Helminth fauna of *Anas undulata*, *Anas erythrorhyncha*, *Anas capensis* and *Anas smithii* at Barberspan, South Africa

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ABSTRACT

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Thirty-four species of gastrointestinal helminths were found in 25 *Anas undulata*, 21 *Anas erythrorhyncha*, ten *Anas capensis* and seven *Anas smithii* collected at Barberspan, South Africa. Excluding four new taxa, 11 new African records, and 14, 11, 12 and nine new host records were established for *Anas undulata*, *Anas erythrorhyncha*, *Anas capensis* and *Anas smithii*, respectively. The helminth community included 13 cosmopolitan species, seven species known only from the holarctic, one species known only from the south Pacific and 13 new or unidentified species that appear to be restricted to Africa. The infection levels of the common helminth species in the mainly carnivorous *Anas capensis* and *Anas smithii*, were generally much higher than those of species infecting *Anas undulata* or *Anas erythrorhyncha*

Keywords: *Anas*, Barbespan, carnivorous, cosmopolitan species, gastrointestinal, helminth

INTRODUCTION

Some 20 indigenous and 25 migrant species of waterfowl (Anatidae) occur in Africa (Sibley & Monroe 1990). However, in contrast with the situation in North America, Europe and the former Soviet Union, the helminth fauna of this group of birds has attracted surprisingly little attention (Graber, Blanc & Delavenay 1980; Alexander & McLaughlin 1997). With the exception of a study by Woodall (1977), all the available information on waterfowl helminths in Africa comes from small numbers of birds examined in more general surveys, from descriptions of new taxa, from life-history studies or from case reports (Alexander & McLaughlin 1997). Virtually nothing is known about the overall fauna in individual species of waterfowl nor about interaction between the helminth communities of different species using the same wetlands.

Barberspan, in the North-west Province, South Africa, is one of a few permanent natural water bodies in the region and has been designated as a wetland of international importance (Skead & Dean 1977b). It is an important moulting area for some waterfowl species, several species overwinter there and it is an important refuge during the dry season.

Dispersal of most species to outlying wetlands follows closely after spring rains. Nevertheless, residual and, in some cases, significant numbers of several species remain year round (Skead & Dean 1977a, 1977b; Milstein 1975).

Barberspan has a rich zooplankton community (Milstein 1975) that includes crustacean groups which serve as intermediate hosts for many of the helminths that infect waterfowl (cf. McDonald 1969). This, coupled with the variety and numbers of waterfowl that use Barberspan and the availability of dietary data on several of the species that occur there year round (Mitchell 1983; Skead & Mitchell 1983; Skead

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unpublished data), afforded a unique opportunity to study the helminth fauna of anatids in a region that, until now, has received little attention.

This study is divided into two parts. The present paper describes the gastrointestinal helminth fauna of yellow-billed ducks (*Anas undulata* Dubois), red-billed ducks (*Anas erythrorhyncha* Gmelin), Cape shoveller [(*Anas smithii* (Hartert)] and Cape teal (*Anas capensis* Gmelin), collected just prior to spring dispersal. It focuses primarily on geographical and host-parasite records and on factors influencing the levels of infection seen in each host species. A second paper will examine and compare the structure of the helminth communities within and between these host species.

MATERIALS AND METHODS

The collecting was done in November and December 1978 in the vicinity of the Barberspan Ornithological Research Station (26° 33´S; 25°36´E). Milstein (1975) has provided a summary of the physical and biotic features of the area.

Twenty-five yellow-billed ducks and 21 red-billed ducks were collected at Barberspan and Leeuwpan —a smaller, shallower, and more alkaline lake adjacent to Barberspan. Ten Cape teal and seven Cape shovellers were collected at Leeuwpan. The species were collected in relation to their local abundance. Yellow-billed ducks and red-billed ducks were abundant, whereas Cape teal and Cape shoveller occurred in small numbers. Ducks were either shot or trapped, and were examined for gastrointestinal helminths within 1 h of death. The proventriculus, gizzard, intestine and caeca were removed, placed in separate Petri dishes, opened and examined for helminths with the aid of a dissecting microscope. No attempt was made to recover schistosomes.

Cestodes and digeneans were fixed in 5 % formalin then stored in 70 % ethanol. Specimens prepared as whole mounts were stained in acetocarmine or Erhlich's hematoxylin. Where necessary, specimens were sectioned at ten microns and stained in hematoxylin and eosin.

Nematodes were fixed in hot 70 % ethanol, cleared in glycerine alcohol, and studied as temporary mounts in glycerine. Representative head collars of echinostome digeneans and copulatory bursae of nematodes were severed and mounted in glycerine jelly to facilitate the counting and measurement of collar spines and the measurement of spicules, respectively.

An attempt was made to recover and preserve all the helminths during necropsy. However, time constraints and the large numbers of small cestodes encountered in Cape teal and Cape shovellers, made this impossible. In these species, representative samples were collected from the intestine of each host and the remaining gut contents were fixed and stored in 5 % formalin. Volumetric subsampling was used to estimate the total numbers of the helminth species in these samples. After the the larger species had been removed, the initial volume of the remaining contents was measured and three 1-mℓ subsamples were taken. All the helminths in each subsample were stained, identified and counted. Extrapolation of the mean number of helminths from the three 1-mℓ samples was used to estimate the total numbers in the original volume.

Identification of nematode and digenean species was based on keys in McDonald (1974), Dubois (1968) and McDonald (1981), respectively. Identification of cestodes to the generic level was based on keys in Schmidt (1986). Species identification was based on descriptions in the literature.

The terms prevalence (% infected), abundance (number of helminths of a given species in each bird) and intensity (number of helminths of a given species in birds infected with that species) follow the usage of Margolis, Esch, Holmes, Kuris & Schad (1982).

RESULTS

All 63 ducks were infected. The total number of helminths, digeneans, cestodes and nematodes, and the relative percentage of each helminth group in the total from each host species are shown in Table 1. Far greater numbers of helminths were obtained from Cape teal and Cape shovellers, despite the fact that the sample sizes for these species were one-half to one-third of those of yellow-billed ducks or red-billed ducks. Cestodes dominated the communities in Cape teal and Cape shovellers. Digeneans and, to a lesser extent, cestodes predominated in yellow-billed ducks. Nematodes formed the greatest percentage of the helminths found in red-billed ducks, but neither they nor cestodes nor digeneans predominated in this host.

Thirty-four helminth species were found in the four host species examined (Table 2). Yellow-billed ducks, red-billed ducks, Cape teal and Cape shoveller were infected with 20, 17, 18 and 13 species, respectively. Individual ducks harboured between one and 14 helminth species. Sixteen of the 23 cestodes, including four new species: *Sobolevicanthus transvaalensis*, *Echinocotyle capensis*, *Microsomacanthus macrotesticulata* and *Fimbriasacculus africanensis* which have been described elsewhere (McLaughlin 1984, 1989; Alexander & McLaughlin 1993, 1997, respectively), were identified to the species level. Seven other species of cestodes could not be identified beyond the generic level because they were either

TABLE 1 Total number and the relative percentage of each helminth group in the helminth fauna of *Anas undulata*, *Anas erythrorhyncha*, *Anas capensis* and *Anas smithii* examined at Barberspan, RSA

Helminth groups	Host species							
	Anas undulata		*Anas erythrorhyncha*		*Anas capensis*		*Anas smithii*	
	Total	Relative %	Total	Relative %	Total	Relative %	Total	Relative %
Helminths	1 345,00		389,00		51 066,00		27 222,00	
Cestodes	521,00	38,70	121,00	31,10	51 046,00	> 99,90	27 140,00	99,70
Digeneans	579,00	43,10	121,00	31,10	2,00	< 0,01	29,00	0,11
Nematodes	245,00	18,20	147,00	37,80	18,00	< 0,01	53,00	0,19

immature (the dilepid species, *Diorchis* 60 and *Diorchis* 68), incomplete or were otherwise unworkable. Throughout this study, these cestodes are designated by their rostellar hook length. Five species of digeneans and six species of nematodes were also identified. One digenean (*Catatropis* sp.) and one nematode species (*Tetrameres* sp.) could not be identified beyond the generic level owing to the condition of the material and the absence of males, respectively.

Capillaria contorta was found in the esophageal mucosa, *Gastrotaenia cygni*, *Amidostomum acutum* and *Epomidiostomum uncinatum* all occurred under the gizzard lining, whereas the *Tetrameres* spp. were found in the glands of the proventriculus. *Diorchis* 23, *Zygocotyle lunata* and the *Catatropis* sp. occurred in the caeca. All other species were found in the intestine.

Cloacotaenia megalops, *Microsomacanthus spiralicirrata*, *Gastrotaenia cygni* and *Epomidiostomum uncinatum* infected all four host species. Six helminths were present in three host species: *Tetrameres ryjikovi*, *Echinoparyphium elegans* and *Capillaria contorta* occurred in approximately equal frequencies in teach of the three species infected, *Skrjabinoparaksis tatianae*, *Fimbriasacculus africanensis* and *Diorchis flavescens* occurred more frequently in Cape teal and/or Cape shovellers. Five of ten species found in two host species occurred in yellow-billed and red-billed ducks; three were restricted to Cape teal and Cape shovelers. One species was found in a Cape teal and a yellow-billed duck, the other in a Cape teal and a red-billed duck. Eight of the 14 species found in a single host species were in yellow-billed ducks; three, two and one species were restricted to Cape shoveller, red-billed ducks and Cape teal, respectively.

The prevalence, range, abundance and intensity of each parasite in each host species are presented in Table 2. Overall, infection levels in Cape teal and Cape shoveller were considerably higher than those in red-billed and yellow-billed ducks (Tables 1 and 2). The prevalences of most species in yellow-billed ducks and red-billed ducks were comparatively low. Only four of 20 species in yellow-billed ducks and five of 17 species in red-billed ducks were found in 40 % or more of the hosts. In contrast, 12 of 18 species in Cape teal and eight of 13 species in Cape shoveller were found in over 40 % of the hosts and, for most of these, the prevalences exceeded 70 %.

Total worm burdens were considerably greater in Cape teal and Cape shoveller than in either yellow-billed or red-billed ducks. In general, the abundance and intensity of the more common species (i.e. those present in > 40 % of the host sample) in Cape teal and Cape shoveller greatly exceeded those in the other two hosts. A detailed comparison and analysis of the helminth communities within and between host species will be presented elsewhere.

New host and African records are listed in Table 3. Excluding the eight unidentified taxa and the four new species described elsewhere, 11 species, mostly cestodes, represent new records for Africa. Fourteen new host records have been established for yellow-billed ducks, 11 for red-billed ducks, 12 for Cape teal and nine for Cape shovellers.

DISCUSSION

This is the first study to examine the helminth fauna of any species of African anatid in detail. Ducks examined during this study were collected in the spring, just prior to dispersal. Seasonal studies on the helminth populations in several species of *Anas* in Europe (e.g. De Jong 1976; Birova, Macko & Spakulova 1989a, 1989b, 1990) and North America (Buscher 1965; McLaughlin & Burt 1973) have shown that infection levels of most species are lowest in late winter and early spring. Although characteristic of migratory species, these changes also occur in non-migratory species like the Florida duck [*Anas (platyrhynchos) fulvigula* Ridgway] (Kinsella & Forrester 1972), which perhaps approximates the situation in this study more closely. While seasonal studies are necessary to determine whether this pattern occurs in African anatids, the comparatively light infections

TABLE 2 Frequency (prevalence), range, mean abundance (± SD) and mean intensity (± SD) of helminth species in *Anas undulata, Anas erythrorhyncha, Anas capensis* and *Anas smithii* at Barberspan, South Africa

Helminth species	Host species			
	Anas undulata	*Anas erythrorhyncha*	*Anas capensis*	*Anas smithii*
	n = 25	*n* = 21	*n* = 10	*n* = 7
Digenea				
Apatemon minor	15 (60)[a] 1–223[b] 12,9 (44,7)[c] 21,5 (56,8)[d]	9 (43) 1–68 5,4 (15,6) 12,5 (22,5)	–	–
Echinoparyphium elegans	4 (16) 1–249 10,1 (49,8) 63,2 (123,8)	4 (10) 1–3 0,3 (0,8) 1,8 (1,0)	1 (10) 1 0,1 (0,3) 1 (ø)	–
Catatropis sp.	–	1 (5) 1 0,5 (0,2) 1 (ø)	1 (10) 1 0,1 (0,3) 1(ø)	1 (14) 29 4,1 (11,0) 29 (ø)
Hypoderaeum conoideum	1 (4) 1 0,04 (0,9) 1 (ø)	–	–	–
Zygocotyle lunata	1 (4) 2 0,08 (0,4) 2 (ø)	–	–	–
Cestoda				
Cloacotaenia megalops	12 (48) 1–8 1,7 (2,4) 3,6 (2,3)	14 (67) 1–10 2,8 (2,6) 4,2 (2,0)	8 (80) 1–26 7,7 (10,4) 9,6 (10,9)	7 (100) 1–59 25,0 (22,8) 25,0 (22,8)
Dicranotaenia coronula	3 (12) 1–3 0,25 (0,65) 1,7 (1,2)	–	3 (30) 1–5 0,7 (1,6) 2,3 (2,3)	–
Diorchis flavescens	4 (16) 1–3 0,3 (0,7) 1,8 (1,0)	–	9 (90) 3–84 32,7 (29,2) 36,3 (28,4)	2 (29) 103–245 49,7 (94,3) 174,0 (160,4)
Diorchis (60)[e]	2 (8) 1 0,08 (0,3) 1 (ø)	1 (4,8) 1 0,05 (0,2) 1 (ø)	–	–
Diorchis (68)	8 (32) 1,7 0,7 (1,6) 2,1 (2,2)	1 (5) 1 0,05 (0,2) 1 (ø)	–	–
Diorchis (23)	–	–	10 (100) 1–63 25,9 (20,7) 25,9 (20,7)	1 (14) 3 0,4 (1,1) 3 (ø)

a – Number of hosts infected [Prevalence (%)]
b – Range of worm numbers detected
c – Abundance
d – Mean intensity
e – Length of rostellar hooks in micrometers
ø – Null set

TABLE 2 *(continued)*

Helminth species	Host species *Anas undulata* n = 25	*Anas erythrorhyncha* n = 21	*Anas capensis* n = 10	*Anas smithii* n = 7
Diorchis (43)	– 0,2 (0,6)	– 2	1(10) 2 (ø)	–
Echinocotyle capensis	–	–	10 (100) 4–4103 1063,8 (1271,5) 1063,8 (1271,5)	7 (100) 1–3003 1197,6 (1413,4) 1197,6 (1413,4)
Echinocotyle clerci	–	–	9 (90) 7–801 119,6 (242,3) 132,9 (253,1)	7 (100) 2–1151 315,1 (416,0) 315,1 (416,0)
Echinocotyle rosseteri	–	–	9 (90) 1–2475 541,9 (774,7) 602,1 (796,5)	–
Echinocotyle (36)	–	–	–	6 (86) 5–3451 775,6 (1254,0) 904,8 (1321,6)
Fimbriaria fasciolaris	–	1 (5) 1 0,05 (0,2) 1 (ø)	–	–
Fimbriasacculus africanensis	3 (12) 1 0,1 (0,3) 1 (ø)	1 (5) 2 1,0 (0,4) 2 (ø)	5 (50) 2–1412 168,5 (443,5) 337 (609,5)	–
Gastrotaenia cygni	9 (36) 1–8 1,0 (1,9) 2,7 (2,5)	12 (57) 1–4 1,0 (1,1) 1,7 (1,0)	9 (90) 2–15 6,7 (5,7) 7,4 (5,5)	7 (100) 7–30 14,1 (8,6) 14,1 (8,6)
Hamatolepis teresoides	–	2 (9,6) 1 0,1 (0,3) 1 (ø)	–	–
Microsomacanthus macrotesticulata	8 (32) 2–31 3,1 (7,7) 9,8 (11,4)	2 (9,6) 1–6 0,3 (1,3) 3,5 (3,5)	–	–
Microsomacanthus spiralicirrata	9 (36) 1–9 1,5 (2,9) 3,0 (2,8)	4 (19) 1–4 0,5 (1,1) 2,5 (1,3)	10 (100) 277–5903 2125,7 (1753,4) 2125,7 (1753,4)	6 (86) 38–2147 488,7 (786,4) 570,2 (828,3)
Microsomacanthus (25)	4 (16) 1–3 0,3 (0,7) 1,8 (1,0)	–	–	–

[a] – Number of hosts infected [Prevalence (%)]
[b] – Range of worm numbers detected
[c] – Abundance
[d] – Mean intensity
[e] – Length of rostellar hooks in micrometers
ø – Null set

TABLE 2 *(continued)*

Helminth species	Host species			
	Anas undulata	*Anas erythrorhyncha*	*Anas capensis*	*Anas smithii*
	n = 25	*n* = 21	*n* = 10	*n* = 7
Skrjabinoparaxis tatianae	–	1 (4,8) 1 0,05 (0,2) 1 (ø)	10 (100) 24–275 98,8 (87,8) 98,9 (87,8)	7 (100) 11–6366 1009,3 (2364,5) 1009,3 (2364,5)
Sobolevicanthus gracilis	9 (36) 1–25 3 (6,1) 8,3 (7,9)	4 (19) 1–9 0,9 (2,4) 4,5 (4,1)	–	–
Sobolevicanthus transvaalensis	–	–	10 (100) 13–5108 963,5 (1614,8) 963,5 (1614,8)	–
Platyscolex ciliata	4 (16) 1–131 8,56 (30,1) 53,5 (63,6)	–	–	–
Dilepedid sp.	–	–	–	1 (14) 1 0,14 (0,38) 1 (ø)
Nematoda				
Amidostomum acutum	4 (16) 1–4 0,3 (0,8) 1,8 (1,5)	–	–	–
Epomidiostomum uncinatum	13 (52) 1–13 2,4 (4,0) 4,5 (4,5)	10 (48) 1–2 0,6 (0,7) 1,2 (0,5)	1 (10) 1 0,1 (0,3) 1 (ø)	1 (14) 10 1,4 (3,8) 10 (ø)
Tetrameres crami	10 (40) 1–98 7,0 (20,5) 17,4 (30,3)	–	–	–
Tetrameres ryjikovi	–	14 (67) 1–41 6,0 (9,8) 9 (10,9)	6 (60) 2–4 1,7 (1,6) 2,8 (0,8)	5 (71) 2–23 7,6 (8,1) 10,6 (7,7)
Tetrameres sp.	2 (8) 8–11 0,8 (2,7) 9,5 (2,1)	–	–	–
Capillaria contorta	–	2 (10) 2–6 0,4 (1,4) 4 (2,8)	1 (10) 1 0,1 (0,3) 1 (ø)	–

a – Number of hosts infected [Prevalence (%)]
b – Range of worm numbers detected
c – Abundance
d – Mean intensity
e – Length of rostellar hooks in micrometers
ø – Null set

TABLE 3 New continental and host records for helminths found in *Anas undulata, Anas erythrorhyncha, Anas capensis* and *Anas smithii* at Barberspan, South Africa

	African record	Host record			
		Anas undulata	*Anas erythrorhyncha*	*Anas capensis*	*Anas smithii*
Digenea					
Apatemon minor	Y	Y	Y	–	–
Echinoparyphium elegans	N	Y	Y	Y	–
Zygocotyle lunata	N	Y	N	–	–
Cestoda					
Cloacotaenia megalops	N	Y	N	Y	Y
Dicranotaenia coronula	N	Y	Y	N	–
Diorchis flavescens	Y	Y	Y	Y	Y
Echinocotyle clerci	Y	–	–	Y	Y
Echinocotyle rosseteri	Y	–	–	Y	–
Fimbriaria fasciolaris	N	Y	Y	Y	Y
Gastrotaenia cygni	Y	Y	Y	Y	Y
Hamatolepis teresoides	Y	–	Y	–	–
Microsomacanthus spiralicirrata	Y	Y	Y	Y	Y
Skrjabinoparaxis tatianae	Y	–	Y	Y	Y
Sobolevicanthus gracilis	N	Y	Y	–	–
Platyscolex ciliata	Y	Y	–	–	–
Nematoda					
Amidostomum acutum	N	Y	–	–	–
Capillaria contorta	N	–	Y	Y	–
Epomidiostomum uncinatum	N	Y	Y	Y	Y
Tetrameres crami	Y	Y	–	–	–
Tetrameres ryjikovi	Y	–	Y	Y	Y

Y = New host or continental record
N = Helminth previously reported from host or continent
– = Helminth not reported from host

found in yellow-billed ducks and red-billed ducks at this time of year are consistent with observations in other studies and this suggests that the helminth populations in these hosts may behave in a similar manner. In contrast, Cape teal and Cape shovellers had much heavier infections, indicating that different processes are at work. Nevertheless, at least 34 species of helminths were present in these four host species at Barberspan just prior to spring dispersal, and it is evident that a diverse helminth fauna exists in African anatids. Doubtless additional helminth species were present in anatid species not examined in this study.

Of the helminths found at Barberspan, only *Hypoderaeum conoideum, Zygocotyle lunata, Amidostomum acutum, Epomidiostomum uncinatum, Cloacotaenia megalops* and *Fimbriaria fasciolaris* have previously been reported from waterfowl in Africa (Alexander & McLaughlin 1997); *Echinoparyphium elegans, Capillaria contorta* and *Echinocotyle rosseteri* have been reported from other avian hosts (McDonald 1969). However, the description of *Echinocotyle rosseteri* from *Spermaspiza haematina* (Passeriformes) by Southwell & Lake (1939) does not correspond with other descriptions of this species; both the identification and the geographical record are in error (McLaughlin & Burt 1979).

The helminth fauna identifed at Barberspan included several species with cosmopolitan distributions, a smaller number of species with less extensive distributions throughout Eurasia, one species apparently restricted to Australia and the south Pacific and several new species, apparently unique to the region. The cosmopolitan species: *Hypoderaeum conoideum, Zygocotyle lunata, Cloacotaenia megalops, Dicranotaenia coronula, Echinocotyle rosseteri, Fimbriaria fasciolaris, Gastrotaenia cygni, Hamatolepis teresoides, Platyscolex ciliata, Sobolevicanthus gracilis, Amidostomum acutum, Epomidiostomum uncinatum* and *Capillaria contorta* have been reported from a wide range of anatid species (McDonald 1969) and all are common parasites of European waterfowl.

The geographic distribution of *Apatemon minor, Echinocotyle clerci, Microsomacanthus spiralicirrata, Skrjabinoparaksis tatianae, Tetrameres crami* and *Tetrameres ryjikovi* is more limited, with most reports originating in Eurasia. *Tetrameres crami, Tetrameres ryjikovi* and *Apatemon minor* have been reported from North America as well (McDonald 1969; Turner & Threlfall 1975; Mahoney & Threlfall 1978).

Approximately 25 species of European waterfowl use North Africa and the upper Nile valley as part of their wintering range (summarized from Sibley & Monroe 1990). Few European species invade the Ethiopian region (Sibley & Monroe 1990) although occasional vagrants occur as far south as Barberspan (Skead & Dean 1977a). While further studies will doubtless add to the list of helminth species in waterfowl from the Ethiopian region, the present data and those summarized from the literature (Alexander & McLaughlin 1997) suggest that there has been little intrusion of European species into the helminth communities of waterfowl of sub-Saharan Africa. Most of the species that have done so are generalists that infect a broad range of waterfowl genera, and many infect a variety of other avian hosts as well (McDonald 1969).

Diorchis flavescens is apparently restricted to the Southern hemisphere. Czaplinski & Aeschlimann (1987) concluded that the only reliable records of this species were from Australia. Bray and Burt (1988) provided evidence suggesting that the natural range of this species extends to Papua New Guinea. All the remaining records of *Diorchis flavescens*, (North America, Europe and Asia) appear to be misidentifications (Czaplinski & Aeschlimann 1987; Bray & Burt 1988).

There appears to have been extensive speciation among the hymenolepidid cestodes of waterfowl in the Ethiopian region. Ten of the 21 hymenolepidid species encountered in this study represent undescribed taxa. This includes four new species for which formal descriptions have been published (McLaughlin 1984, 1989; Alexander & McLaughlin 1993, 1997) and six others that do not resemble any currently recognized species closely enough to warrant identification with them. Several additional reports of unidentified hymenolepidids in waterfowl from sub-Saharan Africa exist (Alexander & McLaughlin 1997) and these probably include a number of new taxa as well.

Infections varied among the four host species with respect to the species present, the prevalence of each species and the magnitude of the worm burdens. The majority of species (14 of 34) infected a single host species and, in most cases, occurred in comparatively small numbers. Progressively fewer helminths infected two, three or four host species. Cape teal and Cape shoveller tended to be infected more frequently, with a greater number of species and a greater number of helminths, than either yellow-billed ducks or red-billed ducks.

Diet is a major factor in determining the composition of helminth communities (Bush 1990). Except for *Amidostomum acutum, Epomidiostomum uncinatum* and *Capillaria contorta* (McDonald 1969), all the helminths found at Barberspan require invertebrate intermediate hosts for transmission. Consequently, the amount and type of animal material in the diet will have a significant effect on the recruitment of helminth infections. Cape teal and Cape shovellers are carnivorous, whereas yellow-billed ducks and red-billed ducks consume varying amounts of plant and animal material (Skead & Mitchell 1983; Mitchell 1983; Skead, unpublished data). The diet of Cape teal and Cape shovellers consists mainly of entomostracans (Mitchell 1983) which are important intermediate hosts for many helminths, especially cestodes. The animal component in the diets of yellow-billed ducks and red-billed ducks includes entomostracans, but consists mainly of larger taxa (insect larvae, corixids, etc.) (Mitchell 1983; Skead & Mitchell 1983; Skead, unpublished data) which are of little importance as intermediate hosts for helminths that infect waterfowl.

In carnivorous species like Cape teal and Cape shoveller, recruitment of new infections will occur continuously and helminth populations will remain large as long as intermediate host populations are available. Entomostracans were abundant during the study and, in several instances, over 100 ostracods were found in the intestines of individual hosts. The tendency for these hosts to feed extensively on entomostracans and to forage within the relatively restricted confines of Leeuwpan, increases the chances of their encountering infective larvae and can result in heavy infections, especially by cestodes, as seen in these ducks.

In contrast, digenean infections were more common in yellow-billed ducks and red-billed ducks. Snails, which serve as the first intermediate host, are absent from Barberspan (Roode & Van Eeden 1970) and Mitchell (1983) found no trace of snails during food-habit studies on red-billed ducks, Cape teal or Cape shoveller at Barberspan. Snails are present in surrounding river systems (Milstein 1975) and in nearby pans, in accordance with their presence in unfledged yellow-billed ducks at Barberspan (Skead, unpublished data). Vagile species like yellow-billed ducks and red-billed ducks would be more likely to encounter areas where snails are present and to acquire infections than would the more sedentary Cape teal or Cape shoveller.

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