THE PARASITE FAUNA OF THE GREEN-WINGED (ANAS CRECCA L.) AND BLUE-WINGED TEAL (ANAS DISCORS L.)

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THE PARASITE FAUNA OF THE GREEN-WINGED TEAL (ANAS CRECCA L.) AND BLUE-WINGED TEAL (ANAS DISCORS L.)

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ABSTRACT

One hundred and forty-eight ducks (87 *Anas crecca* Linnaeus; 61 *Anas discors* Linnaeus) collected from three localities in eastern Canada were examined for parasites. Ninety-five per cent of the *A. crecca* were infected; twenty-three parasite species being represented. Four are new host records and six are new records for *A. crecca* in North America. One hundred per cent of the *A. discors* were infected; twenty-one parasite species being represented, including eight new host records.

The number and percentage of each sex and age group of both host species infected, and mean and range of parasite numbers per infected bird is given. Parasite species are discussed with regard to incidence and intensity of infection, location of parasites within host, host records, authorities used in specific determination and minor variations, if any, from previous descriptions. Infections in the two hosts are compared and differences, if any, are discussed.

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INTRODUCTION

The Green-winged Teal (*Anas crecca* Linnaeus) and Blue-winged Teal (*Anas discors* Linnaeus), closely related and sympatric over a large part of their ranges, are common waterfowl species in North America. The widely distributed *A. crecca* nests from Alaska east to Newfoundland and from the northern tree limit south to central California and Maine. It winters from British Columbia and Newfoundland south to Venezuela (Moisan *et al.*, 1967). *A. discors* breeds from the Yukon throughout southern Canada to southwestern Newfoundland and south as far as North Carolina and California. It winters from the southern United States, south to Ecuador and Brazil (Godfrey, 1966).

Due to the economic and aesthetic value of waterfowl, many aspects of their biology have been studied, including their helminth fauna. Anatid helminths have been investigated by workers in many parts of the world and the published literature is extensive. Lapage (1961) and McDonald (1969) have provided host-parasite and parasite-host lists respectively and both reviews include a bibliography. Only the literature directly pertinent to this study was examined.

Although works dealing specifically with the parasites of *A. crecca* and *A. discors* are limited in number, several papers containing quantitative data have been

published on the helminths of various anatids in North America. Bishop (1971) and Bishop and Threlfall (1974) studied the helminth fauna of the Common Eider (*Somateria mollissima* (Linnaeus)) in Newfoundland and Labrador. Buscher (1965a; 1965b) reported on the seasonal dynamics of the intestinal helminth fauna of the Pintail (*Anas acuta* Linnaeus), Gadwall (*Anas strepera* Linnaeus) and Northern Shoveler (*Anas clypeata* (Linnaeus)) and later (Buscher, 1966) examined the intestinal helminths of a population of *A. discors* on their breeding grounds. Cannon (1939) reported on the trematodes of ducks and geese taken in eastern Canada. Cornwell and Cowan (1963) investigated the helminth fauna of the Canvasback (*Aythya valisineria* (Wilson)) while Crichton and Welch (1971) examined the helminth parasites of the Mallard (*Anas platyrhynchos* Linnaeus) and the Pintail. Gower (1938) studied the seasonal abundance of helminths from 12 species of ducks but separate treatment was not afforded to each anatid species in calculating percentages of infection as "there is practically no evidence of host specificity". Graham (1966) studied the ecology of helminths in breeding populations of Lesser Scaup (*Aythya affinis* (Eyton)) and Ruddy Ducks (*Oxyura jamaicensis* (Gmelin)). McLaughlin (1970) investigated the cestode fauna of several waterfowl species in New Brunswick while McLaughlin and Burt (1973) studied seasonal changes in the cestode fauna of the Black Duck (*Anas rubripes* Brewster).

The present study was undertaken to determine the helminth fauna of *A. crecca* and *A. discors* in eastern Canada and to note any similarities and/or differences in the parasite fauna of two host species which occupy basically similar habitats.

MATERIALS AND METHODS

The viscera of 148 ducks (87 *A. crecca*; 61 *A. discors*) were collected during August-October, 1972 and 1973. The majority (133) of the specimens (75 *A. crecca*; 58 *A. discors*) were obtained as banding casualties or from hunters at biological check stations on the Tintamarre National Wildlife Area and Missaquash Marsh in the Nova Scotia-New Brunswick border region (Fig. 1). Fifteen specimens (12 *A. crecca*; 3 *A. discors*) were collected on the Magdalen Islands.

Both species were aged and sexed by cloacal examination (Kortright, 1962) and/or characters of the plumage (Carney, 1964). Three age classes were recognized: (1) local--a locally hatched bird, unable to fly; (2) immature--a young bird capable of flight but taken during the same calendar year as hatching; and (3) adult--a bird taken during its second calendar year of life or later.

All material collected was frozen and examined when time permitted. Internal organs examined included: esophagus, proventriculus, gizzard, duodenum, small intestine, large intestine, caeca , cloaca, Bursa of Fabricius, liver, kidneys, spleen, pancreas, heart, lungs, and gall bladder. All organs were isolated in individual Petri-dishes and checked separately for parasites. The liver, kidneys, spleen and pancreas were examined macroscopically and through the use of tissue smears. Examination of these organs was

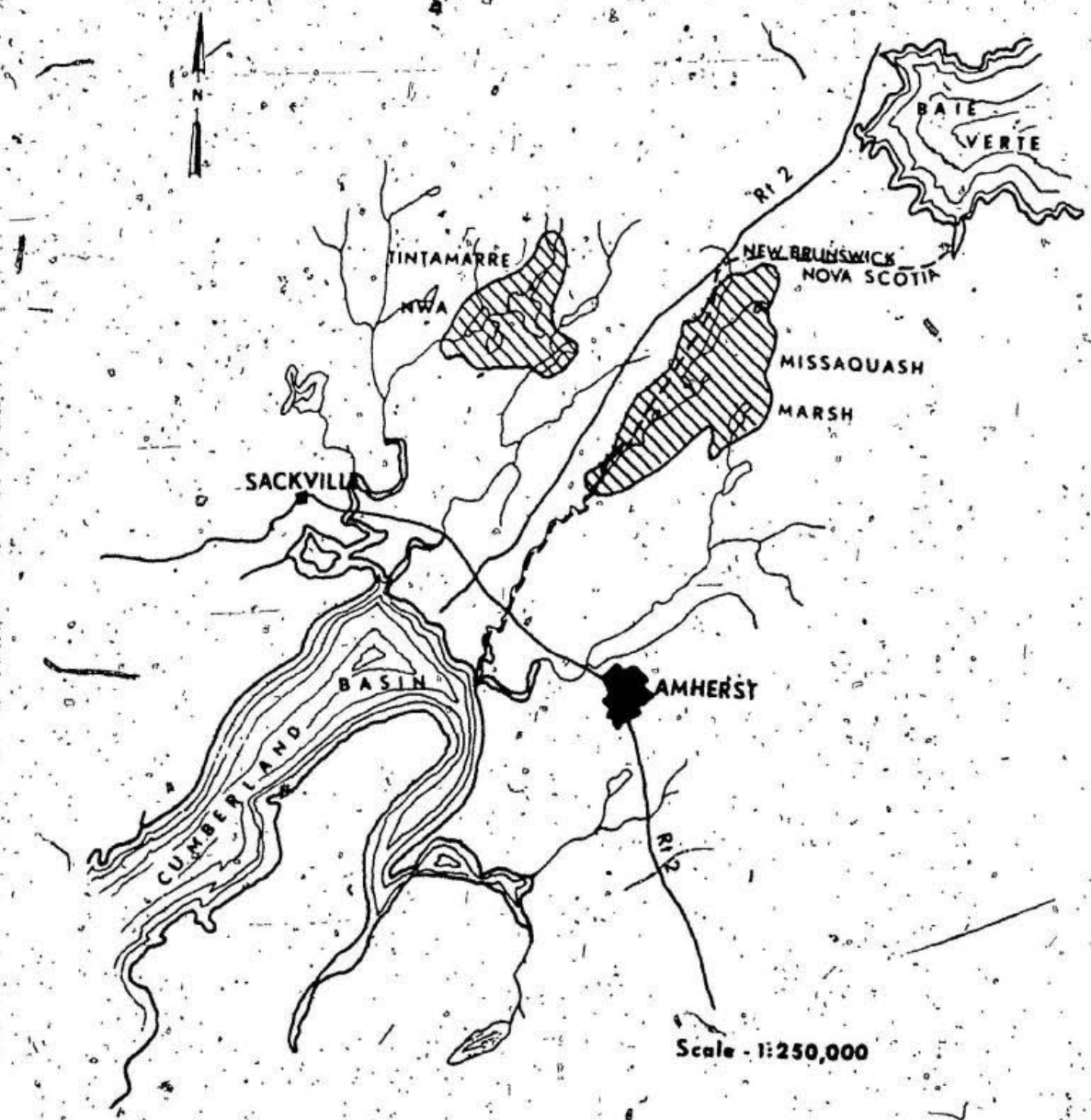

Figure 1

Location of Tintamarre National Wildlife Area and Missaquash Marsh (after Whitman, 1974)

discontinued after 50 sets revealed no metazoan parasites. The small intestine was divided into three sections (S1, S2 and S3) of equal length to determine linear distribution of helminths occurring in this major portion of the alimentary canal.

The duodenum, the three sections of the small intestine, the large intestine and the caeca were slit longitudinally. All contents were scraped into a 149 micron sieve and washed into a Petri dish for examination with a binocular microscope (Nikon #67774; 8-40X). The keratinous lining of the gizzard was removed to expose any concealed parasites. When whole birds were available, the nasal sinuses and external body surfaces were also checked for parasites.

In all cases an attempt was made to obtain an accurate count of the parasite population. When the parasite burden was less than 100 for any particular helminth species, specimens were counted individually. In instances where the parasite numbers exceeded 100, the population size was estimated. A grid of one centimeter square blocks was placed beneath a Petri dish of known area which contained parasites. An average number, obtained from counts of 5 random blocks was used to calculate the total parasite numbers.

Cestodes and trematodes were preserved in 70% ethanol, stained with Mayer's HCl carmine or Semichon's

Acetic Carmine, cleared with xylene and mounted in Canada Balsam or Permount. Nematodes were preserved in 70% glycerine alcohol, cleared in hot lactophenol and mounted in glycerine jelly or placed directly in Rubin's Fluid which serves both as a clearing agent and a mountant. Acanthocephalans were fixed in Demke's Solution and mounted directly in Rubin's Fluid as were all specimens of Mallophaga which had been fixed and stored in 70% ethanol. The techniques and procedures used in the fixing, staining, and mounting of all parasites were described by Andrews (1974).

Blood smears were made, when possible, using blood taken directly from the heart of the birds. Bennett *et al.*, (1974, in press), report on the analysis of these smears.

Since whole host specimens were not always available and cestodes were not identified to species, Mallophaga and Cestoda were not included in calculation of the mean and range of species composition of parasites.

Infections are recorded as incidence (i.e. per cent of ducks infected) and intensity (i.e. average number of helminths per infected duck). Data was analysed using standard statistical tests (Chi-square; t-test).

All measurements are given in microns unless otherwise specified.

RESULTS AND DISCUSSION

Twenty-four species of parasites (excluding Cestoda) were recovered from the two host species during the present study. Among those collected were 14 species of Trematoda (13 genera), 6 of Nematoda (6 genera), 1 of Acanthocephala and 3 of Mallophaga (3 genera). Eighty-three (95%) of the *A. crecca* were infected and 20 helminth species were collected from this host (range 1-7; mean 2 per infected bird). Sixty-one (100%) of the *A. discors* were infected with representatives of 18 helminth species (range 1-8; mean 2 per infected bird).

Trematoda

Fourteen trematode species (Table 1) were collected from the *A. crecca* (range 1-6, mean 1 per infected bird) and 11 (Table 2) were collected from *A. discors* (range 1-5, mean 2 per infected bird).

Apatemon gracilis (Rudolphi, 1819) Szidat, 1928. Specimens of this species were recovered from 35 (Table 1) *A. crecca* (range 1-320; mean 35 per infected bird) and 36 (Table 2) *A. discors* (range 1-256; mean 40 per infected bird). The incidence of infection was similar in the two hosts ($p > 0.05$) and did not differ with age and sex. The intensity of infection was also similar in the two host species ($p > 0.05$).

TABLE 1

DETAILS OF TREMATODE INFECTIONS (EXCLUDING *ECHINOSTOMA REVOLUTUM* AND *ECHINOSTOMA RECURVATUM*) IN *A. CRECCA*

		Apatemon gracilis	*Cotylurus platycephalus**	*Cotylurus cornutus***	*Notocotylus attenuatus*	*Miorophallus primas**	*Paramonostomum alveatum***	*Hypoderaeum conoideum*	*Prosthogonimus cuneatus***	*Zygocotyle lunata***	*Psilostomum* sp. *	*Trichobilharzia querquedulae**	*Psilochasmus oxyurus***
Adult Male	No. (%) birds infected	2(18)	-	-	4(36)	2(18)	1(9)	-	-	1 (9)	-	-	-
	Range of parasite nos.	4-15	-	-	1-4	5-40	32	-	-	1	-	-	-
	Mean no. parasites/infected bird	10	-	-	3	23	32	-	-	1	-	-	-
	Total no. parasites	19	-	-	12	45	32	-	-	1	-	-	-
Adult Female	No. (%) birds infected	5(56)	-	-	2(22)	-	-	-	1(11)	1(11)	1(11)	-	1(11)
	Range of parasite nos.	2-320	-	-	3-5	-	-	-	1	1	2	-	1
	Mean no. parasites/infected bird	87	-	-	4	-	-	-	1	1	2	-	1
	Total no. parasites	433	-	-	8	-	-	-	1	1	2	-	1
Immature Male	No. (%) birds infected	10(58)	-	-	8(31)	1 (4)	1(4)	1(4)	-	-	-	-	2(8)
	Range of parasite nos.	2-198	-	-	1-36	51	882	1	-	-	-	-	1-3
	Mean no. parasites/infected bird	53	-	-	11	51	882	1	-	-	-	-	2
	Total no. parasites	531	-	-	88	51	882	1	-	-	-	-	4
Immature Female	No. (%) birds infected	17(43)	1(3)	1(3)	13(13)	2(5)	4(10)	1(3)	1(3)	-	2(5)	1(3)	3(8)
	Range of parasite nos.	1-77	1	2	1-29	16-23	3-1675	1	1	-	1-9	6	1-2
	Mean no. parasites/infected bird	13	1	2	7	20	409	1	1	-	5	6	1
	Total no. parasites	220	1	2	85	39	2199	1	1	-	10	6	4
Total	Total No. (%) birds infected	35(40)†	1(1)	1(1)	27(31)	5(6)	6(7)	2(2)	2(2)	2(2)	3(3)	1(1)	6(7)
	Range of parasite nos.	1-320	1	2	1-36	5-51	3-1675	1	1	1	1-9	6	1-3
	Mean no. parasites/infected bird	35	1	2	7	27	519	1	1	1	4	6	1
	Total no. parasites recovered	1231	1	2	193	135	3113	2	2	2	12	6	8

†Includes 1 bird of unknown age and sex. *New host record. **New record for *A. crecca* in N. America.

TABLE 2

DETAILS OF TREMATODE INFECTIONS (EXCLUDING *ECHINOSTOMA REVOLUTUM* AND *ECHINOPARYPHIUM RECURVATUM*) IN *A. DISCORS*

		Apatemon gracilis	*Cotylurus platycephalus**	*Notocotylus attenuatus*	*Microphallus primas**	*Paramonostomum alveatum**	*Hypoderaeum conoideum*	*Prosthogonimus cuneatus**	*Trichobilharzia querquedulae*	*Psilochasmus oxyurus**
Adult Male	No. (%) of birds infected	-	-	2(67)	1(33)	-	1(33)	-	1(33)	-
	Range of parasite nos.	-	-	5-46	14	-	3	-	3	-
	Mean no. parasites/infected bird	-	-	26	14	-	3	-	3	-
	Total no. parasites	-	-	51	14	-	3	-	3	-
Adult Female	No. (%) of birds infected	3(50)	-	1(17)	-	-	1(17)	-	3(50)	-
	Range of parasite nos.	1-120	-	49	-	-	8	-	1-4	-
	Mean no. parasites/infected bird	54	-	49	-	-	8	-	3	-
	Total no. parasites	161	-	49	-	-	8	-	10	-
Immature Male	No. (%) of birds infected	13(65)	-	10(50)	-	1(5)	3(15)	2(10)	6(30)	1(5)
	Range of parasite nos.	1-201	-	1-50	-	23	2-29	1	1-5	23
	Mean no. parasites/infected bird	51	-	16	-	23	11	1	3	23
	Total no. parasites	664	-	164	-	23	34	2	17	23
Immature Female	No. (%) of birds infected	18(72)	-	14(56)	1(4)	-	3(12)	1(4)	13(52)	-
	Range of parasite nos.	1-256	-	1-114	15	-	1-27	1	1-7	-
	Mean no. parasites/infected bird	34	-	20	15	-	14	1	3	-
	Total no. parasites	617	-	277	15	-	41	1	41	-
Local Male	No. (%) of birds infected	-	1(33)	1(33)	-	-	1(33)	-	-	-
	Range of parasite nos.	-	2	1	-	-	32	-	-	-
	Mean no. parasites/infected bird	-	2	1	-	-	32	-	-	-
	Total no. parasites	-	2	1	-	-	32	-	-	-

TABLE 2 (CONTINUED)

		Apatemon gracilis	*Cotylurus platycephalus**	*Notocotylus attenuatus*	*Microphallus primas**	*Paramonostomum alveatum**	*Hypoderaeum conoideum*	*Prosthogonimus cuneatus**	*Trichobilharzia querquedulae*	*Psilochasmus oxyurus**
Total	Total No. (%) birds infected	36(59)†	1(2)	30(49)†	2(3)	1(2)	9(15)	3(5)	23(38)	1(2)
	Range of parasite nos.	1-256	2	1-114	14-15	23	1-29	1	1-7	23
	Mean no. parasites/infected bird	40	2	18	15	23	13	1	3	23
	Total no. parasites recovered	1442	2	549	29	23	116	3	71	23

†Includes 2 birds of unknown age and sex. *New host record.

The majority of specimens were collected from the duodenum, S1, and S2 but also occurred in decreasing numbers in S3, the large intestine and the caecae (Table 3). McDonald (1969) cites the duodenum and anterior portion of the small intestine as the preferred habitat of this parasite. Occasionally, these helminths were recovered from the coelom and air sacs, probably having moved to these locations through gunshot perforations of the digestive tract.

A common and widely distributed parasite, (*vide* McDonald, 1969b), *A. gracilis* was first reported in eastern Canada from the American Goldeneye (*Bucephala clangula* (Linnaeus)) by Cannon (1939) who did not present quantitative data but merely stated that "a considerable infestation of these strigeids occurred in the small intestine . . ." Beverly-Burton (1972) noted an incidence of 14.3% and range of intensity of 0-72 for this trematode collected from *A. crecca* in England. Both values are considerably lower than those obtained during the present study (Table 1, 2).

Measurements and morphological characters (Table 4) compare favourably with those of Dubois (1968) and Beverly-Burton (1961).

This parasite has been reported to be associated with mortality in domestic geese (Trofimov, 1962; *vide* McDonald, 1969). No apparent pathological effects were observed in the present study.

TABLE 3

DETAILS OF INFECTION OF *A. CRECCA* AND *A. DISCORS* WITH *APATEMON GRACILIS*

	A. crecca		*A. discors*	
	No. parasites	% of total	No. parasites	% of total
Duodenum	338	27.5	195	13
Small intestine, S1	228	18.6	690	47.5
Small intestine, S2	450	36.5	327	22.5
Small intestine, S3	18	1.5	144	9.9
Large intestine	17	1.3	8	0.5
Caecae	1	0.1	1	0.1
Other	179	14.5	94	6.5
Total	1231	100	1442	100

TABLE 4

MEASUREMENTS OF *APATEMON GRACILIS* (RUDOLPHI, 1819) SZIDAT 1928 FROM *A. CRECCA* AND *A. DISCORS* COMPARED WITH THOSE OF OTHER WORKERS

	Present Study				Beverly-Burton (1961)	Dubois 1968
	A. crecca		*A. discors*			
	Mean	Range	Mean	Range	Range	Range
Forebody, length	566	459- 694	447	387-510	380 - 610	400- 720
" width	432	234- 796	360	306-398	210 - 400	340- 540
Hindbody, length	1100	846-1530	835	754-989	680 -1010	930-1800
" width	479	336- 846	368	337-387	190 - 560	430- 600
H/F*	1.9	1.5- 2.3	1.9	1.6-2.1	1.23 - 1.8	1.9- 3.0
Oral sucker, length	118	93- 170	92	86-100	-	110- 180
" " width	111	90- 163	93	85-103	-	80- 140
" " diameter	-	-	-	-	90 - 40	-
Ventral sucker,						
" " length	140	108- 212	100	105-115	- -	180-255
" " width	135	110- 212	102	105-115	-	110-245
" " diameter	-	-	-	-	80 - 160	-
Egg length	105	97- 115	107	100-115	101 - 126	90-115
" width	66	63- 73	65	60- 78	61 - 75	60- 80

*Length of hindbody divided by length of forebody.

Cotylurus platycephalus (Hughes, 1928) Dubois, 1948. Both the incidence and intensity of infection with this strigeid were quite low. Only two birds, an immature female *A. crecca* and a local male *A. discors* were infected, harboring 1 and 2 specimens respectively. All three trematodes were collected from the Bursa of Fabricius, a lympho-epithelial organ occurring in young ducks (8 months or younger).

This parasite has not previously been recorded from either host, being normally found in lariform birds. Interestingly, the single infected *A. discors* was a local thus suggesting an available intermediate host within proximity of the collection site.

Van Haitsma (1930; *vide* Dubois, 1968) successfully infected a freshwater snail, (*Lymnaea emarginata* Sowerby) with miracidia of this species while Olivier and Cort (1942; *vide* Dubois, 1968) located metacercaria encysted on Yellow Perch (*Perca flavescens* Mitchill). Whitman (1974) reported on the population of *Lymnaea* sp. and also (Whitman, pers. comm.) confirmed the presence of Yellow Perch at the collection site. Since the Herring Gull (*Larus argentatus* Pontopiddon) and Great Black-backed Gull are frequent visitors to the collection site it is quite conceivable that *C. platycephalus* was introduced via these hosts.

Measurements and morphological characters of

specimens obtained during the present study agree with those of Dubois (1968). The measurements of a single specimen from *A. discors* are as follows: forebody, length 1.43 mm, width 1.82 mm; hindbody, length 3.162 mm, width 1.22mm; forebody/hindbody ratio 2.2; egg, length, 122, width 75.

Cotylurus cornutus (Rudolphi, 1808) Szidat, 1928. Only two specimens of this species were recovered, both from S1 of the small intestine of an immature female *A. crecca* (Table 1). Although McDonald (1969b) listed this strigeid as a common and characteristic helminth of waterfowl, an extensive literature search revealed no evidence of this parasite having previously been recorded from *A. crecca* in North America.

Although quite similar to *Apatemon gracilis* the present species is easily separated by its subterminal genital pore and muscular genital bulb. It is readily distinguished from *Cotylurus flabelliformis* (Faust, 1917) Van Haitsma 1931 on the basis of body length, *C. flabelliformis* being considerably shorter. The measurements of a single specimen are as follows: forebody, length 510, width 459; hindbody, length 1020, width 285; forebody/hindbody ratio, 1:2; egg, length 98, width 60. These measurements agree well with those provided by Dubois (1968).

Notocotylus attenuatus (Rudolphi, 1809) Kossack, 1911. This species was collected from 27 (31%) of the *A. crecca* and 30 (49%) of the *A. discors* with numbers per infected bird ranging from 1-36 (mean 7) and 1-114 (mean 18) respectively (Table 1, 2). Although the incidence of infection was independent ($p > 0.05$) of age and sex within a single host species, a significant difference ($p < 0.05$) did exist for incidence and intensity of infection between the two hosts, *A. discors* showing the higher value in both cases.

Specimens occurred almost exclusively in the intestinal caecae. Infrequently, small numbers were recovered from the large intestine but this can probably be attributed to post-mortem migration.

Buscher (1966) reported an incidence of 23% and a mean intensity of 13 per infected bird for this parasite in a population of *A. discors* on their breeding grounds in Manitoba. Values for the same parameters are higher in the present study, particularly in the case of *A. discors*.

Considerable confusion has been expressed over the identity of *Notocotylus attenuatus* and *Notocotylus imbricatus* (Looss, 1893) Szidat 1935, the two having often been regarded as synonyms (Beverly-Burton, 1961). Szidat (1935, *vide* Beverly-Burton, 1961) separated *N. attenuatus* from *N. imbricatus* on differences in the pattern of the ventral adhesive glands. Beverly-Burton (1961) recognized the two

TABLE 5

MEASUREMENTS OF *NOTOCOTYLUS ATTENUATUS* RECOVERED FROM *A. CRECCA* AND *A. DISCORS* DURING THE PRESENT STUDY COMPARED WITH THOSE OF BEVERLY-BURTON (1961)

	A. crecca		*A. discors*		Beverly-Burton (1961)
	Mean	Range	Mean	Range	Range
Body length	3.63mm	2.04-4.81mm	2.58mm	1.85-3.08mm	2.01-2.96mm
" width	799	591-1050	534	479- 724	480-850
Esophagus length	155	125- 200	103	60- 150	-170
Oral sucker, length	141	100- 160	104	78- 125	100-170
" " width	151	88- 170	121	90- 157	100-220
Cirrus sac, length	1.14mm	765-1430	846	765-1001	750-940
" " width	122	63- 143	83	45- 100	60- 90
Left testis length	530	469- 663	338	255- 377	280-420
" " width	230	160- 275	170	132- 204	110-330
Right testis length	520	510- 632	338	242- 395	270-470
" " width	233	153- 285	187	132- 220	140-330
Ovary length	255	200- 316	207	242- 395	110-340
" width	235	190- 265	168	125- 197	110-320
Mehlis' gland length	131	83- 200	115	102- 122	40-260
" " width	157	125- 220	149	112- 204	110-240
Egg length	21	20- 22	20	18- 22	19- 20
" width	11	10- 12	10	10- 12	11- 13

forms and suggested that several descriptions of *N. attenuatus* may have been based on a mixture of these two species. On the basis of Szidat's criterion only one species, *N. attenuatus* is recognized in the present work in spite of the fact that some measurements fall outside the range of *attenuatus* as presented by Beverly-Burton and are similar to those of *N. imbricatus*. However, most of these differences occur as larger measurements and are confined to specimens from *A. crecca* suggesting a host reaction or increased parasite size associated with a smaller parasite burden. Measurements of specimens from both hosts are compared to those of Beverly-Burton (1961) and are presented in Table 5. The numbers of ventral adhesive glands ranged from 13-16 in lateral rows and 11-15 in median rows.

Microphallus primas (Jägerskiöld, 1908). This species was collected from 5 (6%) of the *A. crecca* and 2 (3%) of the *A. discors*, the intensity of infection ranging from 5-51 (mean 27 per infected bird) and 14-15 (mean 15 per infected bird) respectively (Table 1, 2). All specimens were recovered from the intestinal caecae.

M. primas, normally occurs in charadrii form birds (*vide* McDonald, 1969b) and has not previously been recorded from any members of the Anatini. It has, however, been recorded from the Common Eider, Greater Scaup (*Aythya marila*

(Linnaeus)) and three species of Mergini (*vide* McDonald, 1969b) all of which are exposed, by the nature of their marine habits, to metacercariae which occur encysted in marine decapod and amphipod crustaceans. The salt marshes in the vicinity of the collecting sites probably serve as the focus of infection for this trematode.

Measurements and morphological characters agree with those given by Deblock and Pearson (1969). The measurements of 6 mature specimens (mean (range)) are as follows: body length 694 (622-765), width 225 (200-255); oral sucker, length 63 (55-70), width 78 (70-83); ventral sucker, length 62 (58-63), width 54 (45-63); prepharynx, length 43 (38-45); pharynx, length 39 (38-40), width 30 (27-37; seminal vesicle (2 measured), length 78 (73-83), width 34 (30-38); egg, length 17 (16-18), width 10 (8-10).

Paramonostomum alveatum (Mehlis 1846) Lühe 1909. Representatives of this species were found in 6 *A. crecca* (range 3-1675; mean 519 per infected bird) and 2 *A. discors* (range 2-149; mean 76 per infected bird) (Table 1, 2). Specimens were collected from the duodenum and three sections of the small intestine but occurred most abundantly in S2.

P. alveatum has been reported from many species of waterfowl including 4 *Anas* spp., 4 *Aythya* spp., 5 Anserini, 2 Somateriini and 3 Mergini (*vide* McDonald, 1969b). However, it has not previously been recorded from *A. crecca* or

A. discors in North America.

Stunkard (1967) and Kulachkova (1954, *vide* Stunkard 1967) investigated the life cycle of this parasite and found that cercariae develop in marine snails and encyst, after emergence, on the surface of marine molluscs and crustaceans. In view of this it is not surprising that anatid species which occupy the littoral zone of the sea coast are the normal hosts of this parasite. Interestingly 6 of the 8 ducks infected with this trematode in the present study were collected on the Magdalen Islands.

Measurements of specimens from the present study compare favourably with those given by Stunkard (1967). The measurements of 6 mature specimens (mean (range)) are as follows: body, length 591 (510-744), width 358 (295-387); oral sucker, diameter 55 (48-60); egg, length 18 (18-19), width 11 (10-11).

Hypoderaeum conoideum (Bloch, 1782) Dietz, 1909. Representatives of this helminth were collected from both host species. The intensity of infection was similar ($p > 0.05$) in both hosts but the incidence of infection was significantly higher ($p < 0.05$) in *A. discors* (15%) than in *A. crecca* (1%).

H. conoideum, listed by McDonald (1969b) as a very common and characteristic helminth of waterfowl, has been reported throughout the Holarctic region from at least 5

TABLE 6

MEASUREMENTS OF 7 MATURE SPECIMENS OF *HYPODERAEUM CONOIDEUM* (BLOCH 1782) DIETZ, 1909 RECOVERED DURING THE PRESENT STUDY COMPARED WITH THOSE OF BEVERLY-BURTON (1961)

	Present Study		Beverly-Burton (1961)
	Mean	Range	Range
Body length	6.27mm	5.51-7.34mm	6.87-8.74mm
" width	907	724-1050	800-1090
Oral sucker, length	165	150- 183	190- 240
" " width	169	148- 193	180- 250
Ventral sucker			
" " length	604	489- 740	660- 780
" " width	638	530- 744	550- 800
Pharynx length	145	125- 162	140- 200
" width	121	107- 137	100- 140
Anterior testis			
" " length	639	510- 765	590- 910
" " width	310	255- 387	160- 510
Posterior testis			
" " length	638	561- 856	560- 900
" " width	304	224- 377	140- 570
Ovary length	243	155- 316	180- 280
" width	245	188- 326	210- 310
Egg length	92	88- 98	94- 112
" width	63	58- 68	56- 65

orders of birds. Beverly-Burton (1972) reported this parasite from *A. crecca* collected in England, and Buscher (1966) recovered it from *A. discors* in Manitoba. This parasite was first recorded in eastern Canada by Cannon (1939) from the black duck.

The majority of specimens were recovered from S2 (81%) of the small intestine. Smaller numbers were found in S3 (6%), S1 (3%) and the large intestine (1%). The remaining 9% were found free in the coelom and/or on the surface of visceral organs, probably having migrated through gunshot perforations in the intestinal wall.

The measurements of mature specimens (Table 6) agree with those given by Beverly-Burton (1961).

Prosthogonimus cuneatus (Rudolphi, 1809) Braun, 1901. This trematode was recovered from both host species but the incidence and intensity of infection were both quite low (Table 1, 2). A single specimen was collected from each of an adult and an immature female *A. crecca;* a total of 4 specimens were recovered from an immature female and two immature male *A. discors.* The specimens obtained from the immature ducks were found in the Bursa of Fabricius while the single parasite collected from the adult *A. crecca* was located in the cloaca.

P. cuneatus, a trematode which is cosmopolitan in distribution (Yamaguti, 1971), has been recorded from

representatives of at least 11 orders of birds (*vide* McDonald, 1969b). However, it has not previously been reported from *A. discors*, nor has it been recorded from *A. crecca* in North America.

Measurements of the present specimens are similar to those provided by Beverly-Burton (1961) although in some instances the measurements of the testes were larger. The differences can probably be attributed to the method of preparation (Ulmer, 1952) since *P. cuneatus* is quite large and can be easily distorted.

P. cuneatus is reported to be the cause of disease in geese (Szidat 1933a, *vide* McDonald, 1969) but no damage was noted to be associated with this trematode during the present study.

Zygocotyle lunata (Diesing, 1836) Stunkard, 1916. Single specimens of this species were recovered from the caecae of each of an adult male and an adult female *A. crecca* (Table 1).

Z. lunata is not particularly host-specific, having been recorded from three orders of birds as well as the class Mammalia (*vide* McDonald, 1969). Interestingly it is the only paramphistomatid to be recorded from waterfowl; helminths of this family normally occur in ruminants. Cannon (1939) first reported this parasite in eastern Canada from the Black Duck and the Domestic Goose (*Anser anser*

Linnaeus) collected on the island of Montreal.

The measurements of a single specimen compare favourably with those given by Mettrick (1959) with the exception of egg width. Price (1928; *vide* Mettrick, 1959), however, considered the egg size to be quite variable, often differing by 25μ in length and 21μ in width. Mettrick (1959) noted that the small size of the eggs of his specimens were different from previous descriptions.

Mettrick (1959) reported this trematode as the cause of extensive mortality in a flock of domestic ducks (*Anas platyrhynchos* Linnaeus) in southern Rhodesia. The single specimens collected during the present study caused no apparent damage to the host.

Psilostomum sp. Representatives of this genus were recovered from 3 *A. crecca* (range 1-9, mean 3 per infected bird). Five *Psilostomum* spp. have been reported from waterfowl, namely *P. anserum* Oshmarin, 1963; *P. borealis* Ryzhikov, 1913; *P. brevicolle* (Creplin, 1829) Braun, 1902; *P. cygnei* Southwell and Koishner 1937; and *P. marilae* Price, 1942. Only one of these, namely *P. marilae*, recorded by Price (1942) from the Lesser Scaup, has ever been reported from North America. *P. marilae* was later synonymized with *Gryseoma marilae* by Byrd, Bogitsh and Maple (1961) who recovered this species from the Raccoon (*Procyon lotor* (Linnaeus)). No *Psilostomum* sp. has previously been reported from a dabbling duck.

Descriptions of only two species, *P. marilae* and *P. brevicolle* were available. Measurements of the present material did not agree with either of these. The measurements of 6 mature specimens (mean (range)) are: body length 1190 (918-1448), width 400 (357-438); oral sucker, length 124 (110-135), width 114 (100-135); pharynx, length 109 (90-120), width 103 (88-118); esophagus, length 60; ventral sucker, length 169 (153-200), width 192 (163-212); anterior testis, length 157 (112-204), width 209 (170-244); posterior testis, length 157 (112-204), width 214 (175-275); ovary, length 113 (95-125), width 108 (88-132); egg, length 91 (80-98), width 55 (48-58).

Trichobilharzia querquedulae McLeod 1937. The method of preservation of the host (freezing) did not permit accurate counts of schistosome populations since specimens entangled in coagulated blood were easily overlooked and usually of little value. As a result, the hosts were not examined systematically for this group but whenever specimens were encountered they were collected. One per cent of the *A. crecca* (Table 1) and 38% of the *A. discors* were infected. Only males of this species were recovered.

T. querquedulae was first described by McLeod (1937) as *Pseudobilharziella querquedulae*. The validity of the genus *Pseudobilharziella*, erected by Ejsmont (1929) largely on the presence of a gynecophoral fold, has been queried by

McMullen and Beaver (1942) who state:

> Ejsmont (1929) established the genus *Pseudobilharziella* largely on the presence of a gynecophoral canal but a study of the genera in question indicates that this structure is present in both. Consequently *Pseudobilharziella* Ejsmont, 1929 becomes a synonym of *Trichobilharzia* Skrjabin and Zakharow 1920.

More recently these authors (McMullen and Beaver, 1945) stated that *P. querquedulae* was a synonym of *T. physellae* Talbot, 1936. Wu (1953) disputed this contention and suggested that *P. querquedulae* be retained as a separate species, *Trichobilharzia querquedulae* (McLeod, 1937). In his opinion: "There seems little doubt, however, that they are congeneric and McLeod's species is accordingly placed in the genus *Trichobilharzia* as *T. querquedulae* (McLeod, 1937)".

Yamaguti (1958) followed the work of McMullen and Beaver (1945) but later (Yamaguti, 1971) recognized *Pseudobilharziella* as a valid genus on the ground of differences pointed out by Ejsmont (1929).

The measurements of *T. querquedulae* obtained during the present study are compared with those of *T. querquedulae* given by McLeod (1937) and those of *T. physellae* given by McMullen and Beaver (1942) (Table 7). In view of differences between *T. querquedulae* and *T. physellae*, the contention of Wu (1953) is accepted and *T. querquedulae* is regarded as a valid species.

TABLE 7

MEASUREMENTS OF *TRICHOBILHARZIA QUERQUEDULAE* OBTAINED DURING THE PRESENT STUDY COMPARED WITH *PSEUDOBILHARZIELLA QUERQUEDULAE* OF MCLEOD (1937) AND *TRICHOBILHARZIA PHYSELLAE* OF MCMULLEN AND BEAVER (1942)

	Trichobilharzia querquedulae		*Pseudobilharziella querquedulae*	*Trichobilharzia physellae*
	Present study		McLeod (1937)	McMullen & Beaver
	Immature	Adult	Adult	Adult
Body length	4.49-4.70mm(2)	.5.1 (1)	3.7 mm	3.18-5.71
" width	95-125 (7)	112-152(2)	150	63-97
Oral Sucker	60-80x42-60(8)	53-70x45-53(2)	56x64	31-40x38-47
Ventral Sucker	47x78 (6)	53 (1)	73(immature)	31-49x49-51
Distance between oral and ventral sucker	306-530 from ant end (12)	224-275 from ant end (1)	274 from anterior end	226-370
Distance between ventral sucker and gynecophoral fold	1020 from anterior end to ventral sucker	780 from anterior end to ventral sucker	678 from anterior end to ventral sucker	230-536

Psilochasmus oxyurus (Creplin, 1825) Lühe, 1909. Small numbers of this trematode were recovered from the large intestine of both host species (Table 1, 2). Six (7%) of the *A. crecca*, and one (2%) of the *A. discors* harbored this parasite.

A similar species, *Psilochasmus longicirratus*, was described by Skrjabin (1913; *vide* Beverly-Burton 1961) and was characterized by its long cirrus sac. Stunkard and Donihue (1931) assigned specimens from a Long Island duck (species not given) to *P. oxyurus* and regarded *P. longicirratus* as a synonym of *P. oxyurus* since the only character separating the two forms was the difference in the length of the cirrus sac, an extremely variable character.

Cannon (1939) reported *P. longicirratus* from the Black Duck and Canada Goose (*Branta canadensis* (Linnaeus)) in eastern Canada but as indicated above its status as a valid species has been disputed. *P. oxyurus* has not previously been reported from *A. discors*. It has been recovered from *A. crecca* in Europe but this is the first record of its occurrence in this host from North America.

The caudal spike, stalked acetabulum, and relatively few eggs are diagnostic characters of this genus. Measurements and morphological characters of specimens obtained in the present study agree with those given by Stunkard and Donihue (1931) and Beverly-Burton (1961).

Echinostomes (*Echinostoma revolutum* (Frolich, 1802) Looss, 1899 and *Echinoparyphium recurvatum* (von Linstow, 1873) Lühe, 1909). The similarity of both mature and immature *E. recurvatum* to immature *E. revolutum*, compounded by the presence of large numbers of these parasites, eliminated any possibility of accurate assessment of numbers of each species. Fully mature *E. revolutum*, readily distinguished by size were recovered from 70% of each host species. A detailed examination of a random sample of 10 parasites from each infected bird provided an indication of the incidence of infection with *E. recurvatum* (13% of the *A. crecca* and 31% of the *A. discors*). Since the majority of the parasites in this group were not assigned to any particular genus, both species are considered collectively as 'echinostomes'.

The incidence and intensity of infection were significantly higher ($p < 0.05$) in *A. discors* (Table 8) than *A. crecca*. Immature birds of both host species were the most heavily infected (Table 8). The duodenum harbored the largest number of parasites, with smaller numbers occurring in S1, S2, S3, large intestine and caeca (Table 9).

McDonald (1969b) lists both trematodes as very common, characteristic helminths of waterfowl. Both are cosmopolitan in distribution and utilize a wide range of avian and mammalian hosts, particularly *E. revolutum* which has been recovered from man (*vide* McDonald, 1969b).

TABLE 8

DETAILS OF ECHINOSTOME INFECTIONS IN *A. CRECCA* AND *A. DISCORS*

		A. crecca	*A. discors*
Adult Male	No. (%) birds infected	2(18)	3(100)
	Range of parasite nos.	3-4	7-70
	Mean no. parasites/infected bird	4	36
	Total no. parasites	7	107
Adult Female	No. (%) birds infected	6(67)	5(83)
	Range of parasite nos.	1-19	3-183
	Mean no. parasites/infected bird	6	57
	Total no. parasites	37	284
Immature Male	No. (%) birds infected	9(35)	15(75)
	Range of parasite nos.	1-69	4-1349
	Mean no. parasites/infected bird	12	489
	Total no. parasites	112	7342
Immature Female	No. (%) birds infected	13(33)	24(96)
	Range of parasite nos.	1-25	1-2144
	Mean no. parasites/infected bird	8	471
	Total no. parasites	110	11,311
Local Male	No. (%) birds infected	-	2(66)
	Range of parasite nos.	-	15-34
	Mean no. parasites/infected bird	-	25
	Total no. parasites	-	49
Total	Total No. (%) birds infected	31(36)*	50(82)**
	Range of parasite nos.	1-69	1-2144
	Mean no. parasites/infected bird	9	386
	Total no. parasites recovered	279	19,294

*Includes 1 bird of unknown age and sex.
**Includes 2 birds of unknown age and sex.

TABLE 9

LINEAR DISTRIBUTION OF ECHINOSTOMES (*ECHINOSTOMA REVOLUTUM* AND *ECHINOPARYPHIUM RECURVATUM*) IN DIGESTIVE TRACT OF *A. CRECCA* AND *A. DISCORS*

Region of recovery	*A. crecca*		*A. discors*	
	Number recovered	per cent of total	Number recovered	per cent of total
Duodenum	137	49	7950	41
Small intestine, S1	31	11	6446	34
" " S2	5	2	3133	16
" " S3	5	2	787	4
Large intestine	25	9	159	9
Caeca	3	1	23	1
Other*	73	26	796	4
Total	279	100	19294	100

*Post-mortem migration.

The measurements of two mature specimens of *E. revolutum* from each host species and three and six mature specimens of *E. recurvatum* from *A. crecca* and *A. discors* respectively, agree with those given by Beverly-Burton (1961) and are presented in Table 10.

Although both species have been reported as the cause of mortality in waterfowl no apparent damage was noted to be associated with these parasites during the present study.

Nematoda

Four nematode species (Table 11) were collected from *A. crecca* (range 1-3, mean 1 per infected bird) and 5 (Table 12) from *A. discors* (range 1-4, mean 2 per infected bird). Thirty-one per cent of the *A. crecca* and 84% of the *A. discors* harbored nematodes.

Amidostomum acutum (Lundahl, 1848) Seurat, 1918. This species was recovered from 13% of the *A. crecca* (range 1-8, mean 2 per infected bird), and 62% of the *A. discors* (range 1-16, mean 5 per infected bird). Although the intensity of infection did not differ significantly ($p > 0.05$) between the two host species, *A. discors* had the higher incidence of infection ($p < 0.05$). All specimens were collected from beneath the keratinous lining of the gizzard and occurred most abundantly at its junctions with

TABLE 10

MEASUREMENTS OF MATURE SPECIMENS OF *ECHINOSTOMA REVOLUTUM* AND *ECHINOPARYPHIUM RECURVATUM* OBTAINED FROM BOTH HOSTS DURING THE PRESENT STUDY

	Echinostoma revolutum				*Echinoparyphium recurvatum*			
	A. crecca		*A. discors*		*A. crecca*		*A. discors*	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Body, length	10.6 mm	9.69-11.5mm	7.45mm	7.04-7.85mm	2.20mm	2.04-2.51mm	2.38	2.04-3.06mm
" width	1.38mm	1.03-1.73mm	933	795-1020	331	300-346	362	306-469
Esophagus, length	791	765-816	616	612- 620	362	362	-	-
Collar diameter	581	581	520	581	-	-	-	-
Oral sucker, length	255	255	217	200- 234	80	80	85	85
" " width	258	250-265	234	212- 255	70	70	70	70
Ventral sucker, length	796	693-898	602	510- 693	252	225-275	255	255
" " width	734	652-816	536	459- 612	214	200-225	204	204
Pharynx, length	208	193-222	170	152- 187	63	63	65	65
" width	164	162-165	142	122- 163	44	38- 50	45	40- 50
Anterior testis, length	846	846	346	346	220	172-263	211	150-237
" " width	499	499	265	265	140	120-170	140	112-170
Posterior testis, length	755	612-897	459	459	239	190-308	242	192-262
" " width	357	306-408	276	276	133	112-155	139	115-150
Ovary, length	357	306-408	247	187- 306	131	113-150	-	-
" width	403	326-479	281	195- 367	113	113	-	-
Cirrus sac, length	275	-	-	-	205	205	232	200-312
Egg, length	103	100-105	99	93- 105	96	90-102	95	85-105
width	69	65- 73	58	53- 63	53	50- 55	66	60- 70
Collar spine, Oral (length)	93	-	88	-	40	38- 42	40	40
Aboral (length)	-	-	-	-	48	48	46	43- 48
Corner (length)	-	-	-	-	53	50- 58	53	50- 55

TABLE 11

DETAILS OF NEMATODE INFECTIONS IN *A. CRECCA*

		Amidostomum acutum	*Epomidiostomum uncinatum*	*Thominx anatis*	*Capillaria contorta*	*Tetrameres ryjikovi**
Adult Male	No. (%) birds infected	1 (9)	-	-	-	-
	Range of parasite (Nos.)	1	-	-	-	-
	Mean no. parasites/infected bird	1	-	-	-	-
	Total no. of parasites	1	-	-	-	-
Adult Female	No. (%) birds infected	2(22)	-	-	-	1(11)
	Range of parasite (Nos.)	1	-	-	-	1
	Mean no. parasites/infected bird	1	-	-	-	1
	Total no. of parasites	2	-	-	-	1
Immature Male	No. (%) birds infected	3(12)	1 (4)	1 (4)	3(12)	6(23)
	Range of parasite (Nos.)	1-5	1	1	1-4	1-6
	Mean no. parasites/infected bird	2	1	1	2	4
	Total no. of parasites	7	1	1	6	24
Immature Female	No. (%) birds infected	5(13)	-	1 (3)	2 (8)	8(21)
	Range of parasite (Nos.)	1-8	-	2	1-2	1-2
	Mean no. parasites/infected bird	3	-	2	2	1
	Total no. of parasites	14	-	2	3	11
Total	Total No. (%) birds infected	11(13)	1 (1)	2 (2)	5(19)	15 (7)
	Range of parasite nos.	1-8	1	1-2	1-4	1-6
	Mean no. parasites/infected bird	2	1	2	2	2
	Total no. parasites recovered	24	1	3	9	36

*New record for *A. crecca* in North America.

TABLE 12

DETAILS OF NEMATODE INFECTIONS IN *A. DISCORS*

		Amidostomum acutum	*Epomidiostomum uncinatum*	*Thominx anatis* †	*Capillaria contorta*	*Tetrameres pyjikovi*	*Streptocara crassicauda* †
Adult Male	No. (%) birds infected	1(33)	2(67)	-	-	1(33)	-
	Range of parasite nos.	3	1-4	-	-	1	-
	Mean no. parasites/infected bird	3	3	-	-	1	-
	Total no. parasites	3	5	-	-	1	-
Adult Female	No. (%) birds infected	3(50)	-	2(33)	-	1(17)	-
	Range of parasite nos.	4-12	-	1-7	-	2	-
	Mean no. parasites/infected bird	8	-	4	-	2	-
	Total no. parasites	24	-	8	-	2	-
Immature Male	No. (%) birds infected	15(75)	9(45)	8(40)	-	6(30)	-
	Range of parasite nos.	1-15	1-8	1-8	-	2-4	-
	Mean no. parasites/infected bird	4	3	2	-	3	-
	Total no. parasites	64	30	18	-	17	-
Immature Female	No. (%) birds infected	15(60)	10(40)	9(36)	1(4)	1(4)	1(4)
	Range of parasite nos.	1-16	1-4	1-9	1	1	1
	Mean no. parasites/infected bird	6	2	4	1	1	1
	Total no. parasites	88	15	36	1	1	1
Local Male	No. (%) birds infected	2(67)	-	-	-	-	-
	Range of parasite nos.	7	-	-	-	-	-
	Mean no. parasites/infected bird	7	-	-	-	-	-
	Total no. parasites	14	-	-	-	-	-
Local Female	No. (%) birds infected	1(50)	-	-	-	-	-
	Range of parasite nos.	1	-	-	-	-	-
	Mean no. parasites/infected bird	1	-	-	-	-	-
	Total no. parasites	1	-	-	-	-	-
Total	Total No. (%) birds infected	38(62)*	22(36)*	20(33)*	1(2)	10(15)*	1(2)
	Range of parasite nos.	1-16	1-8	1-8	1	1-4	1
	Mean no. parasites/infected bird	5	2	4	1	3	1
	Total no. parasites recovered	194	51	75	1	25	1

† New host record.
* Includes 1 bird or unknown age and sex.

TABLE 13

MEASUREMENTS OF MALE *AMIDOSTOMUM ACUTUM* (LUNDAHL, 1848) SEURAT, 1918 OBTAINED FROM *A. CRECCA* AND *A. DISCORS* DURING THE PRESENT STUDY

	A. crecca (6)*		*A. discors* (10)*	
	Mean	Range	Mean	Range
Body, length	8.43 mm	7.59-9.28 mm	7.67	6.12-8.62 mm
width	135	110-153	102	80-125
Buccal capsule, External diameter	20	18- 21	19	16- 21
" " Internal diameter	10	9- 11	10	9- 11
" " Depth	10	8- 11	9	8- 9
Pharynx, length	613	561-725	556	475-612
Spicule, left, length	155	130-175	108	100-148
" right, length	157	135-175	108	100-148
Gubernaculum, length	84	80- 93	78	63- 93
Dorsal tooth, length	6	5- 8	5	4.5- 6

*(#) = number measured.

TABLE 14

MEASUREMENTS OF FEMALE *AMIDOSTOMUM ACUTUM* OBTAINED FROM *A. CRECCA* AND *A. DISCORS* DURING THE PRESENT STUDY

	A. crecca (6)*		*A. discors* (10)*	
	Mean	Range	Mean	Range
Body, length	10.54 mm	9.38-14.28 mm	10.1 mm	
" width	157	132-250	122	
Buccal capsule, External diameter	21	17- 23	21	
" " Internal diameter	12	10- 13	11	
" " Depth	11	10- 13	9	
Pharynx, length	629	561-816	607	
Tail, length	242	195-287	240	195-275
" width	48	43- 58	45	40- 53
Dorsal tooth, length	7	6- 8	6	5- 7
Distance from vulva to posterior end	1.89 mm	1.58-2.55 mm	1.96 mm	1.7-2.41mm
Egg, length	98	75-118	100	78-118
" width	69	48- 80	62	43- 80

*(#) = number measured.

the proventiculus and duodenum.

A. acutum a very common and characteristic helminth of waterfowl has been reported from anseriformes in many parts of the world (*vide* McDonald 1969b). Buscher (1965) reported on the seasonal changes in intestinal helminths in three species of ducks and found *Amidostomum* sp. infections dropping from 50% on the breeding grounds to 40% along the migration route. Buscher (1966) also reported infection rates of 63% and 20% for *Amidostomum* sp. in immature and adult *A. discors* on their breeding grounds in Manitoba. In the present study 66% of the immature and 44% of the adult *A. discors* were infected.

The measurements of mature specimens (Table 13, 14) from *A. crecca* and *A. discors* agreed with those given by Czaplinski (1962).

Mechanical damage resulting in erosion of the horny lining of the gizzard and necrosis in regions of tunnelling are associated with infections with this nematode (Dubey and Pande, 1965).

Epomidiostomum uncinatum (Lundahl, 1848) Seurat, 1918. Only one (Table 11) of the *A. crecca* (1 specimen recovered) and 22 (Table 12) of the *A. discors* (range 1-8, mean 2 per infected bird) harbored this parasite. As in the case of *Amidostomum acutum* all specimens of this species were recovered from beneath the lining of the gizzard.

Beverly-Burton (1972) reported this nematode from *A. crecca* in England. Fourteen per cent of her sample were infected, intensity of infection ranging from 1-7. Buscher (1965a) noted an infection of 33% for three species of ducks on their breeding grounds; 10% along their migration route and 5% on their wintering grounds. Buscher (1966) also reported on the degree of infection with this parasite in a population of *A. discors* on their breeding grounds, 8% and 61% of the adults and immatures were infected, respectively, while the mean intensity of infection per infected bird was 3 in both age classes. In the present study 1% of the *A. crecca* and 36% of the *A. discors* were infected (Table 11, 12). *E. uncinatum* is a characteristic helminth of waterfowl (*vide* McDonald, 1969b). This, however, is the first record of its occurrence in *A. crecca* in North America.

The measurements of mature specimens of both sexes agreed with those given by Czaplinski (1962)(Table 15).

Thominx anatis (Schrank, 1790) Skrjabin and Shikhobalova, 1954. This nematode was recovered from two (2%) of the *A. crecca* (Table 11) and 20 (33%) of the *A. discors* (Table 12). The intensity of infection was similar in both host species ($p > 0.05$) but the incidence of infection was significantly different ($p < 0.05$), *A. discors* being the more frequently infected. Specimens were usually found in the caeca but occasionally individuals were

TABLE 15

MEASUREMENTS OF MALE AND FEMALE *EPOMIDIOSTOMUM UNCINATUM* OBTAINED FROM *A. DISCORS* DURING THE PRESENT STUDY

	Male (9)*		Female (10)*	
	Mean	Range	Mean	Range
Body, length	6.59 mm	6.17-7.19 mm	10.16 mm	8.93 -11.17 mm
" width	177	120-230	210	153-255
Pharynx, length	907	867-918	1.08 mm	0.918- 1.122mm
Spicule, left, length	129	110-150	-	-
" right, length	130	108-163	-	-
Tail, length	-	-	119	105-138
" width	-	-	45	33- 68
Distance from vulva to posterior end	-	-	2.27 mm	1.99 - 2.53 mm
Egg, length	-	-	86	65-100
" width	-	-	57	43- 68

*(#) = number measured.

collected from S3 of the small intestine.

T. anatis is a widely distributed nematode of waterfowl but has also been recorded from 6 other orders of birds. McDonald (1969b) lists over 65 avian hosts from 4 continents.

The measurements of mature specimens of each sex from both hosts agree with those given by Czaplinski (1962), Mettrick (1959), and Wakelin (1965).

Capillaria contorta (Creplin, 1839) Travassos, 1915. Both the incidence and intensity of infection with this nematode was low. Five (19%) of the *A. crecca* and 1 (2%) of the *A. discors* were infected. All specimens (10 mature females) were recovered from the mucosa of the esophagus.

McDonald (1969) notes that *C. contorta* is a very common and characteristic helminth of waterfowl (restricted to ducks and swans in North America) but also occurring in at least 5 other orders of birds. It is cosmopolitan in distribution, this being facilitated by its direct life cycle and lack of host-specificity.

Measurements of specimens obtained in the present study agree with those given by Czaplinski (1962) and Mettrick (1959).

Cram (1930) reported *C. contorta* as the cause of mortality in waterfowl. The low numbers of helminths encountered in the present study caused no apparent damage.

Tetrameres ryjikovi Khuan Shen-i, 1961. This species was found in 15 *A. crecca* (Table 1) and 10 *A. discors* (Table 2). The incidence and intensity of infection were similar in both host species ($p > 0.05$). All specimens were recovered from the mucus glands of the proventriculus.

T. ryjikovi has not previously been reported from North America nor has it ever been recovered from *A. discors*. The measurements of both males and females agree with those presented by Khuan Shen-i (1961) who first recovered and described this nematode from anatids in the U.S.S.R. (Table 16).

Streptocara crassicauda (Creplin, 1829) Skrjabin, 1961. Only one duck, an immature female *A. discors* harbored this species; a single mature female specimen being located beneath the gizzard lining. Measurements of the specimen agree with those given by Gibson (1968) in his review of the genus *Streptocara* Railliet *et al.*, 1912. This species has not previously been recorded from *A. discors*.

Acanthocephala

Only one species, *Corynosoma constrictum* Van Cleave, 1918 was recovered during the present study.

TABLE 16

MEASUREMENTS OF MALE AND FEMALE *TETRAMERES RYJIKOVI* KHUAN SHEN-I, 1961
OBTAINED DURING THE PRESENT STUDY

	Male (2)*		Female (8)*	
	Mean	Range	Mean	Range
Body, length	3.11 mm	3.06-3.16 mm	2.56 mm	2.14-3.04 mm
" width	93	85-100	1.24 mm	1.12-1.36 mm
Large spicule, length	244	243-245	-	-
Small spicule, length	68	68	-	-
Lateral ala, length	38.5	38- 39	-	-
Buccal capsule, Internal diameter	10.5	9- 12	13	12- 13
" " External diameter	20	18- 22	-	-
" " Depth	-	-	16	14- 17
Egg, length	-	-	46	44- 48
" width	-	-	24	23- 24

*(#) = number measured.

Corynosoma constrictum Van Cleave, 1918. Representatives of this species were recovered from 23 (26%) of the *A. crecca* and 43 (70%) of the *A. discors* (Table 17). Although the intensity of infection was similar in both host species ($p > 0.05$) the incidence of infection was significantly higher in *A. discors* ($p < 0.05$). The majority of specimens were collected from S3 of the small intestine (64% in *A. crecca;* 76% in *A. discors*) of both host species. S2 was the next most heavily infected region (33% in *A. crecca;* 22% in *A. discors*). Small numbers also occurred in S1 and the large intestine.

The occurrence of the heaviest infection in a local duck suggests not only an available intermediate host at the collection site but also the higher susceptibility of younger ducks to parasitism. An immunity acquired with age has often been used to explain the lower parasite burden in adults (Bishop, 1971; Buscher 1965). Cornwell and Cowan (1963) attributed the differences in levels of parasitism in different age groups of Canvasbacks to the feeding habits of the host. The heavy use of invertebrates by ducklings as reported by Chura (1961), Coulter (1955), Mendell (1949, 1958) and Perret (1962) could possibly account for these discrepancies.

Buscher (1966) reported this helminth in *A. discors* in Manitoba where 59% of the adult and 69% of the immature birds were infected, harboring an average of 4 and 9 worms,

TABLE 17

DETAILS OF INFECTION OF *CORYNOSOMA CONSTRICTUM* IN *A. CRECCA* AND *A. DISCORS*

		A. crecca	*A. discors*
Adult Male	No. (%) birds infected	1 (9)	1(33)
	Range of parasite nos.	1	1
	Mean no. parasites/infected bird	1	1
	Total no. parasites	1	1
Adult Female	No. (%) birds infected	3(33)	4(67)
	Range of parasite nos.	3-4	1-6
	Mean no. parsites/infected bird	3	4
	Total no. parasites	10	14
Immature Male	No. (%) birds infected	8(31)	18(85)
	Range of parasite nos.	1-8	1-22
	Mean no. parasites/infected bird	5	6
	Total no. parasites	37	102
Immature Female	No. (%) birds infected	11(28)	15(60)
	Range of parasite nos.	1-6	1-22
	Mean no. parasites/infected bird	2	5
	Total no. parasites	25	68
Local Male	No. (%) birds infected	-	2(66)
	Range of parasite nos.	-	2
	Mean no. parasites/infected bird	-	2
	Total no. parasites	-	4
Local Female	No. (%) birds infected	-	1(50)
	Range of parasite nos.	-	23
	Mean no. parasites/infected bird	-	23
	Total no. parasites	-	23
Total	Total No. (%) birds infected	23(26)	43(70)*
	Range of parasite nos.	1-8	1-23
	Mean no. parasites/infected bird	3	5
	Total no. parasites recovered	73	214

* Includes 2 birds of unknown age and sex.

respectively. Crichton and Welch (1972) also reported *C. constrictum* from the mallard and pintail in Manitoba.

Measurements and morphological characters (Table 18) compare favourably with those given by Van Cleave (1918, 1945).

C. constrictum has never been incriminated as the cause of mortality nor has the pathology of infection by this helminth been described. During the present study the loss of villi and the formation of a nodule at the site of attachment were noted.

Cestoda

Cestodes were recovered from 60 (69%) and 53 (95%) of the *A. crecca* and *A. discors* respectively. Among the *A. crecca*, immature females were most frequently infected (85%), followed by immature males (68%), adult females (56%) and adult males (36%). The most frequently infected of the *A. discors* were local birds (100%), followed by immature males (90%), immature females (88%), adult females (83%) and adult males (33%). McLaughlin (1970) reported on the cestode fauna of waterfowl collected in New Brunswick and found 4 and 9 cestode species in *A. crecca* and *A. discors* respectively.

Mallophaga

During the present study both host species were

TABLE 18

MEASUREMENTS OF MATURE MALE AND FEMALE *CORYNOSOMA CONSTRICTUM* OBTAINED FROM *A. CRECCA* AND *A. DISCORS*

	Males				Females			
	A. crecca (10)*		*A. discors* (10)*		*A. crecca* (7)*		*A. discors* (10)*	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Body, length	3.98mm	2.97-5.51mm	4.31mm	3.01-5.61mm	5.89mm	4.39-8.26mm	7.04mm	5.2-8.28mm
" width	771	438-966	766	500-959	1.10mm	754-1479	1.21mm	714-1509
Proboscis, length	925	714-1140	1.35mm	1.22-1.50mm	-	-	1.68mm	1.68 mm
" width	135	118- 162	143	123-168	152	135- 160	145	142- 165
Cuticular spine, length	28	25- 32	27	23- 30	23	18- 28	25	23- 30
Body spine, proximal, length	36	30- 43	36	30- 45	35	33- 40	35	33- 38
medial, length	41	38- 45	44	38- 50	45	40- 48	45	43- 48
distal, length	35	30- 38	38	35- 40	35	35	40	33- 43
Anterior testis, length	489	336- 612	528	377-612	-	-	-	-
" " width	338	285- 387	338	224-387	-	-	-	-
Posterior testis, length	465	397- 601	536	397-643	-	-	-	-
" " width	280	224- 357	354	204-448	-	-	-	-
Embryo, length	-	-	-	-	83	80- 95	87	80- 98
" width	-	-	-	-	20	20	21	18- 25

*(#) = number measured.

infested with three species of Mallophaga, namely *Trinoton querquedulae* (Linnaeus), *Anatoecus dentatus* (Scopoli), and *Anaticola crassicornis* (Scopoli). All three species are typical Mallophaga of anatids (Keirans 1967). It is of interest to note that *A. dentatus* has not previously been reported from *A. crecca* in North America.

GENERAL DISCUSSION

A total of 20 helminth species (excluding Cestoda) were recovered from the *A. crecca* of which 4 are new host records and 6 are new records for this host in North America. *A. discors* was the host for 18 species of helminths of which 8 are new host records. Buscher (1965) reported 14 species of Trematoda, Nematoda, and Acanthocephala from 3 anatid species that were sampled seasonally from three different regions ((1) Manitoba, breeding grounds; (2) Cheyenne Bottoms Waterfowl Management Area; Kansas, along migration route and (3) Gilchrist, Texas, wintering grounds) and (Buscher, 1966) later recovered 11 species from *A. discors* on its breeding grounds in Manitoba. Beverly-Burton (1972) recovered only 5 species from these three parasite groups from *A. crecca* in England. Crichton and Welch (1971) reported 15 species from the mallard and pintail in Manitoba. The present study revealed a larger species composition than previously reported by other workers. Avery (1966) suggested that migratory birds may be exposed to a wider range of invertebrates which could act as intermediate hosts and therefore carry a more varied helminth fauna. This is particularly true for anatids migrating along the Atlantic coast since these birds might be exposed to marine, freshwater and brackish water invertebrates.

It is generally agreed that helminth infections of waterfowl reach a maximum in both incidence and itensity during the summer and decrease during the autumn (Avery, 1966; Bezubik, 1957; Buscher, 1965b). Buscher (1965) reported a peak incidence of infection of 94% in mallard, pintail and gadwall on their breeding grounds during summer. The incidence ranged from 86% to 70% during October and November along the migration route and dropped to a low of 66% on the wintering grounds. Beverly-Burton (1972), during a study of helminths in anatids collected in the months October to January in England, found 94.4% of the Mallard, 75.6% of the Wigeon (*Anas penelope* Linnaeus), 52.4% of the Common Teal (= green-winged teal), 73.2% of the Pintail and 81.8% of the Shovelers she examined to be infected. One hundred per cent of the *A. discors* and 95% of the *A. crecca* were infected during the present study; however, *A. discors* had the higher incidence of infection for 11 of the 17 helminth species common to both hosts.

The intensity of infection was similar in both host species except in the cases of *Corynosoma constrictum*, *Notocotylus attenuatus*, and 'Echinostomes'. The food habits of the host could possibly explain this, Kortright (1942) stating:

> The animal food of the Green-winged Teal amounts to 9% of its diet so that the Blue-wing consumes more than three times as much animal food as does that species.

Although the intensity of infection with 'Echinostomes' is higher than any previously reported from both host species, *A. discors* was by far the most heavily infected. In addition to their food habits the behaviour of the hosts could also account for this discrepancy. *A. discors* is an early migrant and large numbers concentrate on the Tintamarre National Wildlife Area and Missaquash Marsh from mid-August to early October at which time they continue on their southward migration. On the other hand, *A. crecca* is a later migrant, the larger numbers concentrating on the areas around the opening of the duck hunting season at which time their utilization of the marshes becomes limited. Since *Echinostoma revolutum* and *Echinoparyphium recurvatum* occur in the infective stage on these areas (proven experimentally by infections in Pekin ducks in 1973), the high level of intermediate hosts populations on artificial impoundments as compared to a natural area (Whitman, 1974), compounded with a concentration of definitive hosts could well account for the high level of parasitism with these trematodes in *A. discors*.

Although the sample sizes of adults were too small to statistically compare parasite burdens with immatures, the intensity of infections were generally higher in young birds (Tables 1, 2, 11, 12, and 17). Buscher (1965a) reported a higher incidence and intensity of infection in immature birds and suggested that young ducks have probably

not developed an age immunity to parasitic infections and are more susceptible to parasitism than adults. The heavy utilization of invertebrates by ducklings, as previously mentioned, could also contribute to a higher incidence and intensity of infection.

Eight of the parasite species recovered during the present study have been incriminated as the cause of mortality among waterfowl and several others have been associated with pathological conditions (*vide* McDonald, 1969). During the present study only two species caused observable damage and it is not unlikely that helminth infections are a normal part of anatid biology (Cornwell and Cowan, 1963; Crichton and Welch, 1971).

SUMMARY

A study was conducted to determine the parasite fauna of two anatid species, namely, *Anas crecca* Linnaeus and *Anas discors* Linnaeus, in eastern Canada.

Methods of host collection and techniques used in locating, preserving, staining, mounting and identifying parasites are discussed.

One hundred and forty-eight ducks (87 *A. crecca*; 61 *A. discors*) collected from three localities were examined for parasites.

Twenty-three parasite species (14 Trematoda; 5 Nematoda; 1 Acanthocephala; and 3 Mallophaga) were collected from *A. crecca*. Four are new host records and six are new records for *A. crecca* in North America.

Twenty-one parasite species (11 Trematoda; 6 Nematoda; 1 Acanthocephala; and 3 Mallophaga) were recovered from *A. discors*. Eight are new host records.

Ninety-five per cent of the *A. crecca* were infected with from 1-7 helminth species (mean 2) per infected bird. One hundred per cent of the *A. discors* were infected with 1-8 species of helminths (mean 2) per infected bird.

Parasite species are discussed individually with regard to incidence and mean and range of intensity, of infection for the sex and age groups of each host species.

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 previous descriptions or between specimens from the two host species are discussed.

In some instances, the measurements of specimens recovered from each host species during the present study are compared in tabular form with each other and/or with previous descriptions.

Young birds were generally the most heavily infected host age group and possible reasons for variations in parasitic infection with age are discussed.

Eight of the species recovered have been incriminated as the cause of mortality in waterfowl. Only two species, *Amidostomum acutum* and *Corynosoma constrictum* caused observable damage in the present study.

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APPENDIX

Description of Study Areas

I. Tintamarre National Wildlife Area

The Tintamarre National Wildlife Area, located 5 miles to the north of Sackville, New Brunswick is one of several areas acquired by the Canadian Wildlife Service in eastern Canada for the preservation of waterfowl habitat. The area has been subjected to intense waterfowl management and at present contains 7 man-made impoundments, ranging from 1 - 7 yeas in age. Also included in the area are 4 natural lakes as well as numerous potholes, both natural and man-made. Since the creation of the impoundments waterfowl have tended to concentrate on these areas resulting in decreased utilization of the natural lakes (Whitman, 1974). Whitman (1974) studied the macro-invertebrate fauna of the areas and found considerably higher densities of invertebrate populations in artificial impoundments as compared to the natural lakes on the area. Particularly prominent was the high density of gastropod populations. Five genera of snails have been collected and at least 2 (*Physa* and *Lymnaea*) are known to carry infective stages of echinostomes (shown experimentally with Pekin ducks).

II. Missaquash Marsh

The Missaquash Marsh, located 5 miles to the northeast of Sackville, New Brunswick, was acquired by the province of Nova Scotia to provide nesting and staging areas for waterfowl. The history of the area is not unlike that of the Tintamarre National Wildlife Area. Originally the area consisted of a single large impoundment but recently three smaller compartments have been added to the marsh complex.

Whitman (1974) reported on the invertebrates of the oldest impoundment (8 year) and found a decrease in the densities of invertebrate populations but an increase in species diversity. However the populations of gastropod genera were relatively high.

The Hosts

I. Green-winged Teal (*Anas crecca* Linnaeus)

The Green-winged Teal is one of the earliest spring migrants following closely behind the Black Duck (*Anas rubripes* Brewster). The first arrivals reach the Nova Scotia - New Brunswick border region around the first week of April and tend to concentrate on the salt marshes awaiting ice-out on the impoundments. Population numbers generally peak during the third and fourth week of April and drop suddenly in early May when the bulk of the migrants continue their northward movement. The artificial

impoundments are not used heavily by nesting Green-winged Teal and breeding birds that do remain are usually found on small streams or ponds located within or near the Wildlife Areas.

Although an early migrant in spring, the Green-winged Teal are usually late on their southward migration. Small numbers of birds arrive in late August but large numbers do not begin to concentrate until the third and fourth week in September. By late October most of the ducks of this species have passed through but 'stragglers' occur late into November when they are forced southward by freeze-up.

II. Blue-winged Teal (*Anas discors* Linnaeus)

Unlike the Green-winged Teal, the Blue-winged Teal is a late spring migrant. Small numbers reach the Nova Scotia - New Brunswick border region during the first two weeks of April but the population peak occurs around the first week of May, about 10 - 14 days later than the Green-winged Teal. The population drops gradually during May but relatively large numbers remain to nest. During the nesting and brood-rearing periods, the artificial impoundments are used extensively by this species.

Contrasting with its late spring migration the Blue-winged Teal is an early migrant in the fall. Large numbers concentrate on the impoundments from mid-August to early October at which time they are dispersed by hunter

activity. By late October the majority of the migrants have passed through and only small numbers remain by mid-October.