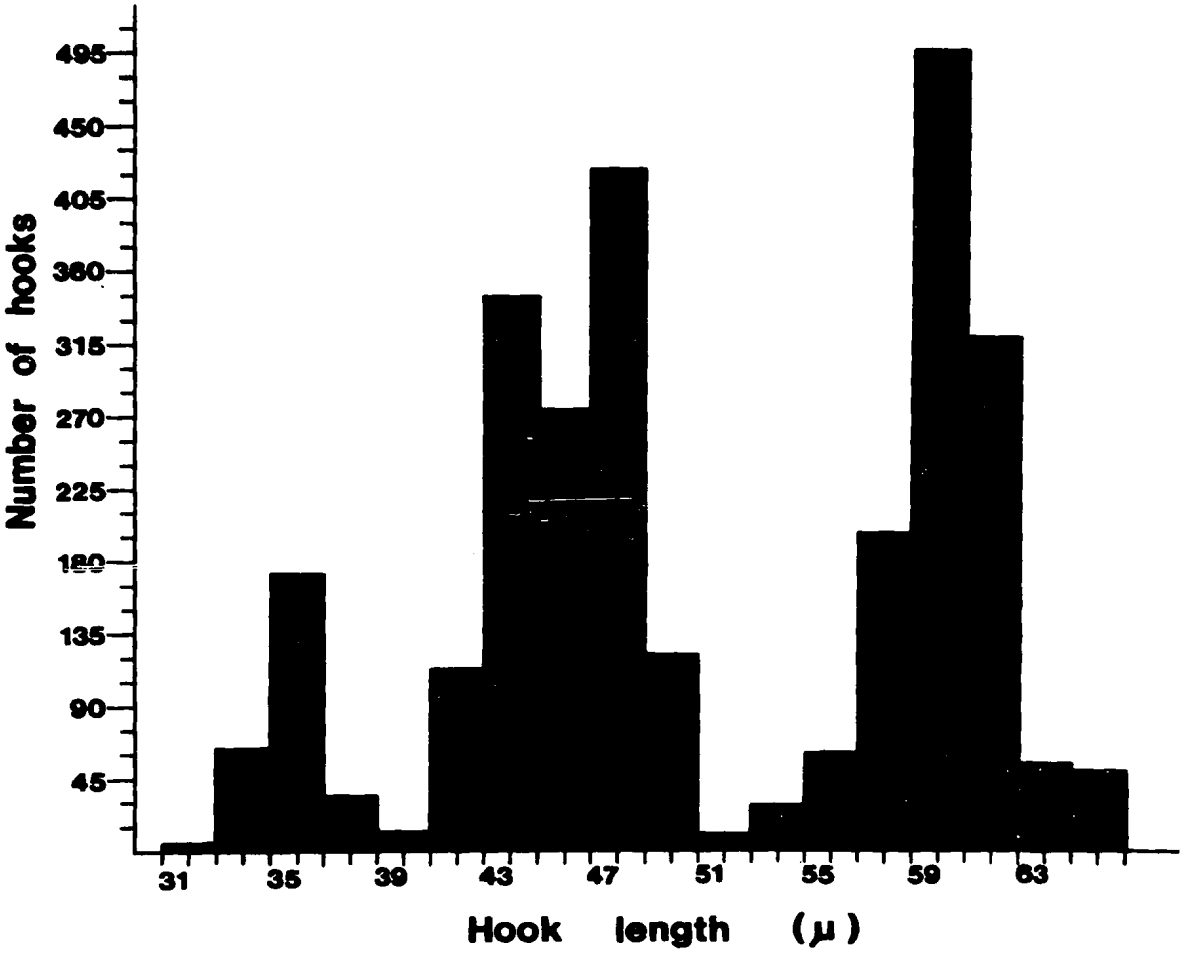

Number of hooks
495
450
405
360
315
270
225
180
135
90
45
31
35
39
43
47
51
55
59
63
Hook length (μ)

Figure 4.

Percentage distribution of rostellar hook lengths per section of gut from a sample of 2797 hymenolepid scolices.

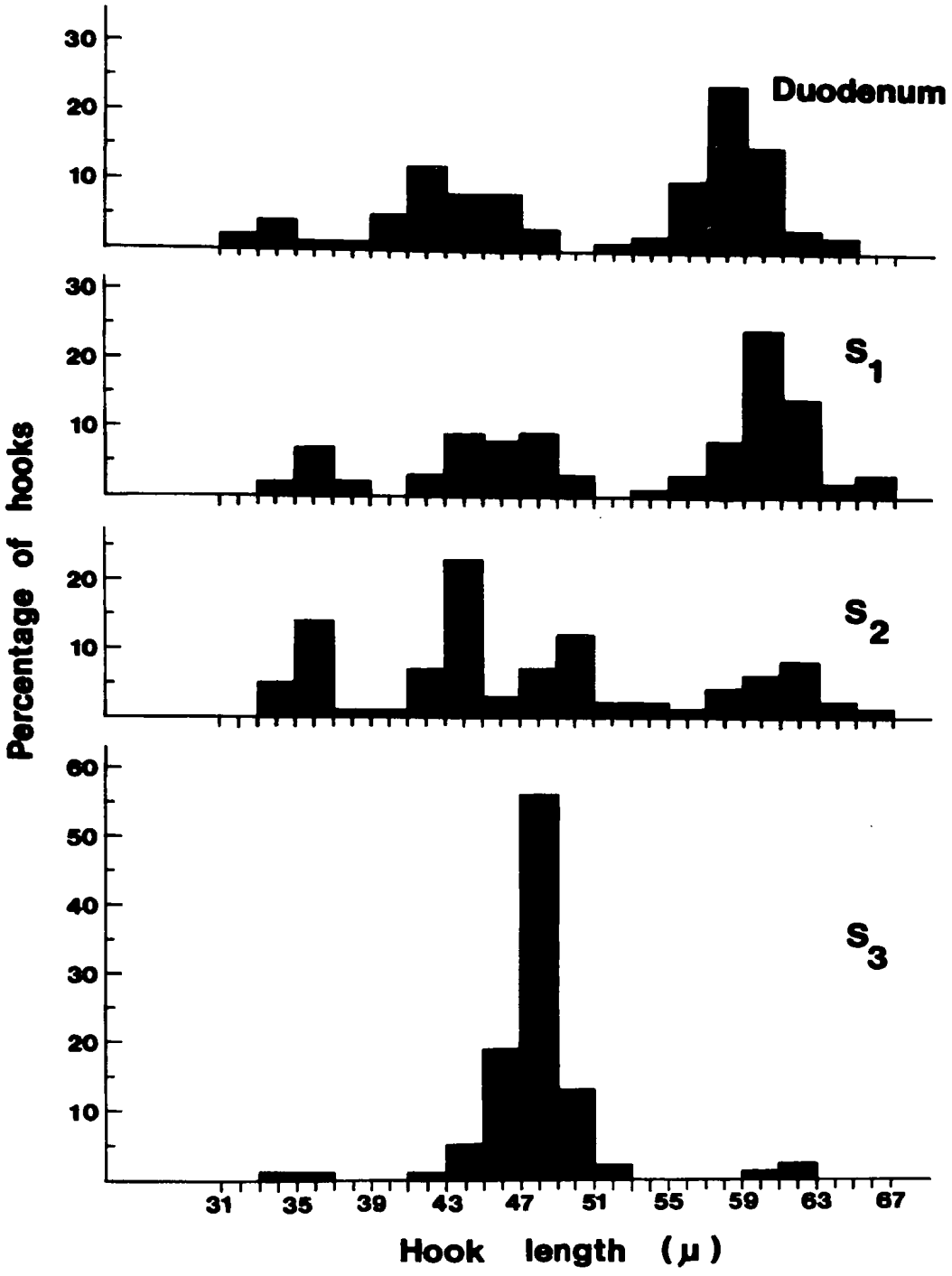
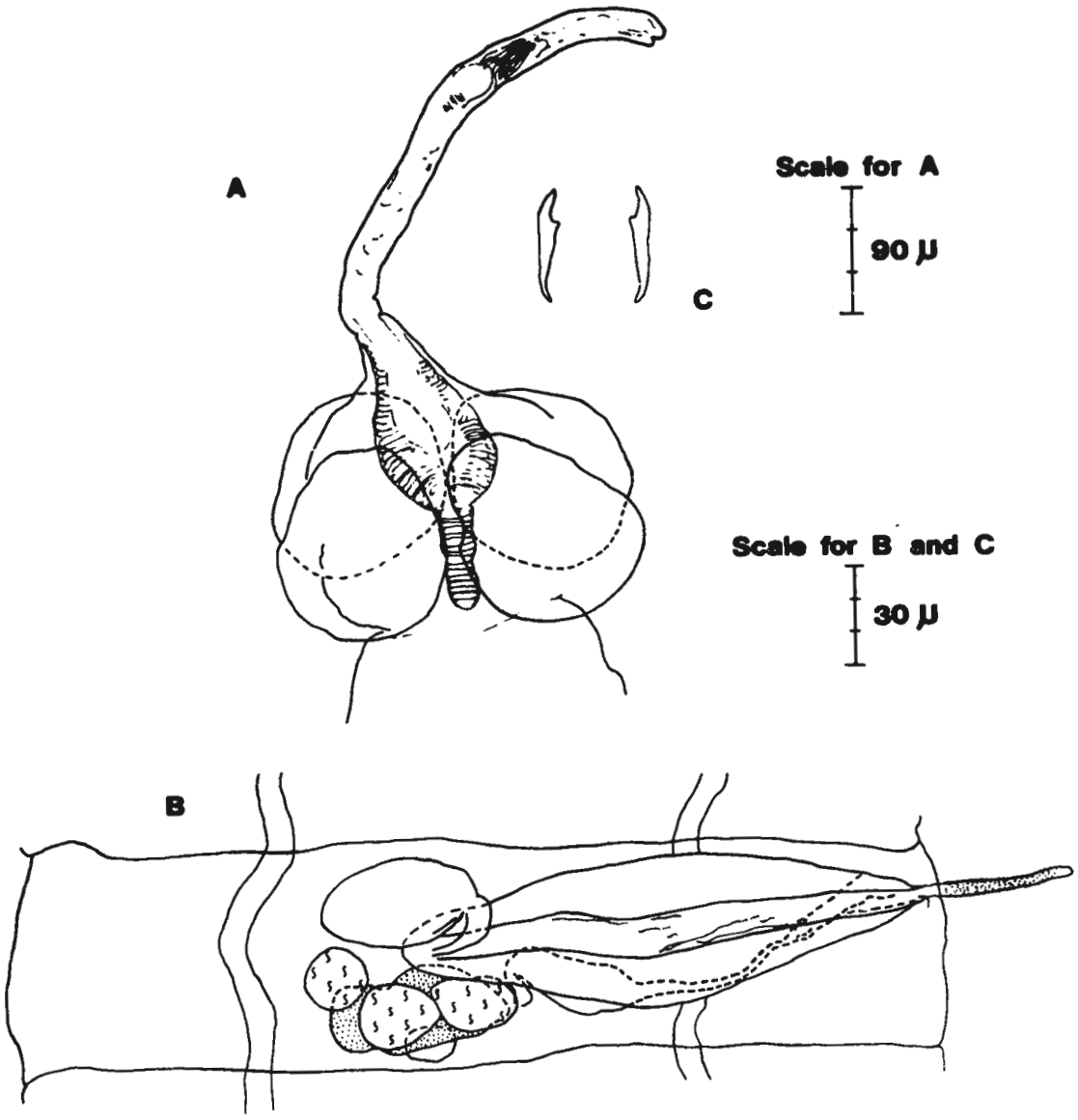

Duodenum
S1
S2
S3
Percentage of hooks
Hook length (μ)
31
35
39
43
47
51
55
59
63
67

Figure 5.

Hymenolepis (Microsomacanthus) formosoides. A. - scolex with everted rostellum. B. - mature proglottid. C. - rostellar hooks.


A
C
Scale for A
90 µ
Scale for B and C
30 µ
B

(Spasskii and Iurpalova, 1966; Tolkacheva, 1966). Measurements of specimens found in this study fell within the range given by Tolkacheva (1966) with the exception of the total length, maximum width, testes width, width of cirrus pouch and width of seminal receptacle (Table 8). The slight differences in dimensions could be the result of the state of maturity of the helminths, differences in techniques of preparation and measurement, and different host influence. In Tolkacheva's illustrations a swelling surrounds the genital openings, a feature not observed in the present specimens.

Hymenolepis (Microsomacanthus) microskrjabini Spasskii and Iurpalova, 1964

This species (Figure 6) was first described from the common scoter (Oidemia nigra (L.)) from Chukotka, eastern U.S.S.R. and subsequently from the scoter (Melanitta fusca (L.)) and oldsquaw (Clangula hyemalis (L.)) in Tamyr, eastern U.S.S.R. (Tolkacheva, 1966). Denny (1969) recorded this species from grebes (natural infection) and ducks (experimental infection) in western Canada. Measurements of specimens found in this study fell within the range given by Denny (1969) and Tolkacheva (1966) with the exception of total length, width of testes, and sucker dimensions (Table 9). The slight differences in dimension could also result from factors discussed under H. (M.) formosoides. The validity of figures given by Tolkacheva for width of the neck and maximum width may be questioned as they do not agree with the dimensions shown in the illustrations.

Table 8

Measurements of Hymenolepis (Microsomacanthus) formosoides Spasskaya and Spassky, 1961 obtained during the present study compared with those of Tolkacheva (1966).

	Hymenolepis (Microsomacanthus) formosoides	
	Tolkacheva (1966)	Present study Mean (Range)
Length (mm.)	1.4	3.0 (2.2-4.0)
Width (neck)	90	94 (60-125)
Width (maximum)	23?	332 (266-404)
Scolex, width	140-230	257 (204-302)
Suckers, length	70-120	130 (108-139)
width		111 (96-134)
Rostellar hook, length	32- 34	35 (35)
Testes, length	23- 42	24 (18- 30)
width	29- 46	19 (12- 24)
Cirrus pouch, length	130-140	130 (103-150)
width	30	42 (37- 46)
Ovary	90	-
Seminal receptacle, length	46- 56	41 (27- 57)
width	42- 46	15 (10- 24)
External seminal vesicle, length	30- 40	36 (23- 50)
width	30	23 (14- 36)
Eggs, length	17- 23	19 (18- 20)
width	15- 25	16 (15- 18)

Figure 6.

Hymenolepis (Microsomacanthus) microskrjabini. A - scolex with everted rostellum. B. - rostellar hooks. C. - egg. D. - scolex with inverted rostellum. E. - gravid proglottid. F. - mature proglottid.

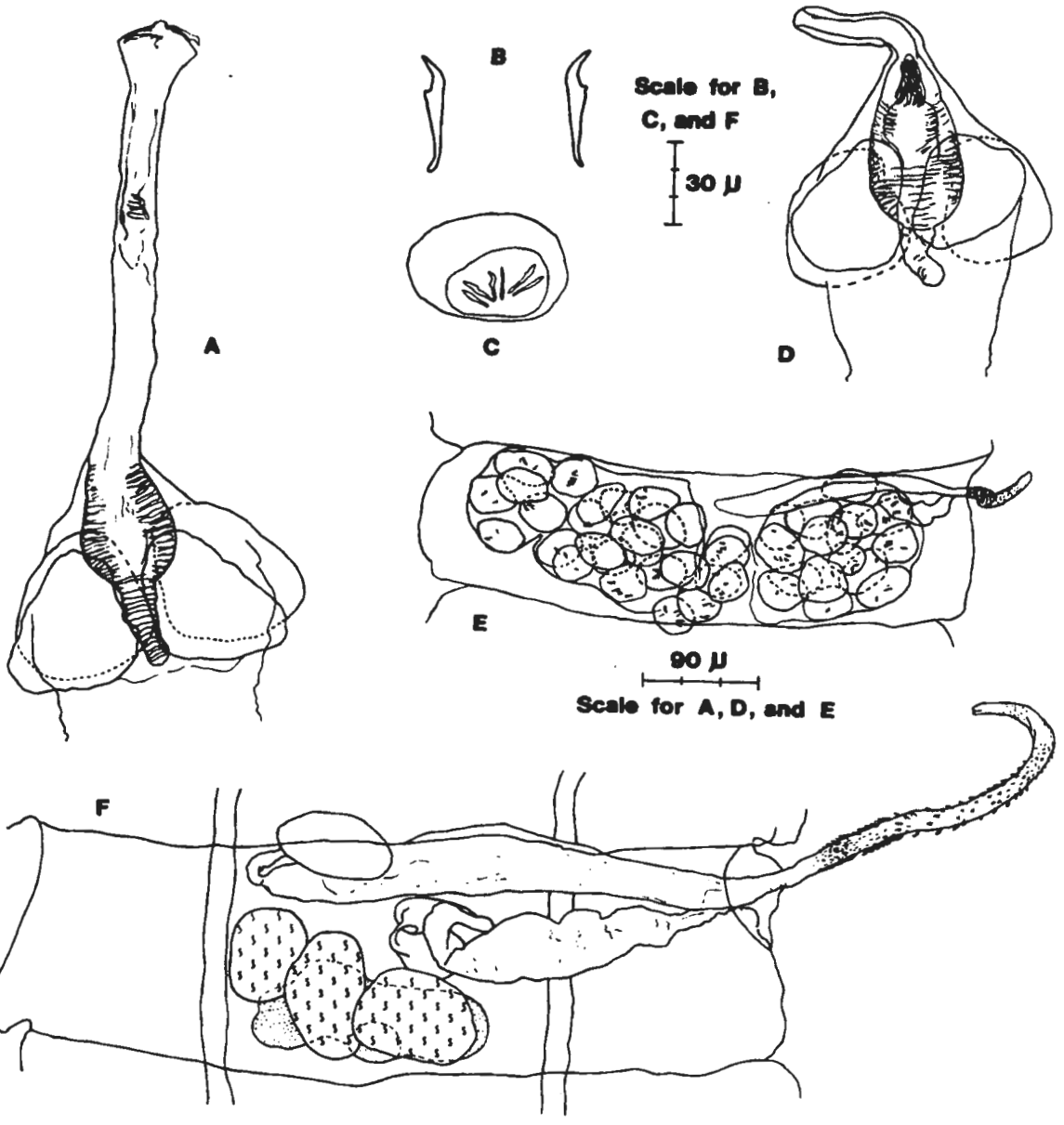

A
B
C
D
E
F
Scale for B, C, and F
30 µ
90 µ
Scale for A, D, and E

Table 9

Measurements of Hymenolepis (Microsomacanthus) microskrjabini Spassky and Iurpalova, 1964, obtained during the present study compared with those of Tolkacheva (1966) and Denny (1969).

	Hymenolepis (Microsomacanthus) microskrjabini		
	Tolkacheva (1966)	Present study Mean (Range)	Denny (1969)
Length (mm.)	2.0	6.2 (2.5-9.2)	2.5-4.5
Width (neck)	42x 11	166 (98-228)	109-117
Width (maximum)	50?	436 (286-542)	475-515
Scolex, width	230	221 (185-256)	197-250
Suckers, length	80x110	120 (115-122)	92-109
width	-	99 (91-105)	54- 65
Rostellar hooks, length	44	42 (40- 44)	39- 43
Testes, length	27- 32	33 (21- 42)	36- 54
width	23- 27	26 (18- 38)	25- 32
Cirrus pouch, length	160-170	173 (144-204)	219-230
width	21	22 (18- 25)	-
Seminal receptacle, length	-	24 (16- 37)	-
width	-	16 (8- 24)	-
External seminal vesicle, length	40	44 (30- 67)	50- 69
width	50	30 (20- 45)	

Hymenolepis (Microsomacanthus) somateriae Ryzhikov, 1965

This species (Figure 7) was first described from the common eider in Chukotka, eastern U.S.S.R. (Ryzhikov 1965). Measurements of specimens found in the present study fell within the range given by Ryzhikov (1965) with the exception of hook length and size of the testes (Table 10). Possible reasons for these slight differences have already been discussed under H. (M.) formosoides. Ryzhikov did not describe the cirrus from the original material nor were his specimens mature enough to contain gravid proglottids.

Fimbriarioides intermedia (Fuhrmann, 1913)

This species was found in 41 (37%) of the birds examined (Table 7). The majority of the worms were found in the duodenum, smaller numbers being found in the gizzard and sections S_1 and S_4. F. intermedia has previously been recorded from the common eider in North America (Cooper, 1921; Schiller, 1955), Iceland (Fuhrmann, 1913) and the U.S.S.R. (Belopolskaya, 1952; Kulachkova, 1958). Belopolskaya (1952) found this species in common eider adults and chicks (74%:75% infection, respectively) from east Murman, U.S.S.R. In the Kandalaksha Gulf Kulachkova (1958) reported it from 54.1% of adults and from two "fledglings" she examined, the worms being found in the duodenum, except in heavy infections in which cases they also occurred in the first part of the small intestine. The mean infection noted was 100 (range 2 - 1100). Specimens from the present study agreed most closely with the descriptions and measurements given by Joyeux and Baer (1936), Schiller (1955), and Webster (1943), the only differences being in the width of the rostellum at the apex (present study 53 (50-55),

Figure 7.

Hymenolepis (Microsomacanthus) somateriae. A. - scolex with everted rostellum. B. - rostellar hooks. C. - egg. D. - scolex with inverted rostellum. E. - gravid proglottid. F. - mature proglottid.

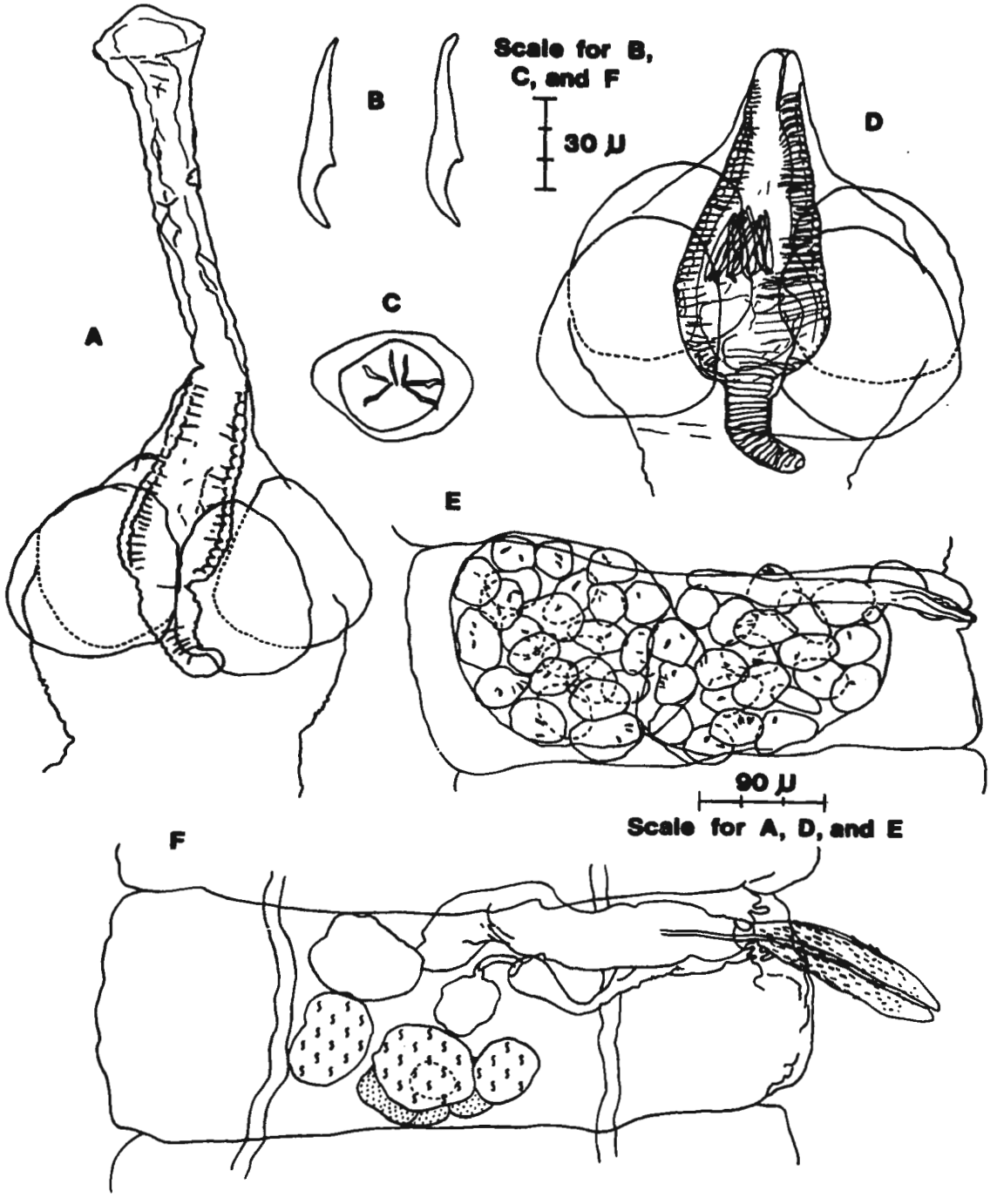

A
B
C
D
E
F
Scale for B,
C, and F
30 µ
90 µ
Scale for A, D, and E

Table 10

Measurements of Hymenolepis (Microsomacanthus) somateriae Ryzhikov, 1965 obtained during the present study compared with those of Ryzhikov (1965).

	Hymenolepis (Microsomacanthus) somateriae	
	Ryzhikov (1965)	Present study Mean (Range)
Length	5.8-7.2	9.7 (7.9-12.0)
Width (neck)	-	139 (106-161)
Width (maximum)	230	267 (204-386)
Scolex, width	230	262 (190-415)
Suckers, length	128	128 (110-149)
width	80	113 (77-168)
Rostellar hook, length	53- 56	60 (58- 61)
Testes, length	15- 18	33 (23- 49)
width		27 (20- 48)
Cirrus pouch, length	76-116	114 (85-156)
width	20	21 (17- 25)
Seminal receptacle, length	15- 18	20 (13- 32)
width		15 (10- 23)
External seminal vesicle, length	18- 20	29 (16- 45)
width		21 (10- 31)

Schiller (35)), and the width of the cirrus pouch (present study 48 (46-50), Joyeux and Baer, 35). Highest intensities and rates of infection were found in the adult and subadult age classes, no chicks being infected.

Nematoda

Seven species of adult nematode parasites, three species of larval parasites and seven species of free-living larvae and adults were noted during this study. A total of 80 (73%) birds were infected with parasitic forms.

Parasitic nematodes: (i) Adults

Capillaria nyrocinarum Madsen, 1945

This species was found in 52 (47%) of the birds studied (Table 11) with numbers varying from 1-44 (mean 3). Worms were found in four sections (S_1, S_2, S_3, S_4) of the small intestine, the large intestine, caeca, cloaca, oviduct, and gizzard. The species has been recorded, previously, from anatids in Europe, Asia, and North America (vide McDonald, 1969 (b)). It was first recorded by Madsen (1945) from eight species of diving ducks in Denmark. He found it most often in the common eider (67% infected; sample size 28 birds, ages not specified), the caeca, rectum and small intestine being the normal sites of infection. Measurements of specimens in the present study agreed with those given in Madsen (1945). Representatives of the species were located in all age classes of birds except chicks. If the chicks are excluded, 56% of the birds examined during the present study were infected, a figure approximating that of Madsen (67%).

Amidostomum acutum (Lundahl, 1848)

Representatives of this species were found in 48 (44%) of the

Table 11

Details of infection of 110 common eiders (S. mollissima L.) with nematodes and acanthocephala.

	No. birds	Percent infection	Nematoda								
			Capillaria nyrocinarum			Amidostomum acutum			Streptocara crassicauda		
			a	b	c	a	b	c	a	b	c
Males											
Adult	3	100	67	(1)	1	67	(6-13)	9	-	-	-
Subadult	23	83	57	(1-18)	4	57	(1-24)	5	13	(1-3)	2
Juvenile	10	70	30	(7-24)	12	20	(1- 3)	2	10	(1)	1
Chick	13	-	-	-	-	-	-	-	-	-	-
Subtotal	49	59	37	(1-24)	5	35	(1-24)	5	8	(1-3)	1
Females											
Adult	44	93	64	(1-44)	6	64	(1-80)	7	14	(1-3)	1
Juvenile	11	82	45	(1-20)	9	27	(1- 2)	1	18	(1-4)	2
Chick	4	-	-	-	-	-	-	-	-	-	-
Unknown	2	50	50	(1)	1	-	-	-	-	-	-
Subtotal	61	84	56	(1-44)	6	51	(1-80)	6	13	(1-4)	2
Total	110	73	47	(1-44)	6	35	(1-80)	6	11	(1-4)	2
Status				* *			* *			* *	

a - percent infection; b - range of numbers per infected bird; c - mean number per infected bird.

Status: * - new host record; ** - new records for common eiders in N. America.

Table 11 (Continued)

	Nematoda												Acanthocephala		
	Echinuria borealis			Echinuria uncinata			Paracuaria tridentata			Tetrameres somateriae			Polymorphus botulus		
	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Males															
Adult	-	-	-	-	-	-	-	-	-	33	(1)	1	100	(3- 40)	25
Subadult	13	(1-3)	2	4	(97)	97	9	(1)	1	57	(1-20)	5	100	(1-468)	90
Juvenile	-	-	-	-	-	-	-	-	-	60	(1- 8)	2	100	(17-654)	152
Chick	-	-	-	-	-	-	-	-	-	-	-	-	62	(8-127)	39
Subtotal	4	(1-3)	2	2	(97)	97	4	(1)	1	41	(1-20)	4	90	(1-654)	90
Females															
Adult	-	-	-	-	-	-	2	(1)	1	43	(1-25)	4	96	(1-406)	63
Juvenile	9	(4)	4	-	-	-	-	-	-	45	(1-39)	10	100	(11-275)	113
Chick	-	-	-	-	-	-	-	-	-	-	-	-	50	(12- 22)	17
Unknown	-	-	-	-	-	-	-	-	-	-	-	-	100	(22- 94)	62
Subtotal	2	(4)	4	-	-	-	2	(1)	1	39	(1-39)	5	93	(1-406)	71
Total	3	(1-4)	3	1	(97)	97	3	(1)	1	40	(1-39)	5	92	(1-654)	80
Status		*			* *			*			* *				

a - percent infection; b - range of numbers per infected bird; c - mean number per infected bird.

Status: * - new host record; ** - new records for common eiders in N. America.

birds examined (Table 11). The worms were located beneath the gizzard lining, most frequently at the junction of the proventriculus and gizzard and the duodenum and gizzard, where the lining is thinner and the gizzard itself is softer. Specimens were occasionally found free in the proventriculus.

McDonald (1969 (b)) records this species as a characteristic helminth of waterfowl occurring in a variety of hosts from many localities. It has been recovered from the common eider in Finland (Czaplinski, 1962 (a)), U.S.S.R. (Kulachkova, 1958) and from other waterfowl in the U.S.A. (vide McDonald, 1969 (b)). Clark, et al. (1958) report finding specimens of an Amidostomum in common eiders from Massachusettts but did not identify them to the species level. Identification of the present specimens was based on the description of Czaplinski (1962 (a)) who revised the genus Amidostomum reducing the numbers of valid species from 17 to 6.

Kulachkova (1958) recorded Amidostomum boschadis for the first time from common eiders in the U.S.S.R. However, in his revision, Czaplinski (1962 (a)) relegates A. boschadis into synonmy with A. acutum, the latter name having precedence. Kulachkova (1958) found this worm in 1% of the 146 chicks and 81.6% of the 61 adult common eiders she examined, finding most of the worms beneath the gizzard lining, individual worms also being encountered in the esophagous, intestine, and caeca.

Streptocara crassicauda (Creplin, 1829)

This species was found in 12 (11%) of the birds examined, (Table 11) in the proventriculus and gizzard. S. crassicauda is a characteristic helminth of waterfowl (vide McDonald, 1969 (b)), having

been found in a variety of hosts from many locations in the Holarctic. Kulachkova (1958) recorded it in a four week old common eider chick from the Kandalaksha Gulf, U.S.S.R. and noted that it had been found in this host in Eastern Murman by Belopolskaya (1952) and in the eastern U.S.S.R. by Oshmarin (1950). Measurements of specimens in the present study agreed with those given by Gibson (1968) who presented a review of the genus Streptocara Railliet et al., 1912.

Echinuria borealis Mawson, 1956

Eight (5 immature) specimens of this species were found in the esophagus and proventriculus of three birds (Table 11). Mawson (1956) first described E. borealis from ducks in the Hudson Bay region of Canada. She records it from the king eider (Somateria spectabilis (L.)) and the oldsquaw (Clangula hyemalis (L.)), the inference from her paper being that the holotype of E. borealis was found in the former species. Measurements of specimens in the present study agreed with those given in Mawson (1956).

Echinuria uncinata (Rudolphi, 1819)

Ninety-seven specimens of E. uncinata were found in the proventriculus and gizzard of one bird (1% of total birds examined). The worms were found in 4 nodules, 2 in the wall of the posterior part of the proventriculus (44 worms - 18 females; 26 males) and 2 in the anterior region of the gizzard (53 worms - 32 females; 21 males).

E. uncinata is a common parasite of waterfowl and has a very wide geographical distribution (vide McDonald, 1969 (b)). It has been

recorded from the European common eider (Bezubik, 1956) but not from the North American subspecies (vide McDonald, 1969 (b)). Measurements of specimens in the present study fell within the range given by Czaplinski (1962 (b)). The latter author also included measurements from Cram (1927) and Bezubik (1956) in his work.

Paracuaria tridentata (Linstow, 1877)

Three specimens of this species were located in the proventricular region of three birds (Table 11). This helminth is typical of lariform birds (vide McDonald 1969 (b)) and has not previously been recorded from the common eider. It has previously been reported by Threlfall (1968 (b)) from the herring gull (Larus argentatus Pont.) in Newfoundland. In the present study specimens were identified using the descriptions of Cram (1927) and Rao (1951).

Tetrameres somateriae Ryzhikov, 1963

Representatives of this species were found in 44 (40%) of the birds examined (Table 11). Specimens were found in the esophagus, proventriculus and gizzard, the proventriculus being the most frequently infected site. The species was described from a series of adult male worms obtained from common eiders examined by Ryzhikov (1963 (c)),seven of which were found to be infected with this helminth (2-26 worms per bird: total recovered 69). Measurements of the present specimens, all males, fell within the range given by Ryzhikov (1963 (c)) except for the distance between the anus and the posterior end (present study 191 (160-223); Ryzhikov 245 (224-261)).

Parasitic nematodes (ii) Larval forms

Capillaria sp.

One specimen, measuring 550 in length and 20 in width, was found in the small intestine (section S_3) of an adult female. The helminth was extremely slender and lacked lips around the mouth.

Tetrameres sp.

Four specimens were found in the esophagus and proventriculus of three adult females and the proventriculus of one male chick. The shape of the buccal capsule and cervical papillae were similar to those seen in adult male Tetrameres somateriae Ryzhikov, 1963. No spicules or body spines were observed which might indicate that the specimens were developing females. Measurements of the larvae are as follows: length, 2000 (1700 - 2400); width 96 (77 - 120); buccal capsule, length 19 (18 - 21), width 9 (6 -11); distance of cervical papilla from anterior end, 116 (111 -120).

Anisakis sp., larva I

A single Anisakis sp.larva was located in the gizzard of an adult female bird. The larva was similar to that described by Berland (1961) from Norwegian fishes as Anisakis sp., larva I, which is always found encysted in the viscera of marine fishes. The bird from which the larva was obtained had fish remains (muscle, vertebrae and eggs) in its proventriculus. The fish was probably a caplin (Mallotus villosus Müller) which is extremely common in Newfoundland waters in the summer, appearing in vast shoals and spawning in inshore waters at the time the bird was

taken (June 28). Anisakis larvae have been recorded previously from caplin in Norway (Berland, 1961) and Newfoundland (G. Winters, pers. comm.).

Free living nematodes:

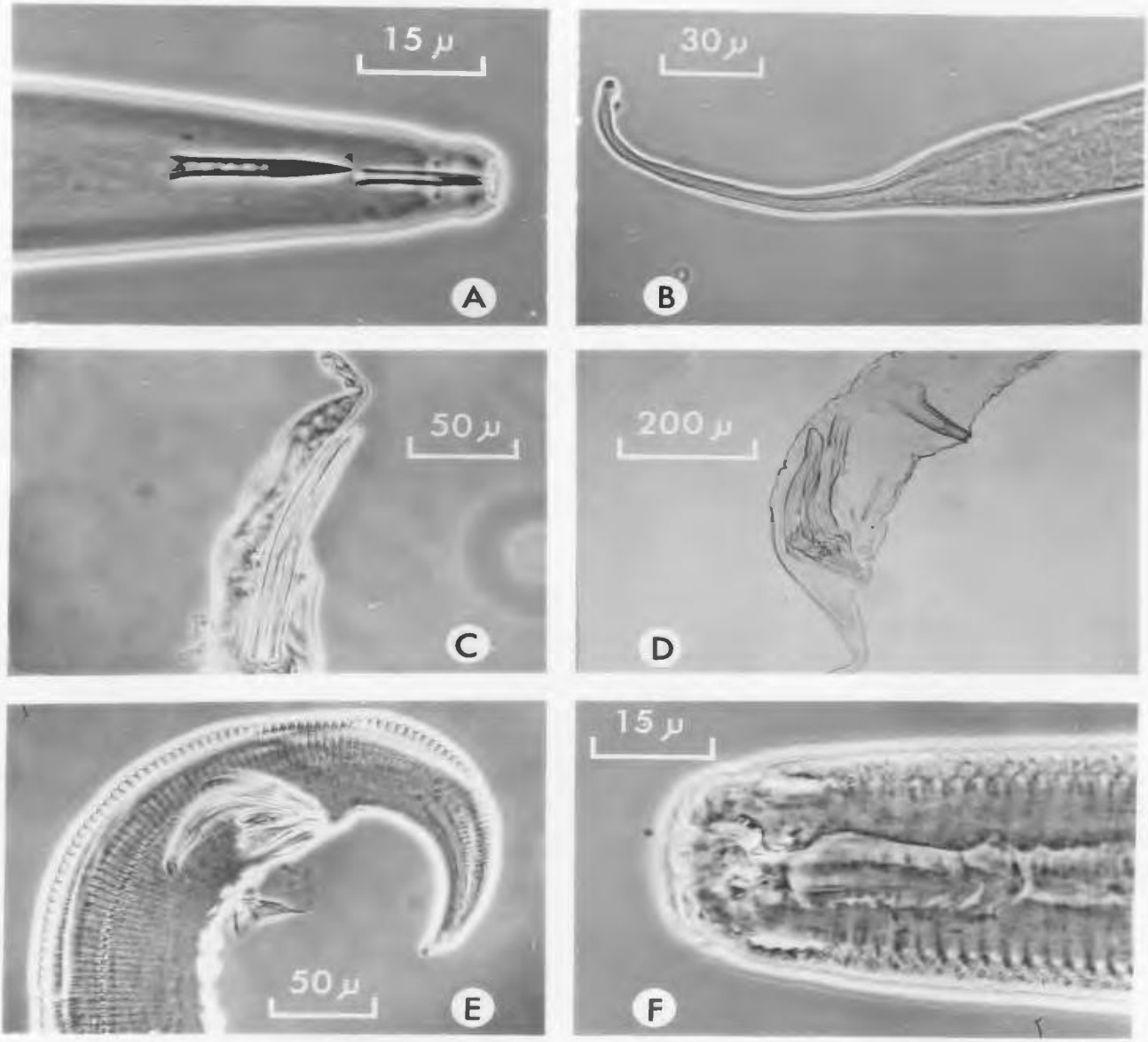
A total of four larvae and three adult free-living forms were found, none of which were identified to the species level. In no case was it possible to assign the larvae to any specific group, consequently these helminths are designated as Form A, Form B, Form C, etc. All these forms were probably ingested with the bird's food and in cases where they were found in organs other than the alimentary tract the helminths were probably there as a result of contamination.

Form A:

Eighteen specimens were found in 14 birds from all age classes of both sexes. Sites infection included, the liver, trachea, lung, proventriculus, gizzard, small intestine (S_1, S_2), large intestine, kidney, ureters, and the oviduct. The main distinguishing feature of these larvae was the presence of two stylets (Figure 8 (A)). One was associated with the buccal capsule and sometimes projected through the mouth, while the second was in a position posterior to the first. The anterior stylet measured 17-23 (mean 21) in length while the posterior one measured 22-30 (mean 27). The larvae measured 1700 to 2300 (mean 2000) in length and had a maximum width of 38 to 65 (mean 50). The buccal capsule was 4 to 8 (mean 5.5) long and 7 to 10 (mean 8) wide.

Figure 8.

Free-living nematodes. A. - Form A; B. - Form C; C. - Form D; D. - Form G; E. and F. - Form F.


15 µ
A
30 µ
B
50 µ
C
200 µ
D
50 µ
E
15 µ
F

Form B:

Thirteen specimens, identified as belonging to either the order Chromadoroidea or Araeolaemoidea as described by Hyman (1951), were found associated with the lungs, liver, spleen, proventriculus, small intestine (S_2, S_3, S_4) and the ureters. These orders contain free living marine forms which possess spiral amphids.

The larvae measured 550 to 950 (mean 780) in total length and 20 to 85 (mean 39) in maximum width. The buccal capsule was 17 - 19 (mean 18) in length and approximately 5 in width and bore two short anteriorly projecting tooth-like structures. The mouth region possessed fine cuticular extensions resembling a corona radiata.

Form C:

Eleven specimens (Figure 8 (B)) were found in a variety of locations in the body (lungs, oviduct, proventriculus, duodenum, small intestine (S_1, S_2, S_3), large intestine, and caeca). The larvae measured 1150 - 2100 (mean 1470) in length and 33 - 75 (mean 49) in width. The buccal capsule was relatively large (28 - 50 (mean 48) long: 9 - 32 (mean 20) wide), and possessed two anteriorly directed tooth-like structures on the internal surface.

Form D:

Nineteen specimens of this form (one in a kidney, 18 in the esophagus) were found in two adult females. These adult forms (4 males, 15 females) measured 5300 to 6300 (mean 5800) in length and 81 to 100 (mean 90) in width. The buccal capsule measured 28 to 51 (mean 37) in

length and 15 to 26 (mean 19) in width, and possessed an anteriorly projected tooth on its inner surface. The two spicules (Figure 8 (C)) were similar in size and shape having a length of 138 to 145 (mean 141) and a width of 8 to 11 (mean 10).

Form E:

Only one specimen of this form was recovered, from the cloaca of a subadult male. It measured 1300 in length, 73 in maximum width, with the distance from the anus to the posterior end being 200. There were also four cuticular projections from the anterior end around the mouth.

Form F:

Two male specimens having lengths of 1100 and 2000 were found in the esophageal region of two male chicks. The buccal capsule (Figure 8 (F)) bore tooth-like structures, while the anterior end also carried four small projections of cuticular origin. The cuticle had an annulated appearance and there were longitudinal and caudal alae. The two spicules (Figure 8 (E)) were similar in size (56 in total length) and shape, having a somewhat enlarged aporal end (29 wide) and a poral tip that was bent at almost 90° to the long axis of the spicule.

Form G: (*Enoplus* sp.?)

Eight specimens (7 female, 1 male) were found in the esophagus of two birds. The females measured 2800 to 3800 (mean 3200) in length, while the lone male was 4700 long. The width of females was 115 - 139 (mean 161) while the male was 161 wide. The distance from the anus

to the posterior end was 168 - 187 (mean 174) in females. In this form the buccal capsule was indistinct and consequently was not measured. The lip region and walls of the buccal capsule were thickened and there were spine-like structures projecting from the cuticle just posterior (approximately 12μ) to the mouth. The male specimen possessed two equal length, irregularly shaped spicules (Figure 8 (D)) approximately 230 in length. Anterior to the spicules was a club shaped accessory copulatory organ. The gut of two specimens contained diatoms (Cocconeis sp., Navicula sp., Licomorpha nervosa, Acnanthes sp.). A photograph of some of these is shown in Figure 9 . Their presence would indicate that the nematode was not parasitic but free living and were acquired by the ducks when they fed. The region of recovery, the esophagus lends weight to this idea as this would be the area where the worms would probably be released from the food.

Acanthocephala:

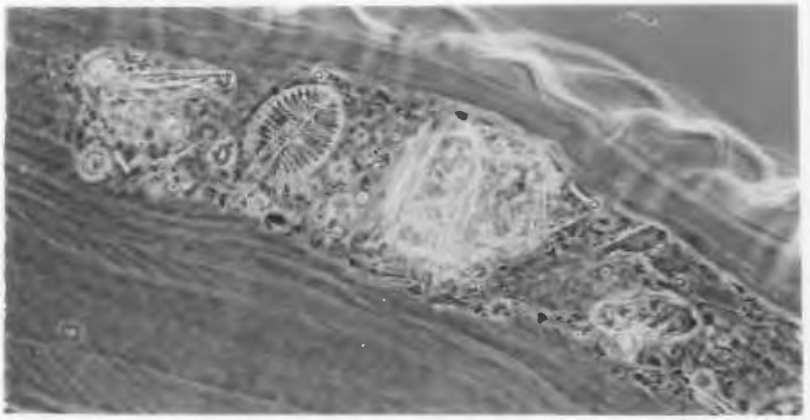
Five species of acanthocephala belonging to two genera (Corynosoma mergi Lundstrom, 1941; Polymorphus anatis (Schrank, 1788); P. arcticus (Van Cleave, 1920); P. botulus (Van Cleave, 1916); P. minutus (Goeze, 1782)) have been reported from common eider ducks, including three from North America (McDonald, 1969 (b)).

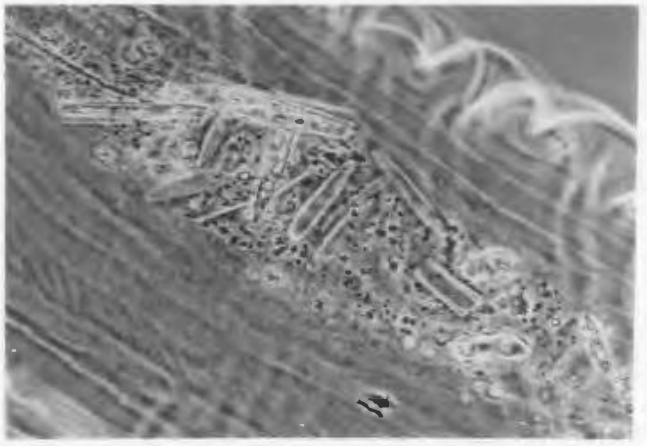
Polymorphus botulus (Van Cleave, 1916)

In the present study this species was found in 101 (92%) of the birds examined (Table 11) in numbers ranging from 1 to 654 worms (mean 80). Worms were found in all sections of the small intestine (S_1, S_2, S_3, S_4), the large intestine, and the caeca, the highest

Figure 9.

Diatoms in gut of a free-living nematode (Form F).





numbers being located in S_2 (25.5% of the total number found) and S_3 (63.6%). Specimens from the present study were identified as P. botulus using the original description of Van Cleave (1916) and a key to the species of Polymorphus by Schmidt (1965). Measurements of helminths recorded in the present study compared favorably with the original data of Van Cleave with the exception of measurements for total length and proboscis (Table 12). These differences plus the wide range of measurements observed for some categories could possibly be explained by normal variation within the species and/or different ages of worms measured. P. botulus has been recorded from the common eider from eastern North America, including Newfoundland (Threlfall, 1968 (a); Van Cleave, 1916: Van Cleave and Rausch, 1951), and from Europe (vide McDonald, 1969 (b); Kulachkova, 1958).

Kulachkova (1958) found this species in 49.1% of the adult common eiders and 6.2% of the fledglings she examined from the Kandalaksha Gulf region (maximum infection 746), the site of infection being the "rear third" of the small intestine, and the large intestine. She also noted a marked seasonal pattern of infection, frequency and intensity being highest in the spring and lowest in the summer, while in the fall the intensity remained low but the frequency of infection increased. She stated that the birds receive most of these parasites either in late autumn or in winter with reduction in numbers beginning in late May. Garden, et al. (1964) examined 193 common eiders in Scotland and found 79% infected with P. botulus. Highest infection rates were found in immature birds, intensities ranging as high as

Table 12

Measurements of Polymorphus botulus (Van Cleave, 1916) obtained during the present study compared with those of Van Cleave (1916).

	Polymorphus botulus		
	Present study		Van Cleave (1916)
	Males Mean (Range)	Females Mean (Range)	
Body length (mm.)	9.5 (8- 10)	11.2 (8.5-13.5)	approx. 20
width (mm.)	1.5 (1.0-1.8)	1.8 (1.5- 2.2)	
Proboscis width	254 (218-306)	308 (247-415)	570
No. rows of proboscis hooks	17 (16- 17)	16 (16)	16
No. proboscis hooks per row	(6- 7)	(6- 7)	7- 8
Length of proboscis hooks * (1	66 (48- 82)	56 (53- 60)	60- 62 (basal hooks)
(2	65 (48- 84)	63 (53- 86)	
(3	64 (55- 82)	61 (50- 84)	
(4	62 (48- 82)	67 (62- 78)	
(5	69 (55- 84)	67 (60- 82)	
(6	69 (60- 77)	60 (50- 70)	
(7	63 (55- 77)	55 (55)	
Testes, length	866 (722-1050)		
width	473 (395-589)		
Ovarian balls, length		224 (125-297)	
width		118 (77-191)	
Eggs, length		90 (72-106)	71- 83
width		31 (16- 43)	30

* Numbers indicate the row of proboscis hooks beginning at the basal row.

2401 per bird. Females of both adult and immature age groups had heavier infections than males. The degree and intensity of infection in birds that had been found dead was similar in the two sexes and various age groups suggesting some correlation between the degree of infection with parasite and mortality rate.

In the present study numbers of birds collected per age group and per month were considered insufficient to draw any conclusions as to seasonal or age variation. The mean number found per month, however, showed infections to be low in the fall and early winter (November - 46/ infected bird; December - 69/infected bird), high in winter and early spring (January - 104/infected bird; March - 510/infected bird), and low again in summer (June - 72/infected bird; July - 37/ infected bird). It was found that adult females which were nesting or with young had few or none of these parasites. Thirty of the 44 adult females were collected in the summer (23 breeding birds; 7 non breeding), the mean for breeding birds, being 33 (1-209) while that for non-breeders was 119 (22-406). The breeding female harboring the highest infection (209) had not finished egg laying and consequently had not fully entered the nesting cycle. If this high number is omitted the mean infection for breeding birds becomes 25.

The freeing of the breeding adult females from acanthocephala has been related to the fact that the birds do not feed, or if so, feed on plant material while nesting (Kulachkova, 1958). Cornwell and Cowan (1963) in a study on the helminth populations of the canvasback duck (Aythya valisineria (Wilson)) in North America also commented on the reduction or loss of intestinal helminths when the birds change feeding

habits and utilize plant food, mainly algae. They suggest that either through abrasion or chemical alteration of intestine contents the algae are a natural means of deworming the host. Of the 23 breeding females examined during the present study ten had no food in their digestive tracts while seven contained shell fragments (Mytilus edulis L.) and six contained small quantities of items such as fish, fish eggs, shell fragments, small gastropods, and algae. The non-breeding summer females also had little food in their digestive tract. In the breeding females it was also observed that the gizzard and the intestine appeared much reduced in size.

Considerable host reaction to the presence of this worm was observed in the present study, a feature also reported by other authors, (Clark, et al. (1958), Harrison (1955). Scars were noted on the intestine wall in all cases where there was an infection and often in the absence of an infection. These scars, a condition referred to as nodular taeniasis by Harrison (1955), are host reactions to the embedded proboscis of the worm, (Figure 10.).

P. botulus has been reported as being pathogenic to eiders (Christiansen, 1948; Clark, et al. 1958; Garden, et al. 1964; Grenquist, 1951; Kulachkova, 1958; Lampio, 1946; Swennen and Van Den Broek, 1960) and has been cited as the cause of heavy mortality and epizootics in some common eider populations. In four birds studied worms were found protruding through the wall of the small intestine. In two, a male chick and a juvenile male, there was little apparent damage, possibly because the condition was of recent origin, while in the other two, both adult

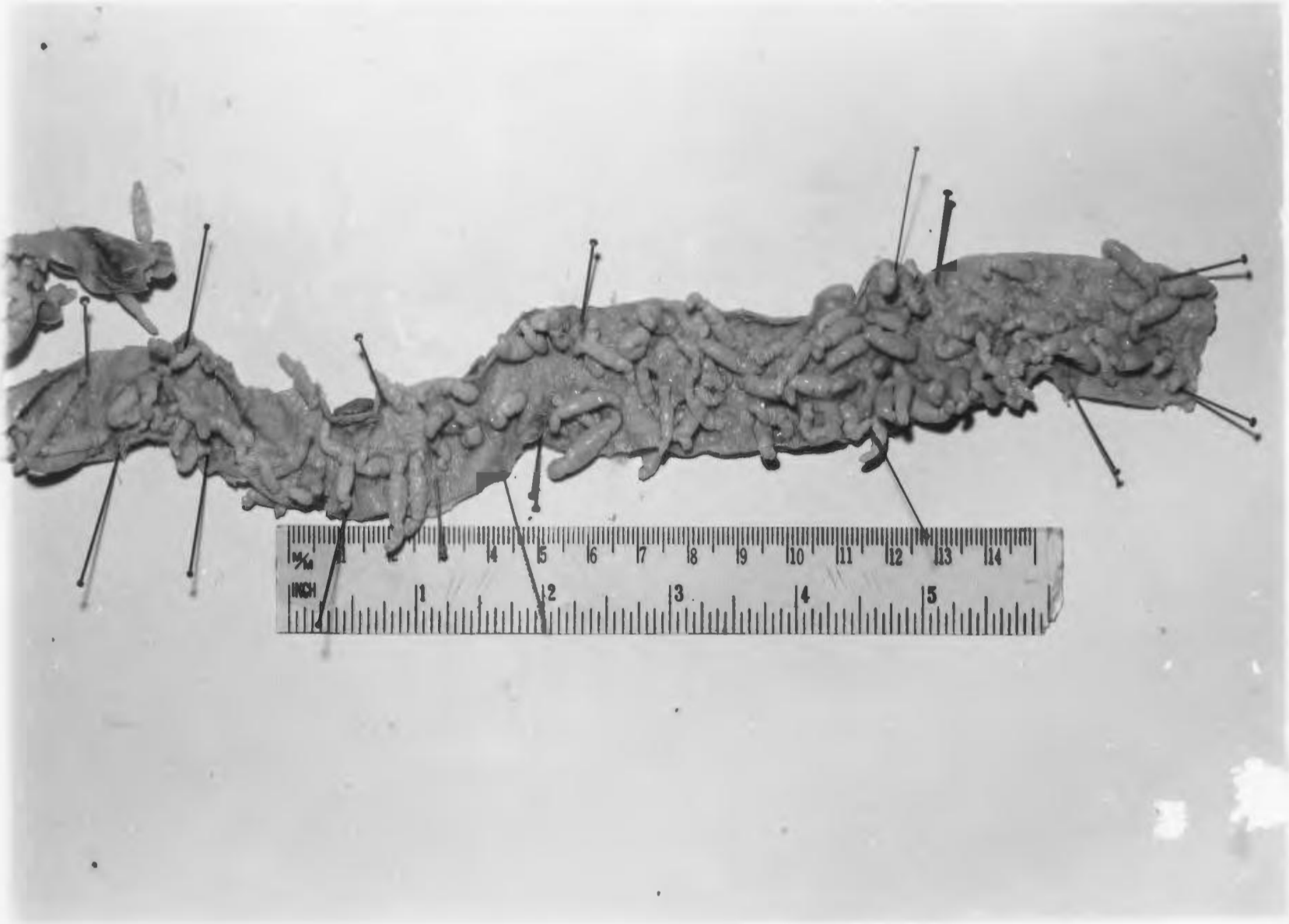

INCH
1
2
3
4
5

Figure 10.

Polymorphus botulus attached to the small intestine of a common eider duck (*S. mollissima* L.).

females, considerable damage was evident (Figure 11). In both birds the intestines were held together by adhesions particularly around the area of worm protrusion. This condition probably reduced the mobility of the gut and consequently interfered with its proper functioning. Host reaction in the area of worm protrusion took the form of a thickening of that portion of the gut wall. It was also observed that shell fragments from ingested food seemed to gather in these infected areas forming hard plugs of material. The birds were emaciated and light in weight, even though they had been feeding. Parts of the viscera also appeared anemic as evidenced by their pale colour and blood that was much less viscous than normal. In these birds it was found difficult to obtain a good blood smear. In no other instances was the presence of these helminths thought to be detrimental to the host's well being.

Miscellaneous:

Haematozoa:

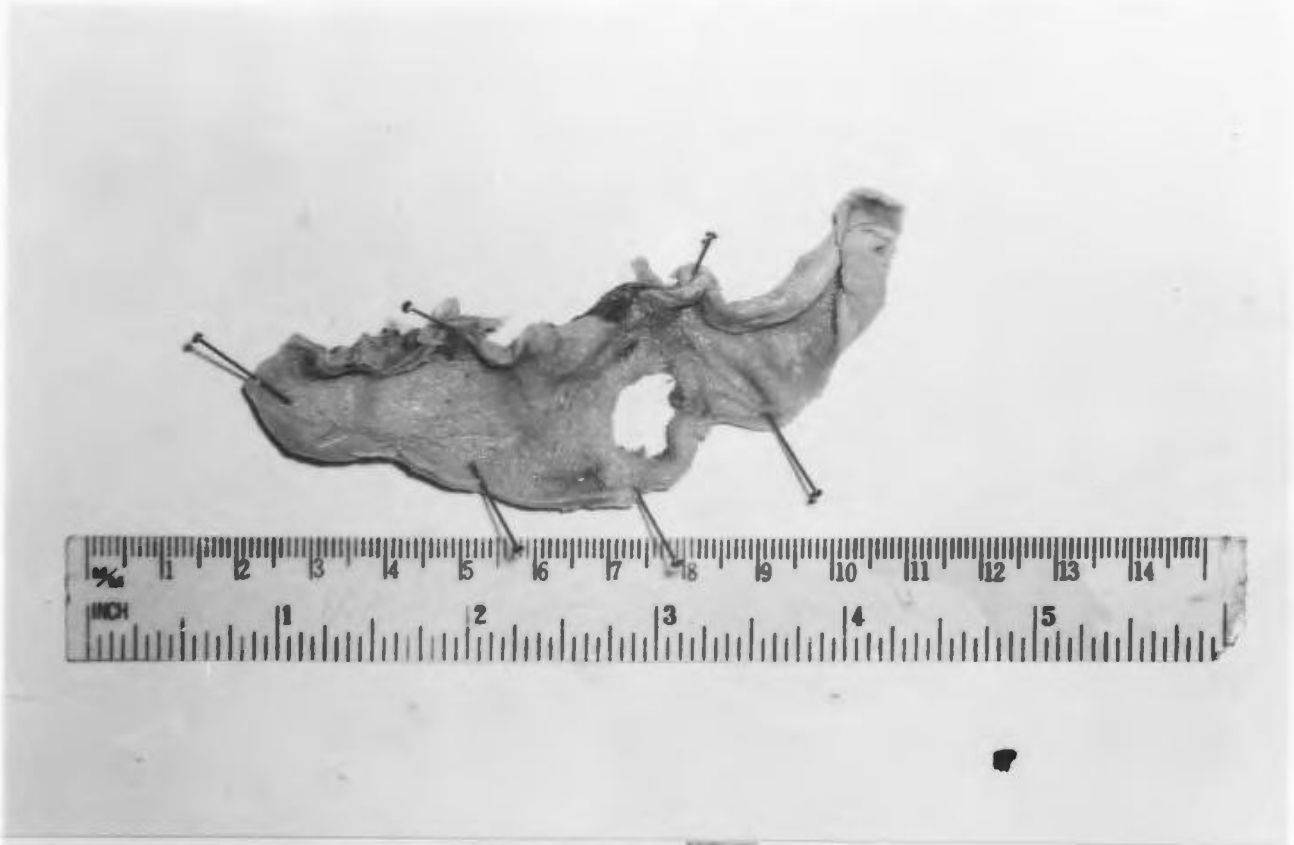
Blood smears were taken from 32 frozen and 57 freshly killed birds. Two of these, both breeding adult females collected from Area 3 (Figure 2), were infected with a Plasmodium sp. Specimens similar to this parasite have previously been found in waterfowl from the eastern United States and the maritimes of Canada, but not from the common eider (Dr. G. Bennett, pers. comm.).

Rotifera:

Organisms, identified as rotifers (Trichocerca sp. (?)), were found associated with the ureters, kidneys, tracheae, lungs, and oviducts

Figure 11.

Showing regions of common eider duck (S. mollissima L.) small intestine damaged by infection with Polymorphus botulus.


1
2
3
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5
INCH

of eight birds, seven of which were collected during the winter months.

Insect larvae:

Organisms identified as larval Chaoborus sp. (?) (Diptera, Culicidae), were located in six birds, from the kidney, trachea, oviduct, proventriculus, and esophagus. Some of these larvae were found alive even though the organs with which they were associated had been in 10% formalin for approximately 12 months.

Mallophaga:

One species of mallophagan (not identified to date) was found on 24 (22%) of the birds examined (up to 11 per infected bird). No differences were noted in the number of each age class infested nor was there any difference in intensity of infection. No sexual differences were noted, while chicks proved to be louse free.

Siphonaptera:

Ceratophyllus garei Rothschild, 1902

This species was recovered from 3 common eider nests collected on July 4, 1969 at St. Peters Is., Labrador. The numbers of fleas found per nest ranged as high as 100. C. garei has been recorded from common eiders and their nests in Britain (Rothschild, 1955; Waterston, 1906), Iceland (Henriksen, 1939) and Finland (Nordberg, 1936). The only record of its occurrence in North American eiders is that of Fox (1940) who found it in "eider down" from St. Mary's Is., Quebec. As stated by Holland (1949) "this Holarctic species is widespread across the northern part of North America, where it occurs on a variety of ground-nesting birds."

General Discussion

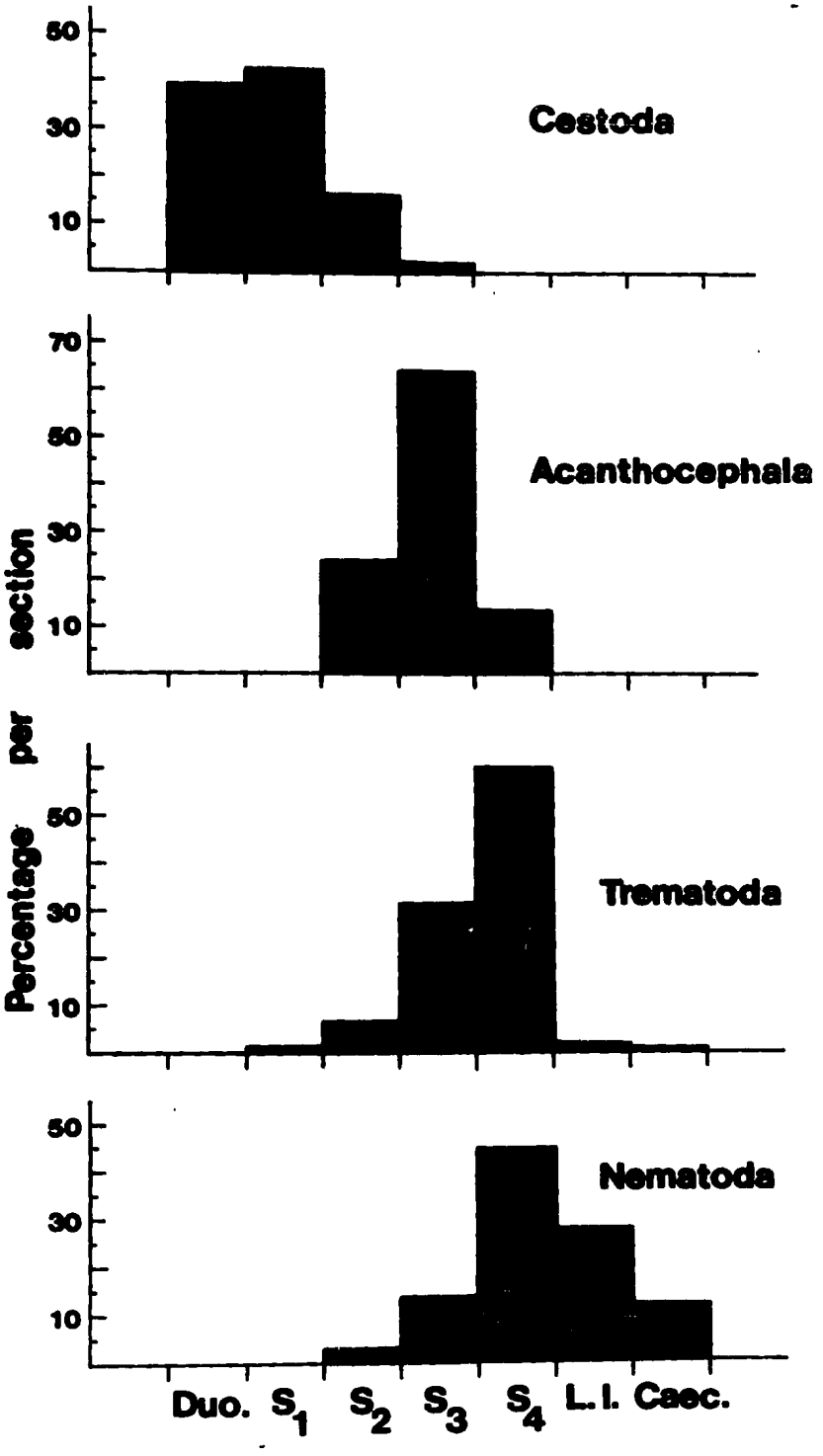
The total number of cestodes, trematodes, nematodes, and Acanthocephala, treated separately and expressed as a percentage occurrence for each section of the intestine infected is shown in Figure 12. Cestodes occupied the first portion of the intestine, Acanthocephala the middle and the posterior, and trematodes and nematodes the posterior part. The mean number of species of parasites found per adult female was 8 and male, 7; subadult male, 10; juvenile female, 9; and male, 9; and female chicks,2; male, 3. The lower numbers found in adult males might be influenced by the small sample size (3) and that for adult females by the reduction and loss of parasites by this group when breeding.

Considering the total parasite burden it was noted that juvenile birds are much more heavily infected than adults, the chicks becoming infected at an early age (2 weeks). In some cases 2 - 3 week old birds were found to contain large numbers of worms. Variations in the helminth burden with age could possibly be explained by an acquired immunity on the part of adult birds or by differences in feeding habits. Cornwell and Cowan (1963) also commented on the great variation within a group of birds, even within the same brood of ducklings. They attributed most of this variation to differences in feeding habits.

Eight of the parasite species found in this study have been previously recorded as being pathogens (*vide* McDonald, 1969 (b)) and some to cause epizootics and death in the host. In some cases it has been shown that the parasites have been the actual cause of death based on pathological evidence, while in other instances parasites have been incriminated in the deaths of large numbers of birds in the absence of other causes.

Figure 12.

Distribution of four parasite classes per section of gut examined.


Cestoda
Acanthocephala
Trematoda
Nematoda
Percentage per section
50
30
10
70
Duo.
S1
S2
S3
S4
L.I.
Caec.

The two species that have been recorded most frequently as pathogens are Polymorphus botulus and Echinuria uncinata. P. botulus has been recorded as the cause of mortality in Europe and North America. Cornwell (1963) reported the incidence of E. uncinata in waterfowl in Manitoba and claimed it to be a cause of mortality among young birds, listing the effects produced on the condition and behavior of the birds. Vehn (1954), Gibson and Barnes (1957) and Buxton, et al. (1952) also noted that this worm caused mortality in domestic waterfowl in Britain. In the present study no birds examined were found dead and the only parasitic species seen to cause observable damage to the ducks were Echinuria uncinata and Polymorphus botulus.

This study gives some indication of the parasite burden of common eiders in Newfoundland. Species and numbers of parasites found in European eiders would indicate that the numbers found in the present study are not abnormally high and that the numbers recorded in the present study possibly represent the "normal" parasite burden of a wild population of the common eider.

Summary

A survey was conducted to determine the parasite burden of the common eider duck (Somateria mollissima L.) in Newfoundland and Labrador coastal waters.

Methods of collection of specimens, of aging and sexing of the ducks and measurements taken, are discussed. Techniques used in the location of parasites, specific determination and in counting are dealt with.

A total of 110 ducks from six localities were examined. Twenty-seven species of parasites were recovered, eight being new host records and eighteen new records for the common eider in North America. They included ten species of trematodes, five cestodes, eight nematodes, one acanthocephala, one siphonapteran,one mallophagan and one haematozoan. Ninety-five percent of the ducks were infected with parasites, the number of species per infected bird ranging from 1 to 13 (mean 8).

For each of the major groups of parasites the percentage infection, range of numbers and mean number per infected bird for each sex and age group are given. Also discussed under each species recovered are the location of the parasite within the host, other host records, the authority used in specific determination and an explanation of variations, if any, from the original descriptions. When species were recorded previously from common eiders, the results obtained by the particular author and those of the present study were compared.

For some species the measurements from the original description and those from the present study are presented together in tabular form to compare similarities and minor variations, if any.

Three species of Hymenolepis (Microsomacanthus) were recovered and were found to vary somewhat in their distribution throughout the gut, the relative proportions of each being determined by a method of sampling rostellar hooks. The three species recovered are illustrated.

Both adult and larval, parasitic and free-living nematodes were found. Free-living nematodes were described but not identified to the species level. The seasonal occurrence of Polymorphus botulus is considered.

Age variation with parasitic infection showed juveniles to be much more heavily infected than adults. Chicks became infected at an early age (< 2 weeks).

Eight of the species found had previously been recorded as pathogens. In this study no birds were found dead and only Polymorphus botulus and Echinuria uncinata caused observable damage in the ducks.

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Appendix 1

Little data on the age of common eider chicks based on measurements has been reported to date. The tarsus measurements of two "known age" chicks in the ornithological collection of the Biology Department, M.U.N. were as follows: 24 mm. (1 day old chick), and 26 mm. (3 day old chick). Koskimies and Lahti (1964) gave the weight of one day old chicks in Finland as 61.4 gms., while Gerasimova and Baranova (1960) reported one day old chicks to be 78.5 gms. (59-98) based on measurements of 112 birds from the Kandalaksha Gulf, U.S.S.R. Gerasimova and Barnova (op. cit.) also give the growth rate as 10-15 gms. per day for the first 15-20 days. Research in Quebec (W. Threlfall, pers. comm.) on common eiders showed that two to three week old chicks averaged 280 gms. (235-338). This material would indicate that most if not all chicks in the present study (Table 13) were less than two weeks of age.

Table 13

Measurements of common eider (S. mollissima L.) chicks.

No.	Sex	Wt. (gms.)	Right Tarsus *	Culmen * *			
				Right exposed culmen	Exposed culmen to midline	Nostril to Rt. exposed culmen	Right culmen extension
83	Male	75	29	24	19	12	6
81	"	75	26	23	18	12	7
82	Female	80	29	25	18	12	7
86	Male	85	28	25	20	12	7
84	Female	95	29	24	18	12	7
85	Male	105	29	25	19	12	7
63	"	105	30	26	21	18	7
64	"	120	31	27	21	15	9
65	"	125	30	28	21	19	8
103	"	130	30	28	20	14	9
109	"	165	32	32	23	15	9
100	Female	185	32	31	22	15	9
102	"	195	32	32	24	17	11
101	Male	220	33	39	25	17	11
99	"	240	34	35	24	18	12
113	"	285	34	37	26	18	12
96	"	335	-	38	26	19	12

* - Measurements by method outlined by Godfrey (1967).

** - See Figure 13 for method of measurement.

Appendix 2

Birds were weighed on a direct reading counter style scale in the lab and with a hand held spring balance in the field. Data of measurements taken are given in Table 14 with the method of bill measurement being shown in Figure 13.

Table 14

Measurements of common eider (S. mollissima L.)

juveniles, subadults, and adults.

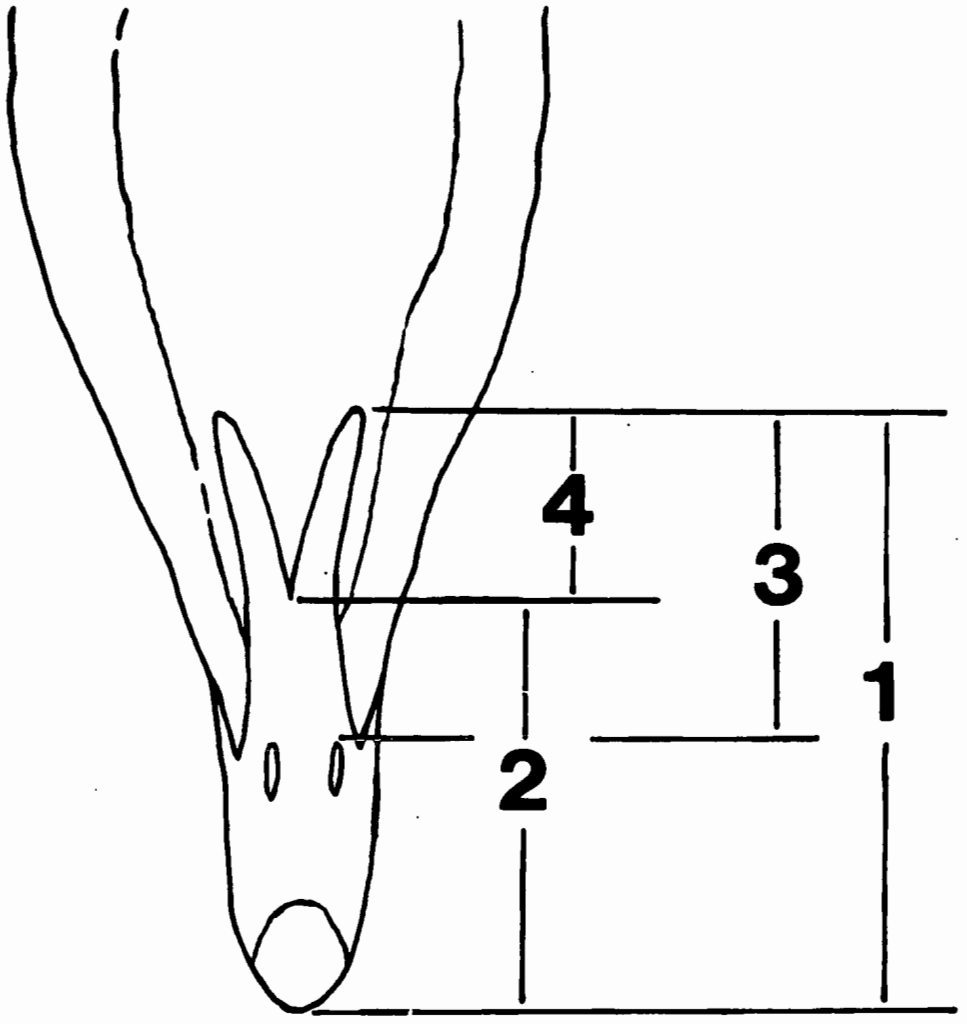
	No. Meas.	Weight	No. Meas.	Primary wing length	No. Meas.	Tail
		Mean(Range)±s.d.		Mean(Range)±s.d.		Mean(Range)±s.d.
Females						
Adult	44	1626(1225-2160)±220.9	44	287(272-303)±8.61	43	87(64-97)±7.18
Juvenile	11	1758(1395-2037)±179.6	11	280(272-288)±4.78	11	78(70-88)±4.68
Unknown						
Males						
Adult	3	1847(1635-2050)±169.5	3	294(287-298)±5.19	3	91(89-95)±2.62
Subadult	23	1877(1630-2284)±150.7	23	286(275-296)±5.98	23	81(64-90)±7.22
Juvenile	10	1900(1655-2176)±126.8	10	284(278-295)±5.37	10	78(72-83)±3.62

Table 14 (Continued)

	No. Meas.	Right exposed culmen	No. Meas.	Exposed culmen - midline	No. Meas.	Nostril to right exposed culmen	No. Meas.	Right culmen extension
		Mean(Range)±s.d.		Mean(Range)±s.d.		Mean(Range)±s.d.		Mean(Range)±s.d.
Females								
Adult	42	71(65-79) ±3.43	42	52(46-58) ±2.65	41	34(29-40) ±3.33	43	20(15-26) ±3.00
Juvenile	11	69(66-74) ±2.31	11	52(46-56) ±2.57	10	32(30-36) ±1.62	11	19(16-23) ±1.82
Unknown	2	67(67)	2	52(51,53)	2	30(29,30)	2	17(16,18)
Males								
Adult	3	74(72-76) ±1.70	3	54(52-55) ±1.25	3	35(34-37) ±1.25	3	21(19-23) ±1.70
Subadult	23	72(68-78) ±2.90	23	52(48-58) ±2.72	23	34(31-41) ±2.64	23	21(17-25) ±2.04
Juvenile	9	72(68-79) ±3.01	9	53(50-56) ±1.81	7	34(31-40) ±2.90	10	20(17-26) ±2.61

Figure 13.

Method of bill measurement. 1. exposed culmen; 2. exposed culmen-midline; 3. nostril to culmen extension; 4. culmen extension.


4
3
1
2