The life-cycle and seasonal abundance of *Echinoparyphium montgomeriana* n. sp. (Trematoda: Echinostomatidae) in Natal, South Africa

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A new species of *Echinoparyphium*, *E. montgomeriana*, is described from Durban, South Africa. Certain unusual aspects of its morphology are discussed. The adult fluke is a parasite of the alimentary tract of birds. Its larval stages are common parasites of freshwater snails belonging to the family Planorbidae including *Bulinus africanus*, the intermediate host of *Schistosoma haematobium* and *S. mattheei* in the area. These intra-molluscan stages are shown to have a seasonal transmission cycle.
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'n Nuwe spesie van *Echinoparyphium*, *E. montgomeriana*, afkomstig uit Durban, Suid-Afrika, word beskryf. Sekere ongewone morfologiese kenmerke word bespreek. Die volwasse bot is 'n parasiet van die spysverteringskanaal van voëls. Die larfstadia kom algemeen voor as parasiete van varswaterslakke van die familie Planorbidae wat *Bulinus africanus*, die tussengasheer van *Schistosoma haematobium* en *S. mattheei* in hierdie gebied insluit. Daar word aangetoon dat hierdie slakstadia 'n seisoenstransmissiesiklus het.
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As part of an unpublished survey of larval echinostome flukes in the Johannesburg area, Taplin (1964) described *Cercaria montgomeriana* (Trematoda: Echinostomatidae) as well as its redia and metacercarial cyst, from the freshwater snails *Bulinus (Bulinus) tropicus* and *Bulinus (B.) forskali* collected at Montgomery Park. She was unable to recover the adult flukes despite feeding metacercarial cysts to a variety of vertebrate hosts. *Cercaria montgomeriana* as illustrated by Taplin (1964) possessed two features which are unusual amongst echinostome cercariae. These were (i) a 'brush' of needle-like spines in the prepharyngeal sac and (ii) branched and not simple excretory canals.

Similar echinostome infections have been found to be common in the snail *Bulinus (Physopsis) africanus* from the Amanzimtoti River, 30 km south of Durban, Natal. *Bulinus africanus* is also the intermediate host for *Schistosoma mattheei*, the bilharzia parasite of cattle, in this river (Donnelly 1981). Since echinostome infections were always more prevalent than schistosome infections in this snail population, the possibility is raised of interspecific competition between these fluke populations for a limited resource, the snail intermediate host. This contribution extends Taplin's (1964) data on *C. montgomeriana* by describing the adult fluke and its egg and also recording its prevalence in the *B. africanus* population of the Amanzimtoti River over a 21-month-period.

Materials and Methods

Adult *Echinoparyphium montgomeriana* were recovered from the alimentary tract of feral pigeons (*Columba livia*) which had been fed infected snails 15 – 29 days earlier. The flukes were flattened by placing them in a drop of 0,85% saline on a slide with a coverslip on top. They were then fixed by introducing drops of 5% buffered formalin at one edge of the coverslip and drawing this fixative over the specimen with a piece of filter paper placed at the opposite edge. Flukes were removed after 10 min and subsequently stained in Mayer's Haemalum.

Eggs of *E. montgomeriana* were recovered from the faeces of infected birds using the formol-ether concentration technique of Allen & Ridley (1970). Rediae and metacercarial cysts were dissected out of infected *B. africanus* while cercariae were collected after being shed spontaneously from infected snails. Drawings were made from fresh and stained material. Measurements were made to the nearest 0,001 mm from fresh material immobilized by being passed through a bunsen flame several times.

Monthly samples of *B. africanus* were collected by one of us (F.A.D.) from the marginal vegetation of an approximately

300-m stretch of the Amanzimtoti River between 3,3 and 3,6 km upstream. The snails were then exposed individually in test tubes to strong light and the number which shed cercariae was recorded. This procedure was shown by Sturrock, Karamsadkar & Ouma (1979) to provide a good estimate of the prevalence of patent schistosome infections in an aquatic snail population.

Results

Adult

The adult *Echinoparyphium montgomeriana* is shown in Figure 1 and its major morphological dimensions are listed in Table 1. The flukes were recovered mostly from the duodenum of pigeons. In heavy infections small numbers of worms were also found in the small intestine and cloaca. Attempts to infect multimammate mice, *Praomys (Mastomys) natalensis*, were unsuccessful.

Mature flukes measured approximately 3,02 × 0,52 mm when fixed in 5% buffered formalin. The collar bears 42 – 44 (mean 43) spines which are arranged in two, alternate, dorsally uninterrupted rows (Figure 2).

Five angle spines were grouped together on each lappet of the collar, two in the oral position and three in the aboral position. In some cases, however, only three or four angle spines were present and sometimes some were broken. These angle spines were the largest of all the spines on the collar and ranged in length from 0,073 – 0,093 mm (mean 0,083 ± 0,0012 mm, n = 16). Three lateral spines, spaced well apart, were always present. They varied greatly in length from 0,063 – 0,095 mm with a mean of 0,080 ± 0,004 mm (n = 10). Of the remaining dorsal spines, those in the aboral row were 0,056 – 0,071 mm long (mean 0,064 ± 0,001 mm, n = 23) while those of the oral row were smaller, 0,040 – 0,059 mm long (mean 0,050 ± 0,001 mm, n = 24).

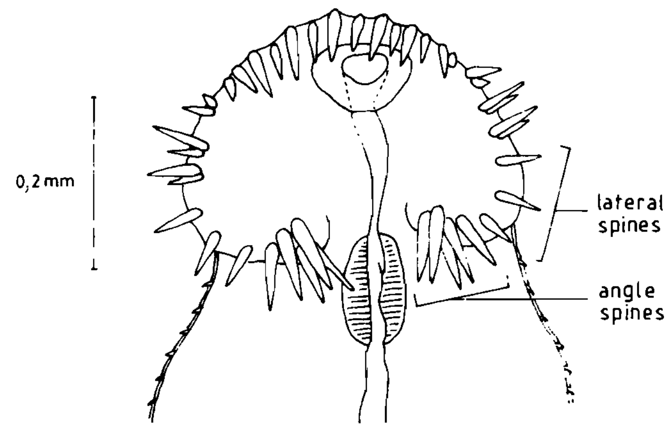

Figure 2 Detail of collar of adult *Echinoparyphium montgomeriana* showing the arrangement of the spines.

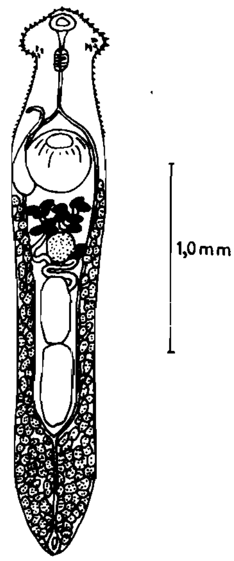

Figure 1 Adult *Echinoparyphium montgomeriana* from the duodenum of an experimentally infected pigeon.

Table 1 Mean dimensions of adult *Echinoparyphium montgomeriana*. All measurements are in millimetres ± standard error and the number of replicates (n) is given in parentheses after each measurement

Body length	3,02 ± 0,10 (27)
Maximum body width	0,52 ± 0,02 (27)
Collar width	0,33 ± 0,01 (20)
Prepharynx length	0,14 ± 0,01 (19)
Pharynx	0,12 ± 0,004 × 0,01 ± 0,01 (21)
Oral sucker diameter	0,15 ± 0,01 (26)
Acetabulum diameter	0,36 ± 0,01 (26)
Oesophagus length	0,41 ± 0,02 (11)
Ovary diameter	0,16 ± 0,01 (20)
Anterior testis	0,37 ± 0,02 × 0,16 ± 0,01 (22)
Posterior testis	0,45 ± 0,03 × 0,17 ± 0,02 (22)
Cirrus sac	0,33 ± 0,01 × 0,15 ± 0,01 (20)

The cuticle, which was approximately 0,028 mm thick, was spinose over the anterior quarter of the body, to the level of the acetabulum. The acetabulum was more than twice as large as the oral sucker. The cirrus sac lay to the side of the acetabulum and reached its posterior margin and the cirrus, seen only once, was translucent and without spines. The ovary was spherical. The uterus was short with few convolutions and contained 16 – 33 (mean 25) oval eggs. The testes lay in tandem and were markedly elongate and not lobed. The vitellaria extended from the posterior margin of the acetabulum to the posterior end of the body.

Possible natural definitive hosts include the Egyptian goose, *Alopochen aegyptiacus*; yellowbill duck, *Anas undulata*; black-headed heron, *Ardea melanocephala*; green-backed heron, *Butorides striatus* and hamerkop, *Scopus umbretta*, which all occur along the margins of the Amanzimtoti River.

Egg

The egg of *E. montgomeriana* was oval, (Figure 3) unembryonated and pale yellow-green in colour. Intra-uterine eggs measured 0,099 ± 0,001 × 0,060 ± 0,001 mm (n = 21). The mean dimensions of those recovered from the faeces of infected birds were slightly larger, 0,104 ± 0,001 × 0,065 ± 0,005 mm (n = 26) and the diameter of the operculum measured 0,019 ± 0,0003 mm (n = 26). The miracidum of *E. montgomeriana* has not been seen.

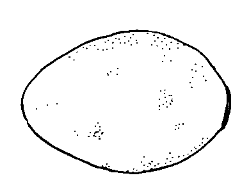

Figure 3 Egg of *Echinoparyphium montgomeriana*.

Redia

When freshly dissected from the snail, the rediae (Figure 4) were pale yellow in colour. Their major dimensions are listed in Table 2. Most rediae were found in the ovotestis and between the lobules of the digestive gland, but some were lodged around the albumen gland and in the mantle cavity around the stomach and heart. Their size varied from 0,93 × 0,11 mm to 1,41 × 0,33 mm (n = 20). A pharynx, between 0,40 and 0,60 mm long led into a long gut which extended half to three quarters the length of the redia. This gut was filled with dark granules and was therefore most conspicuous. The birth pore through which the developed cercariae emerged, although not shown in Figure 4, was situated just posterior to the pharynx. Two locomotory processes lay near the posterior end of the redia. Approximately 12 embryonic cercariae were present in each redia, with only about five approaching maturity at any time.

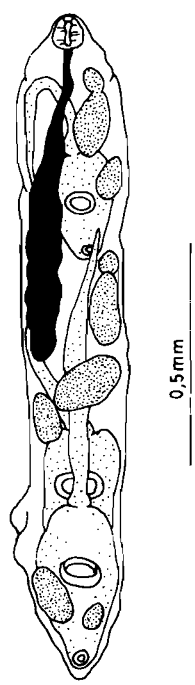

Figure 4 Redia of *Echinoparyphium montgomeriana* from the digestive gland of *Bulinus africanus.*

Table 2 Mean dimensions of the redia of *Echinoparyphium montgomeriana*. All measurements are in millimetres ± standard error and the number of replicates (n) is given in parentheses after each measurement

Body length	0,93 ± 0,005 (20)
Maximum body width	0,17 ± 0,007 (20)
Pharynx length	0,04 ± 0,002 (20)
Maximum pharynx width	0,04 ± 0,001 (20)
Gut length	0,47 ± 0,03 (19)
Number of developing cercariae	12,4 ± 3,50 (20)

Cercaria

The cercaria is illustrated in Figure 5 and its major morphological features are listed in Table 3. The collar spines proved difficult to count, even under oil immersion, but were estimated to number between 48 and 54 arranged in a single row. The prepharyngeal sac contained a 'brush' or tuft of 53 – 55 (mean 54) fine needles each approximately 0,005 mm long (Figure 6). The intestinal caeca almost reached the posterior end of the body. They were bulbous throughout most of their length and did not taper distally. The acetabulum was larger than the oral sucker. The excretory bladder was bipartite, with the anterior chamber smaller than the posterior one. The basic arrangement of the collecting canals conformed to the usual echinostome pattern but the lateral canals each gave rise to six pairs of granule-filled lateral diverticula. The canal excretory duct opened to the exterior via two lateral ducts close to the base of the tail. The tail was slightly longer than the body with the distal one-fifth of the tail, approximately 0,140 mm, modified to form a contractile tip. Both dorsal and ventral fin-folds were present near the distal end of the tail.

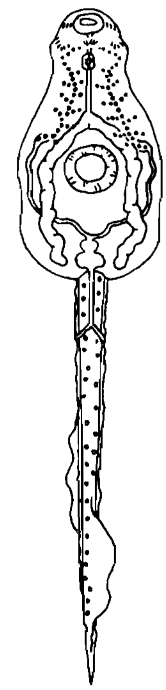

Figure 5 Cercaria of *Echinoparyphium montgomeriana.*

Table 3 Mean dimensions of the cercaria of *Echinoparyphium montgomeriana*. All measurements are in millimetres ± standard error and the number of observations is given in parentheses after each measurement

Total length	1,42 ± 0,07 (16)
Body	0,61 ± 0,04 × 0,24 ± 0,02 (16)
Tail	0,75 ± 0,04 × 0,06 ± 0,003 (16)
Oral sucker diameter	0,07 ± 0,005 (13)
Ventral sucker diameter	0,09 ± 0,005 (13)
Distance from oral to ventral sucker	0,33 ± 0,02 (13)
Pharynx length	0,03 ± 0,001 (12)
Distance from ventral sucker to tail	0,12 ± 0,01 (12)
Distance from constriction to tip of tail	0,14 ± 0,01 (12)

Metacercarial cyst

Large numbers, up to 110, of nearly spherical metacercarial cysts (Figure 7) were found lodged in the pericardial cavity and proximal end of the kidney of all *B. africanus* with patent in-

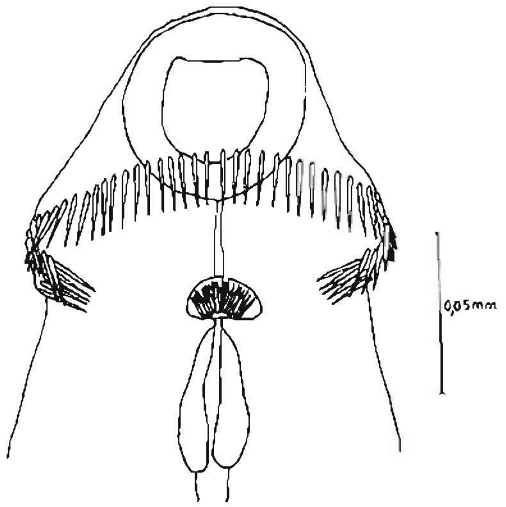

Figure 6 The arrangement and 'brush' of needles in the prepharyngeal sac of the collar spines of the cercaria of *Echinoparyphium montgomeriana* (adapted from Taplin 1964).

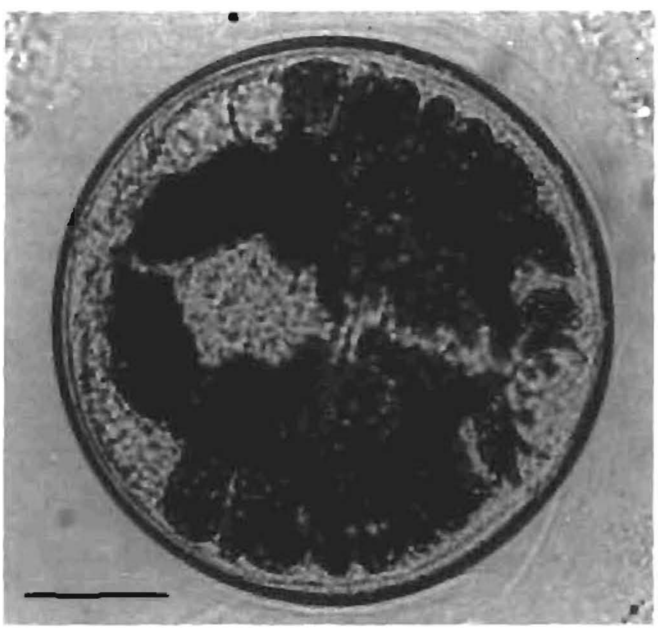

Figure 7 Metacercarial cyst of *Echinoparyphium montgomeriana*. The branched excretory canals are clearly visible. Scale bar = 0,055 mm.

fections that were examined. Smaller numbers of cysts occurred in the same organs of approximately 33% of otherwise uninfected snails and those carrying the germinal sacs of other trematodes. The *E. montgomeriana* cysts had a mean diameter ± standard error of 0,221 ± 0,023 mm (n = 33). The cyst wall consisted of two layers; a translucent outer layer 0,007 ± 0,003 mm thick and a darker, inner layer of 0,003 ± 0,001 mm thick. In younger cysts the 'brush' of prepharyngeal needles was easily seen but in older cysts this was either visible though no longer arranged in a neat 'brush' or, more commonly, it could not be found. Also, in the older cysts the excretory granules were more abundant and gave these cysts a very dense appearance.

Seasonal abundance

Figure 8 shows the monthly prevalence of patent *E. montgomeriana* infections in the *B. africanus* population of the Amanzimtoti River over a period of 21 months (data from Donnelly 1981). Infections were most frequent during the summer with a distinct peak of 17,5% in January. The prevalence fell to much lower levels (< 1%) during the winter months.

Discussion

The possession of the following morphological features in the adult stage is characteristic of the genus *Echinoparyphium* Dietz (1910); two dorsally uninterrupted rows of collar spines with those of the aboral row being larger than those of the oral row; the cirrus sac lying anterior to the acetabulum, an aspinose cirrus, and the distribution of the vitteline follicles from the posterior margin of the acetabulum to the posterior extremity of the body. The shape of the testes is also regarded as being of taxonomic importance and according to Dawes (1956) and Yamaguti (1958) is ovoid and lobed in *Echinoparyphium*. Various authors (Bisseru 1967; Lie, Heyneman, Jeyarasasingam, Mansour, Lee, Lee & Kostanian 1975; Lie & Umathevy 1965; Taplin 1964) have, however, illustrated species of *Echinoparyphium* possessing testes varying in shape from elongate to almost circular and seldom lobed.

The present authors have not been able to obtain the stained material from which Taplin (1964) identified *Cercaria montgomeriana* for comparison with the present specimens. However, inspection of her report has shown that the present

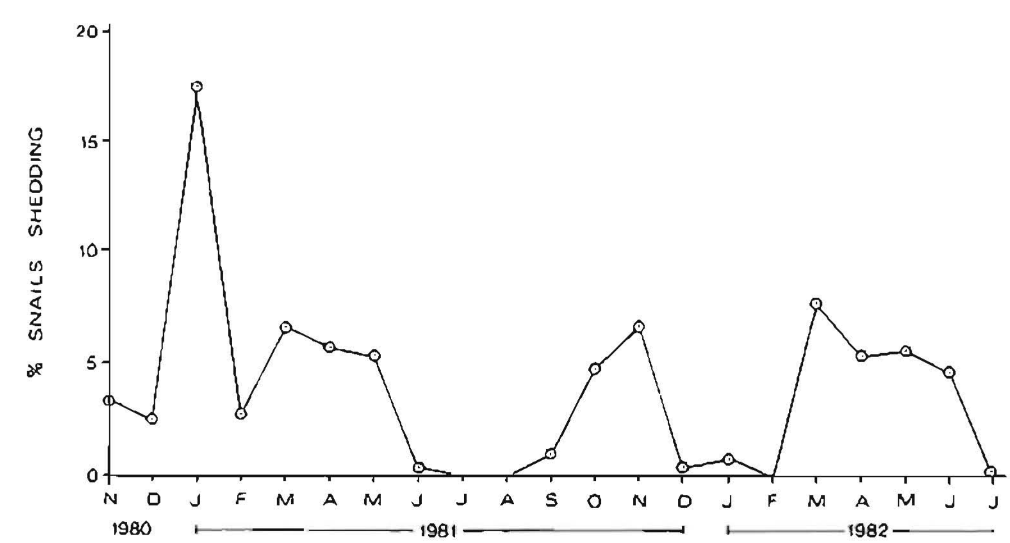

Figure 8 Fluctuation in the prevalance (%) of patent *Echinoparyphium montgomeriana* infections in *Bulinus africanus* in the Amanzimtoti River over a 21-month-period.

echinostome larvae from *B. africanus* differed only slightly from *C. montgomeriana*. These differences are considered to be of a minor nature and this, coupled with the striking and unusual features common to both sets of larvae, suggests that they do in fact represent the same species. This is named *Echinoparyphium montgomeriana* thereby retaining the unpublished specific name given to the intra-molluscan stages by Taplin (1964). The differences from Taplin's (1964) material were: (i) there are approximately 54 needles in the prepharyngeal sac of the present cercariae whereas Taplin recorded 25 – 35 (mean 30); (ii) in the present case, metacercarial cysts were found in infected as well as uninfected snails whereas Taplin failed to find them in uninfected snails. This latter discrepancy may possibly be explained by the fact that although echinostomes use a variety of species as their second intermediate hosts (Evans, Whitfield & Dobson 1981), they may not all be utilized equally. Some host species harbour metacercariae more frequently than others. As far as *E. montgomeriana* is concerned, *B. africanus* is obviously an important host while *B. tropicus*, which Taplin (1964) found to be infected, may be much less so.

The 'brush' of needles in the prepharyngeal sac of the cercaria of *E. montgomeriana* is an uncommon character amongst echinostome cercariae and, as far as can be ascertained from the literature, the present case is the only one known from Africa. None of the 15 echinostome cercariae reported from South African molluscs by Porter (1938) possessed comparable structures. Tufts of needles similar to those in the cercaria of *E. montgomeriana* seem only to have been reported for two species of Malaysian echinostomes, *Echinostoma malayanum* (Lie 1963) and *Echinostoma hystricosum* (Lie & Umathevy 1966). This 'brush' of needles breaks up in the metacercarial cysts and therefore appears only in young metacercariae and no needles are found in the adult fluke.

Branched lateral excretory canals such as occur in the cercaria of *E. montgomeriana* are another unusual feature of this echinostome. Normally these canals are unbranched. No other examples are known from Africa but Ito (1964) recorded apparently similar diverticula on the collecting canals of the *Cercaria yamagutii*, a marine parasite possibly belonging to the genus *Acanthoparyphium*, from Japan.

The number and arrangement of the collar spines in the adult stage was considered by Lie & Umathevy (1965) and Lie *et al.* (1975) to be the single most useful character in the systematics of the genus *Echinoparyphium*. On this basis therefore, *E. montgomeriana* appears to belong to a group of species possessing a complement of approximately 43 collar spines. These are *E. bioccalerouxi* Dolfuss, 1953 from Sardinia; *E. elegans* (Looss 1899) from Egypt; *E. dunni* Lie & Umathevy, 1965 from Malaysia and *E. ralphaudyi* Lie *et al.*, 1975 from Egypt, Yemen Arab Republic and Ethiopia. In her unpublished thesis, Taplin (1964) described another species, *E. alloeidium* from South Africa. *Echinoparyphium montgomeriana* differs from these in that its cercariae possess the unusual structures already described, *viz.*, a 'brush' of needles in the prepharyngeal sac, branched lateral excretory canals, dorsal and ventral caudal fin-folds and a contractile tip to the tail.

Another interesting feature of *E. montgomeriana* is that although the adult has 42 – 44 collar spines, its cercaria has 48 – 54 and, in addition, Taplin (1964) recorded 54 for *C. montgomeriana*. Normally adult echinostomes would be expected to bear the same number of collar spines as their cercariae and the loss of some 12 spines presumably during the metacercarial stage has, as far as we are aware, not been recorded before. The collar spines of the *E. montgomeriana* cercaria are not only unusually numerous for the genus, but they are also far more slender than those of the adult.

As far as the second intermediate host is concerned, *E. montgomeriana* apparently utilizes another planorbid gastropod and may even re-infect the one in which its cercariae were produced. Attempts to get these cercariae to penetrate and encyst in tadpoles (*Bufo* sp.) were unsuccessful as were similar attempts by Taplin (1964) to get *C. montgomeriana* to encyst in tadpoles of *Xenopus laevis* and young *Haplochromis* sp.

Echinoparyphium montgomeriana is the dominant echinostome infecting the *Bulinus africanus* population of the Amanzimtoti River. It has been recorded from one other locality in the Durban area, a stream at Chesterville. Occasional collections of snails from this second habitat have revealed the following infection rates: *Bulinus africanus* 14,3 – 20,0%, *Bulinus (Bulinus) natalensis* 4,0% and *Biomphalaria pfeifferi* 1,0 – 3,3%. *Bulinus africanus* appears to be the snail species most frequently utilized by *E. montgomeriana* both as first and second intermediate host.

Larval echinostomes were also the dominant trematode parasites in a *Bulinus truncatus* population studied for a year by Chu, Dawood & Nabi (1972) in the Nile Delta, Egypt. Here the prevalence of infection ranged between 1,9% and 18,8% throughout the year except in midsummer, July, when a peak of 58,9% was recorded. As in the present case, metacarial cysts were found in *B. truncatus* without patent infections and if these were also considered to be infected snails, then the mean prevalence for the year rose from 19,3% to 31,5%. This is comparable to the equivalent of approximately 35,8% recorded in the present study.

Acknowledgements

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