Occurrence of avian Schistosomatidae (Trematoda) in South African birds as determined by a faecal survey

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The abundance, prevalence and distribution of avian Schistosomatidae in South African birds has been estimated by means of a survey for parasite eggs in faecal samples. Eight types of eggs were recovered, mostly from members of the Anatidae and Laridae and these have been assigned to the following schistosome genera: *Austrobilharzia* (1), *Gigantobilharzia* (1), *Trichobilharzia* (5) and *Ornithobilharzia (1).*

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'n Skatting is gemaak van die voorkoms, getalsterkte en verspreiding van die Schistosomatidae in Suid Afrikaanse voëls. Gegewens is verkry deur 'n opname te maak van die eiers van die parasiete wat in voëlmis voorkom. Agt eiertipes is aangetref, die meeste waarvan lede van die Anatidae en Laridae was en hulle is by die volgende skistosoomgenera ingedeel: *Austrobilharzia* (1), *Gigantobilharzia* (1), *Trichobilharzia* (5) en *Ornithobilharzia* (1).

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Knowledge of the avian schistosomes in South Africa is poor with only one species having been identified so far (Porter 1938). This is unsatisfactory from the viewpoint of medical parasitology since these parasites may well play a role in the epidemiology of human schistosomiasis here. Firstly, schistosome dermatitis, which is caused in man by the cercariae of these blood-flukes, has only been reported from Africa on a few occasions (Appleton 1984; Fain 1955a,b; de Meillon & Stoffberg 1954) perhaps due to its similarity to the symptoms of the invasive stage of schistosomiasis itself. Secondly, when people who have experienced this dermatitis but not schistosomiasis are tested for the latter using certain routine immunological tests, a high false positive rate may be expected (Knight & Worms 1972; Krampitz, Piekarski, Saathof & Weber 1974). Thirdly, these avian parasites may be of some significance as immunizing agents conferring a degree of heterologous immunity to schistosomiasis in man (Jordan & Webbe 1969; Pedersen, Christensen & Frandsen 1982). To assess the likelihood of these phenomena being of importance in South Africa, a survey was conducted to estimate the abundance and geographical distribution of avian schistosomes in indigenous birds. A preliminary report (Appleton 1982) described the eggs of three schistosomes, one each of *Austrobilharzia*, *Gigantobilharzia* and *Trichobilharzia*. The present paper records five additional types of eggs as well as the prevalence of infection of seven of these parasites in bird hosts.

Materials and Methods

Samples of bird droppings were collected from various localities south of latitude 19°S (Figure 1). Coastal localities visited were, where possible, breeding sites, viz. Zwartkops (Port Elizabeth), Die Mond, Swartklip (Cape Peninsula), Marcus Island (Saldanha Bay) and Bird Island (Lamberts Bay). Freshwater localities visited were Okavango Delta (Chief's Island), Barberspan, Nsumu Pan (Mkuze Game Reserve) and Rondevlei (Cape Peninsula). These samples were filtered for schistosome eggs using a Helminth Filter as described by Appleton (1982). Since egg-output rates by avian schistosomes are low (Appleton 1983), presumably because worm loads are generally light and many species have one egg *in utero* at a time, it was necessary to use whole droppings whenever possible. In the case of larger birds such as waterfowl, this resulted in a lengthy examination process. To alleviate this the residue from the filter was concentrated using the formol-ether technique or Allen & Ridley (1970) prior to examination under a microscope fitted with a Glarex projection screen. This quantitative procedure also enabled

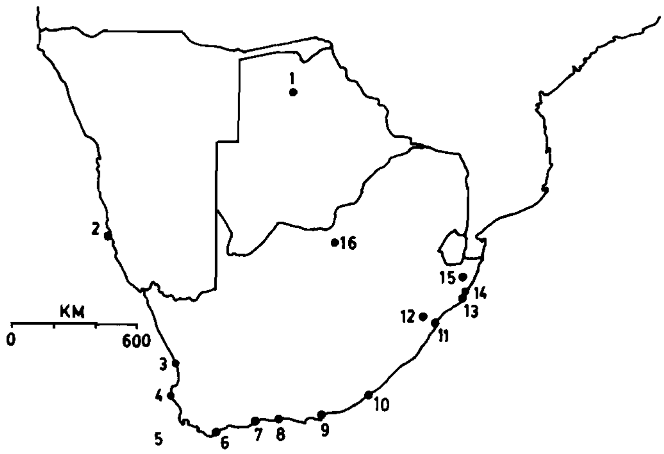

Figure 1 Map of Southern Africa showing collection localities: 1 — Okavango Delta, 2 — Ichaboë Island, 3 — Lamberts Bay, 4 — Saldanha Bay, 5 — Cape Peninsula (Hout Bay, Strandfontein, Swartklip, Rondevlei), 6 — Die Mond & De Hoopvlei, 7 — Mossel Bay, 8 — Keurbooms River Mouth, 9 — Port Elizabeth (Zwartkops), 10 — East London, 11 — Durban, 12 — Pietermaritzburg, 13 — Richards Bay, 14 — St Lucia Mouth, 15 — Mkuze Game Reserve, 16 — Barberspan.

egg-output rates to be calculated. For the purposes of this analysis, one sample was taken to represent one bird. Eggs were measured to the nearest 0,1 μm ± standard deviation.

Eggs were recorded as being those of schistosomes using the criteria listed by Appleton (1982). Blair & Islam (1983) have rightly cautioned against too much reliance on egg shape and size as taxonomic characters at the species level. An examination of the literature has shown that there is nevertheless validity in using these characters at the generic level as has been done here. Eggs of the genus *Austrobilharzia* are spherical or nearly so with a diameter of 67–140 μm. The spine, which may be straight or hooked, measures 6–10 μm (Bearup 1956; Chu & Cutress 1954; Rohde 1977). *Ornithobilharzia* spp. eggs are generally small and oval to drop-shaped with a maximum dimension of 50–100 μm and a straight spine up to 15 μm long (Fain 1955a; Macko 1963; Penner & Wagner 1956; Travassos 1942). The definitive hosts of these two genera are usually marine birds belonging to the Charadriiformes. *Gigantobilharzia* spp. eggs are elongate oval with a maximum dimension of 40–110 μm (Farley 1963; Fain 1955c; Fahmy, Mandour, Arafa & Omran 1976; Leigh 1955; Reimer 1963; Najim 1956) though others may be larger and more lozenge-shaped with a length of 100–140 μm (Rohde 1978). Spines are short and straight but may be absent. These parasites have been recorded from both passerine and coastal birds. The eggs of most *Trichobilharzia* spp. are large, spindle-shaped or crescentic and vary in length from 130–250 μm and from 30–80 μm in width (Blair & Islam 1983; Fain 1956). Most recorded definitive hosts have been members of the Anatidae. With the exception of *Trichobilharzia* type 1, no attempt was made to elucidate the life-cycles of the schistosomes detected in this survey. Life-cycle data on *Trichobilharzia* type 1 will be presented elsewhere.

Results

Faecal samples from 1 554 birds were examined for schistosome eggs. The bulk of this total was from members of five families of aquatic and coastal birds; Anatidae, Sulidae, Scolopacidae, Laridae and Sternidae. Eight types of schistosome egg were found, one *Austrobilharzia*, one *Gigantobilharzia*, five *Trichobilharzia* and one which is assigned tentatively to the genus *Ornithobilharzia*. The occurrence of seven of these in a variety of definitive hosts is shown in Table 1. Only species of which 10 or more individuals were sampled are included here. An additional 73 samples from 26 species of terrestrial birds were examined but all proved negative.

Austrobilharzia sp. (Appleton 1982, Figure 3) (Figure 2)

Egg dimensions were 79,4 ± 7,4 × 74,2 ± 7,0 μm ($n = 13$) with a usually hooked spine measuring 10,8 ± 5,2 μm ($n = 3$). This parasite has only been found in coastal birds at Durban and Port Elizabeth.

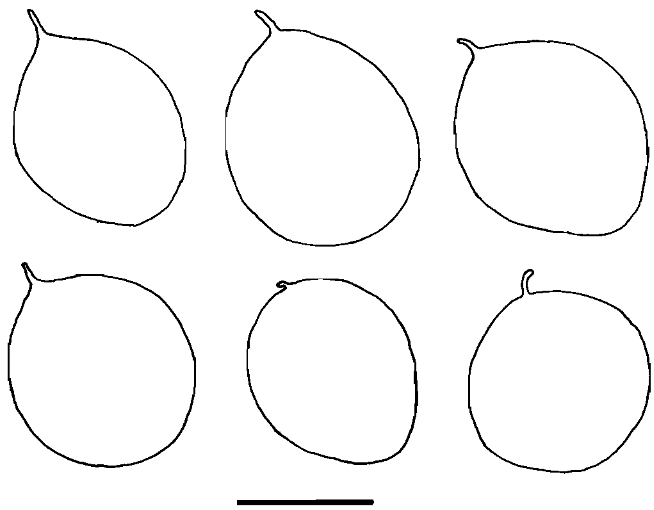

Figure 2 Outlines of *Austrobilharzia* eggs. Bar = 50 μm.

Gigantobilharzia sp. (Appleton 1982, Figure 1) (Figure 3)

Egg measurements were 124,6 ± 21,1 × 80,7 ± 10,4 μm ($n = 152$) usually with a small spine 4,1 ± 6,4 μm long ($n = 40$). This is the most common schistosome in coastal birds. Prevalence data are presented in Table 1. Gulls and gannets appear to be the major hosts for this parasite. A single swift tern stranded near Durban was also found to be infected. Two *L. dominicanus*, one from Die Mond and the other from Saldanha Bay, carried dual schistosome infections with both *Gigantobilharzia* sp. and the next species, *Trichobilharzia* type 1. The frequency distribution

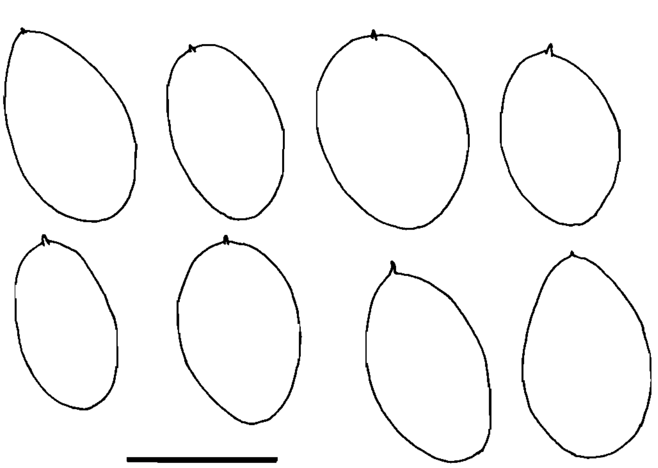

Figure 3 Outlines of *Gigantobilharzia* eggs. Bar = 100 μm.

Table 1 Prevalence of infection and host range of seven schistosome species in 15 species of indigenous South African birds

Bird species and locality	Number of samples	*Austrobilharzia* sp.	*Gigantobilharzia* sp.	*Trichobilharzia* type 1	*Trichobilharzia* type 2	*Trichobilharzia* type 3	*Trichobilharzia* type 4	*Trichobilharzia* type 5
Jackass penguin *Spheniscus demersus*								
Port Elizabeth	18		5,6					
Kerguelen petrel *Pterodroma brevirostris*								
Durban (stranded)	10							
Cape gannet *Morus capensis*								
Durban	17		17,7					
Lamberts Bay	64							
Cape cormorant *Phalacrocorax capensis*								
Lamberts Bay	41		4,9	2,4				
Ichaboë Island	3							
Spurwing goose *Plectropterus gambensis*								
Barberspan	81			60,5	1,2			
Mkuze	76			67,1			2,6	
Durban	28			42,9				
Okavango delta	6			16,7				
Egyptian goose *Alopochen aegyptiacus*								
Barberspan	33			9,1		3,0	6,1	
Durban	9							
Yellowbill duck *Anas undulata*								
Barberspan	72			4,2		12,5		1,4
Durban	6							
Redbill teal *Anas erythrorhyncha*								
Barberspan	28					7,1	3,6	3,6
White-faced duck *Dendrocygna viduata*								
Lake St Lucia	37							
Durban	33							
Coot *Fulica cristata*								
Barberspan	18			17,7				
De Hoopvlei	41							
Mixed waterfowl								
Rondevlei	32							
Unidentified waders								
Richards Bay	22							
Kelp gull *Larus dominicanus*								
Durban	25	24,0	16,0					
East London	24		12,5					
Port Elizabeth	155	6,5	6,5	1,3				
Keurbooms River mouth	15							
Mossel Bay	20		5,0	5,0				
Die Mond	64		9,4	3,1				
Swartklip	44		31,8					
Saldanha Bay	63		15,9					
Green headed gull *Larus cirrocephalus*								
St Lucia mouth	23							
Durban	34	2,9	8,8					
Mixed kelp/grey headed gulls								
Richards Bay	50		12,0					
Hartlaubs gull *Larus hartlaubii*								
Strandfontein	46		2,2					
Hout Bay	17		23,5					
Saldanha Bay	58		3,5	1,7				
Lamberts Bay	41		7,3	7,3				
Mixed kelp/Hartlaubs gulls								
Cape Peninsula	60		36,7					

Table 1 Continued

Bird species and locality	Number of samples	*Austrobilharzia* sp.	*Gigantobilharzia* sp.	*Trichobilharzia* type 1	*Trichobilharzia* type 2	*Trichobilharzia* type 3	*Trichobilharzia* type 4	*Trichobilharzia* type 5
Common/Arctic terns *Sterna hirundo/macrura*								
East London	16							
Port Elizabeth	31	3,2						
Strandfontein	41		2,4					
Durban	37		2,7	8,1				
Thick billed weaver *Amblyospiza albifrons*								
Pietermaritzburg	20							

of *Gigantobilharzia* sp. egg-output measurements is shown in Figure 4. Output rates are generally low with a median in the <1–10 eggs/g class.

Trichobilharzia egg type 1 (= *Trichobilharzia* sp.; Appleton 1982, Figure 4), (Figure 5)

The dimensions of this egg are 124,2 ± 11,6 × 61,7 ± 6,8 μm (*n* = 50) with a spine, usually hooked, measuring 8,0 ± 3,8 μm (*n* = 35). The frequency distribution of all egg-output measurements available for this parasite is shown in Figure 6. As with *Gigantobilharzia* sp., output rates were generally low with the median in the <1–10 eggs/g class. An interesting feature of Figure 6 is that the majority of light infections (<1–10 eggs/g; median 3,4 eggs/g) were from *Plectropterus gambensis* at Barberspan in the Western Transvaal whereas most of the heavier infections (with a median of 40,7 eggs/g), were from birds in Mkuze Game Reserve in northern Natal. A possible explanation for this is that the Mkuze samples were collected at the height of the 1981–84 drought. Both the Mkuze and Pongolo river flood-plains had dried up and Nsumu Pan in Mkuze Reserve was the last remaining water in this normally extensive wetland system. The birds were therefore likely to have been exposed to increased parasite transmission.

Fain (1960) described *Gigantobilharzia plectropteri* from *P. gambensis* in Central Africa and illustrated a single, fusiform, unembryonated, intra-uterine egg measuring 100 × 18 μm and with a prominent, terminal spine. Allowing for some enlargement of such an egg during

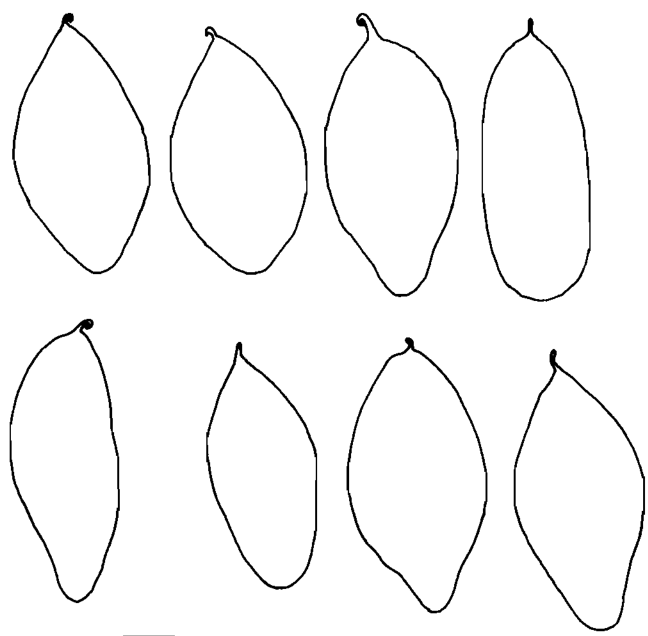

Figure 5 Outlines of *Trichobilharzia* sp. 1 eggs. Bar = 60 μm.

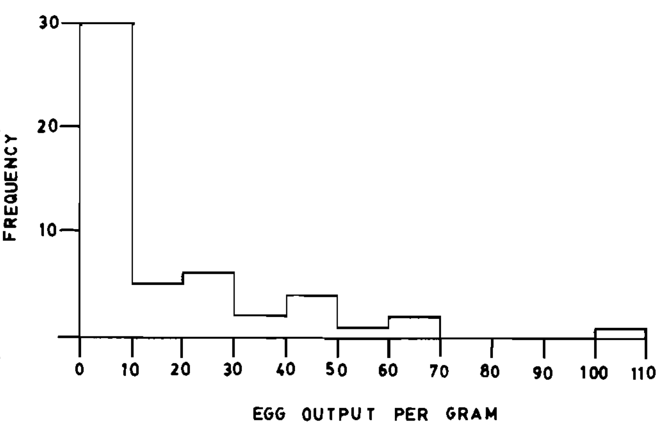

Figure 4 Frequency distribution of *Gigantobilharzia* sp. egg-output rates (*n* = 51).

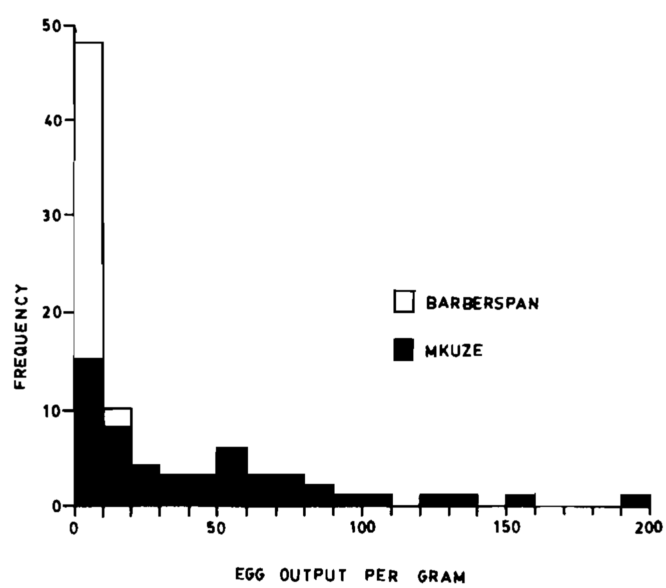

Figure 6 Frequency distribution of *Trichobilharzia* sp. 1 egg-output rates. (*n* = 88).

oviposition and development, it could well resemble that recorded here as *Trichobilharzia* egg type 1. Fusiform eggs are, as Fain (1960) noted, unusual within the genus *Gigantobilharzia*.

Trichobilharzia egg type 2 (Figure 7)

The only egg found measured 160 × 60 μm long and was embryonated with a hooked spine measuring 5 μm at one pole and a conspicuous bulb-like process at the other. This process measured 35 μm in length. The single *P. gambensis* found infected also harboured *Trichobilharzia* type 1.

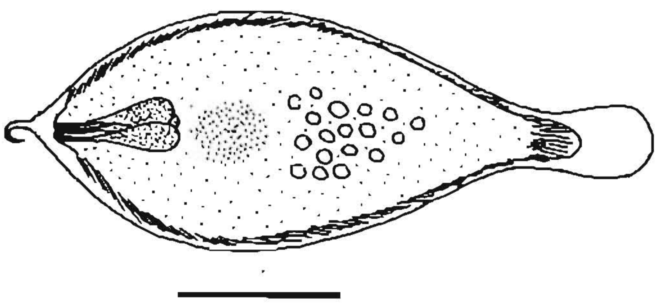

Figure 7 The egg of *Trichobilharzia* sp. 2. Bar = 40 μm.

Trichobilharzia egg type 3 (Figures 8 & 9)

These were large, symmetrically spindle-shaped eggs measuring 196,5 ± 20,6 × 60,5 ± 4,4 μm (*n* = 16) and a terminal spine which was generally hooked. Both poles of these eggs were usually equally attenuated though occasionally the spine-bearing end was shorter. This egg-type was recovered most frequently (12,5%, 9/27) from *Anas undulata*, from Barberspan. Mean output rates were 5,3 ± 5,4 eggs/g (*n* = 9) from *A. undulata* and 0,9–1,4 (*n* = 2) from *A. erythrorhyncha*. This egg is similar in size and shape to those produced by a group of schistosomes inhabiting the portal veins of waterfowl, viz. *Trichobilharzia jianensis* from China (Minsheng, Yuefa & Fengjie 1977), *T. maegraithi* from Thailand (Kruatachue, Bhaibulaya, Chesdapan & Harinasuta 1968), *T. cameroni* from Canada (Wu 1953), *T. physellae* from the USA (McMullen & Beaver 1945) and *T. indica* from India (Baugh 1963). Blair & Islam (1983) have drawn attention to the considerable morphological similarities among this group of schistosomes.

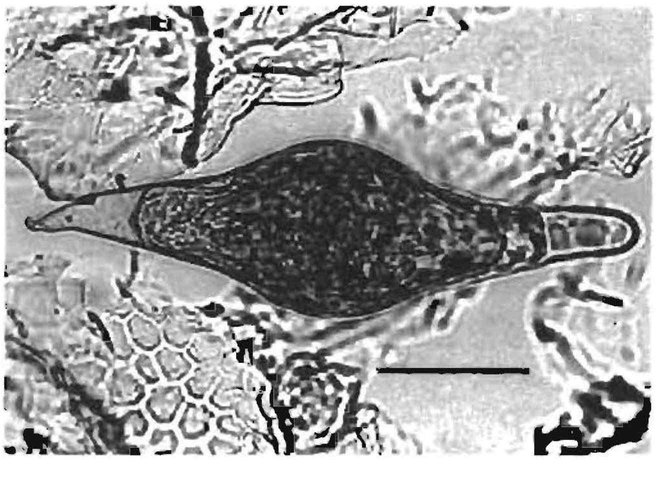

Figure 8 The egg of *Trichobilharzia* sp. 3. Bar = 50 μm

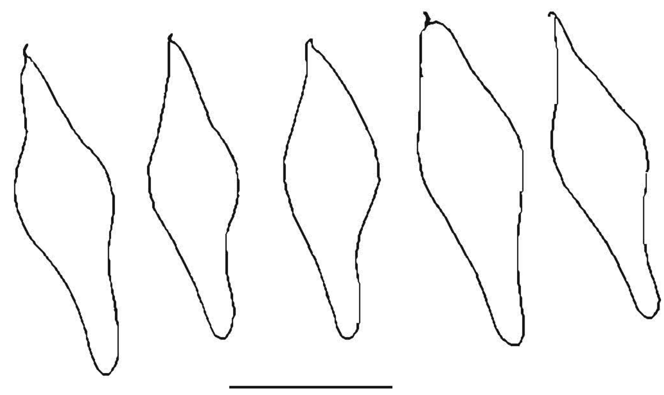

Figure 9 Outlines of *Trichobilharzia* sp. 3 eggs. Bar = 100 μm.

Trichobilharzia egg type 4 (Figures 10 & 11)

This is another large elongate terminal-spined egg but with the anterior pole greatly attenuated and coiled. Dimensions were 258,7 ± 28,7 × 53,9 ± 1,4 μm (*n* = 6) and the spine measured 6,7 ± 2,9 μm (*n* = 3). The attenuated end, measured from the posterior end of the miracidium was approximately 80 μm long. These eggs were found in 4,8% (2/42) Egyptian geese, *Alopochen aegyptiacus* and 3,6% (1/31) *Anas erythrorhyncha* from Barberspan and 2,6% (2/76) *P. gambensis* from Mkuze Game Reserve. Rates of output were 2,0 eggs/g for *A. erythrorhyncha* and 0,13–0,15 eggs/g (*n* = 2) for *Alopochen aegyptiacus*. The general form of this egg, with its elongate anterior projection and relatively great length, is suggestive of the egg from which

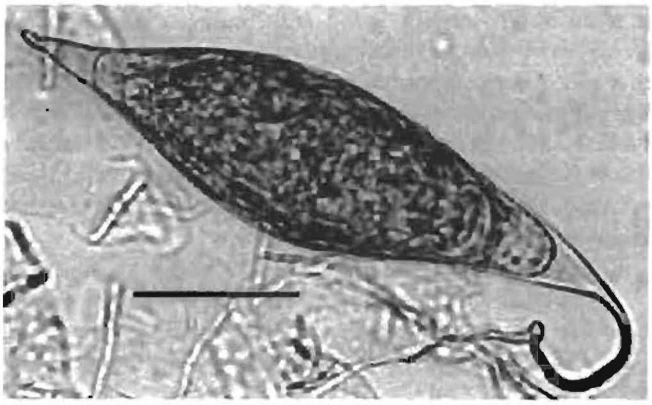

Figure 10 The egg of *Trichobilharzia* sp. 4. Bar = 50 μm.

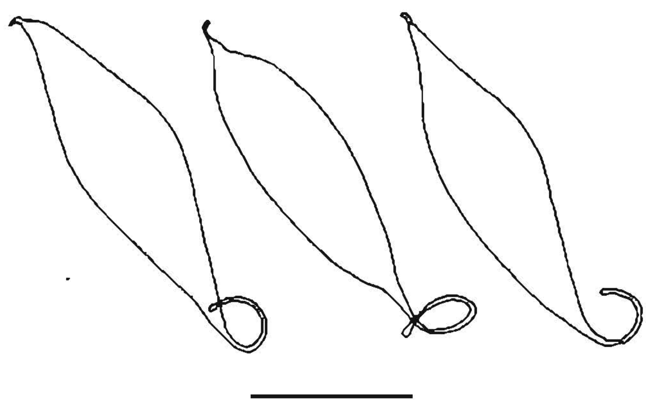

Figure 11 Outlines of *Trichobilharzia* sp. 4 eggs. Bar = 90 μm.

Schistosoma pirajai was described (Travassos, de Freitas & Kohn 1969). This egg measured 250 × 40–43 μm and its final host was *Anas bahamensis*. Yamaguti (1958) noted however that *S. pirajai* might not belong to the genus *Schistosoma*.

Trichobilharzia egg type 5 (Figures 12, 13)

This is a large, curved egg measuring 231,9 ± 11,3 × 52,8 ± 2,5 μm (*n* = 4) with a prominent spine also curved, 4,6–5,0 μm long. Egg-output rates were 0,9 and 3,4 eggs/g from *A. undulata* and *A. erythrorhyncha* respectively. This egg type seems referable to those produced by *Trichobilharzia nasicola*, *T. spinulata* and *T. aureliani*, a group of nasal schistosomes recorded from waterfowl in Rwanda by Fain (1956) and *T. australis* from Australia (Blair & Islam, 1983).

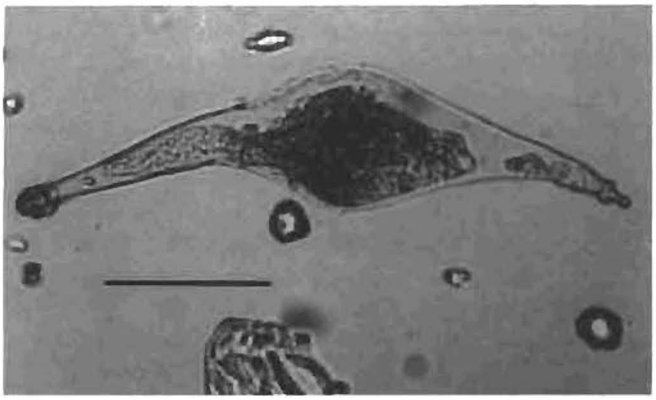

Figure 12 The egg of *Trichobilharzia* sp. 5. Bar = 60 μm.

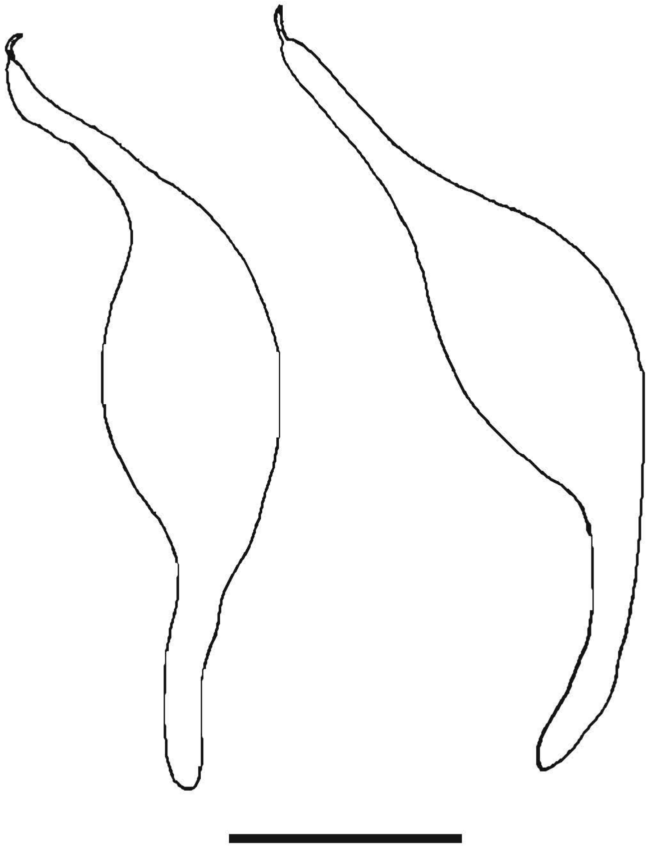

Figure 13 Outlines of *Trichobilharzia* sp. 5 eggs. Bar = 60 μm.

An eighth type of schistosome egg (Figure 14) was recovered from a single *Morus capensis* from Bird Island, off Port Elizabeth. This was a small, asymmetrical, embryonated egg measuring 53,1 ± 7,6 × 30,5 ± 2,5 μm (*n* = 14) and usually with a prominent, straight spine 7,6 ± 2,6 μm (*n* = 13) in length. *Morus capensis* does not frequent fresh water and this coupled with the small size and irregular shape of these eggs suggest that they may belong to the genus *Ornithobilharzia*.

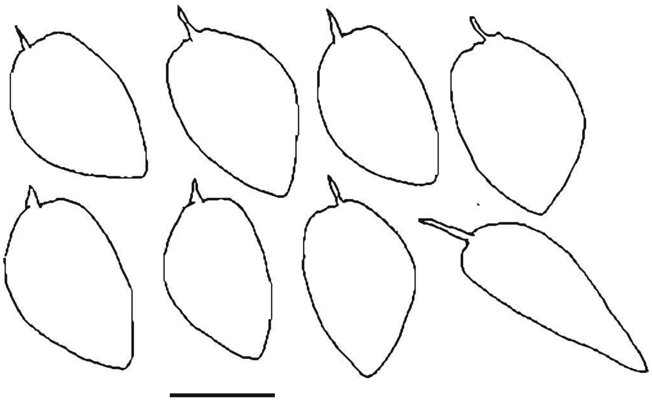

Figure 14 Outlines of *cf. Ornithobilharzia* sp. eggs. Bar = 30 μm.

Discussion

Aquatic and coastal birds were more intensively sampled during this survey than terrestrial species but it should not be concluded from this that schistosome infections do not occur amongst the latter. Recent reearch by Guth, Blankespoor, Reimink & Johnson (1979) and Strohm, Blankespoor & Meier (1981) has shown in fact that passerine birds may frequently be infected. From the points of view of the aims of this study however, two schistosomes stand out as being both common and widespread in South Africa, *Gigantobilharzia* sp. in coastal birds and *Trichobilharzia* type 1 in waterfowl. The cercaria of this latter, which develops in the aquatic snail *Lymnaea natalensis* is now known to cause dermatitis in man (Appleton 1984).

Gigantobilharzia sp. was most frequently found in birds along the coast of the south-western Cape Province between the Cape Peninsula and Saldanha Bay. It was recorded from eight species of coastal birds only, none of which seem to represent a major host. Two of these, *Larus dominicanus* and *Morus capensis*, with prevalence rates of up to 31,8 and 17,7% respectively, and probably also *L. hartlaubi* with an infection rate of 23,5% at Hout Bay on the Cape Peninsula, may however act together to maintain transmission of this parasite. This view is supported by a limited collection of gull samples from various localities on the Cape Peninsula in 1981 which yielded an infection rate of 36,7%. Terns and cormorants, by virtue of their lower infection rates, probably play a less important role in the aetiology of *Gigantobilharzia* sp. here. The occurrence of infections in *Larus cirrocephalus*, a gull which is restricted to the east coast of Africa and certain inland areas, indicates that transmission takes place along the eastern seaboard of South Africa as well. It is noteworthy that of the bird species found to be infected with *Gigantobilharzia* sp. in Natal, the most important hosts, *L. dominicanus* and *M. capensis*, both migrate as sub-adults and non-breeding adults up to the east coast of South Africa from their nesting grounds in the southern and south-western Cape (Crawford, Cooper & Shelton 1982; Crawford, Shelton, Cooper & Brooke 1983). These same breeding areas, particularly on the south-western Cape coast are, as already mentioned, the main areas of *Gigantobilharzia* sp. transmission. The lower prevalence rates of *Gigantobilharzia* sp. infection in *L. dominicanus* along the south and east coats of the country may be a reflection of the coast-wise movements of infected birds to and from transmission areas.

Unlike *Gigantobilharzia*, *Trichobilharzia* type 1 is associated with a single, major bird host, the spurwing goose, *P. gambensis*. Other waterfowl such as *Alopochen aegyptiacus*, *Anas undulata* and *F. cristata*, appear to serve as additional but minor hosts. Interestingly, this fluke was detected at low levels of infection (1,7–8,3%) in four species of coastal birds as well, presumably a consequence of their visits to wetland systems near the coast. The egg-output rates measured for both *Gigantobilharzia* sp. and *Trichobilharzia* type 1 during this study, mostly <10 eggs/g, compare well with the median value of 5 eggs/g recorded for *Austrobilharzia terrigalensis* in *Larus novaehollandiae* by Appleton (1983) in Australia. The white faced duck (*Dendrocygna viduata*) was the only anatid sampled to prove negative for schistosome infection.

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