OCCURRENCE OF DIGENEAN LARVAE IN FRESHWATER SNAILS IN THE RUVU BASIN, TANZANIA

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ABSTRACT

A survey was carried out on digenean larvae infecting freshwater snails in five habitats in Dar es Salaam, Ruvu and Morogoro. 9424 snails belonging to 12 species from five families were examined for digenean infection from July 1996 – June 1997. 20 morphologically distinguishable cercariae were recovered. Multiple infections were not recorded. While the general prevalence of digeneans in snails was low (3.5%), variations occurred between seasons, among habitats and snail host species. Prevalence was high during the dry season but low in the rain season. Among habitats, highest prevalence was recorded at Kinondoni pond and lowest at Ruvu ponds, and was highest in Lymnaea natalensis *followed* by Bulinus tropicus *but was lowest* in Bulinus nasutus.

INTRODUCTION

Several studies to establish the prevelance of *Schistosoma mansoni* and *S. haematobium* (McCullough et al. 1968, Baalawy and Moyo 1970, Rugemalila 1991) in populations of their snail intermediate hosts have been undertaken in east Africa. Some attention has been given to the prevalence of bovine schistosomiasis in *Bulinus* snails (Berrie 1970, Kasuku *et al.* 1988) and of *Fasciola gigantica* in populations of *Lymnaea natalensis* (Ogambo-Ongoma 1971). However, relatively little information on the abundance, morphology and host relationships of other east African trematodes species not of medical or veterinary importance has accumulated (Fain 1953, Vercammen-Grandjean 1960, Loker *et al.* 1980).

Such studies may be useful in a number of ways. They may reveal species that could be useful as biological agents in the control of snail transmitted diseases (Haas 2000). For instance, McCullough (1981) reported that the prevalence of *Schistosoma haematobium* in *Bulinus* species might be reduced drastically by antagonist larval echinostomes naturally present in an endemic area.

The present study was undertaken as a preliminary step to define the digenetic trematode fauna in a geographic area in which *S. haematobium* and *S. mansoni* are endemic. It was hoped that this investigation could provide useful background information on future studies interested in the biological control of these diseases.

MATERIALS AND METHODS

The Habitats

Mindu dam

This is a reservoir for domestic and industrial use for the Morogoro municipality. It also serves for irrigation and flood control down stream. It has an area of 400 hectares, maximum depth 11m, and is located 10 km to the South West of Morogoro Municipality off the main road to Iringa in the Southern Highlands. The snail fauna collected from Mindu dam comprised of *Bulinus tropicus* Krauss 1842, *Bulinus forskalii* Ehrenberg 1831, *Bellamya capillata* Fruenfeld 1869 and *Biomphalaria pfeifferi* Krauss 1848.

Ruvu
At Ruvu snails were collected from fishponds owned by The National Food Corporation (NAFCO). The fishponds are constructed along Ruvu River flood plain and receive water directly from the Ruvu River. The Ruvu drains from Uluguru Mountains south of Morogoro. It also receives water from the Ngerengere River, which has its origins west of the Uluguru Mountains, crosses Mindu dam and flows eastwards to eventually empty into the Ruvu. The snail fauna collected included *Bulinus nasutus* Martens 1875, *B. forskalii*, *Cleopatra ferruginea* Lea and Lea 1850 and *Lanistes stulhamanni* Martens 1897.

Kinondoni pond
This is a shallow pond about 200 m, located near Kinondoni primary court in Kinondoni district. It is rich in aquatic vegetation, particularly water lilies. Snails collected were *Lymnaea natalensis* Krauss 1848, *Helisoma duryi* Wetherby 1879, *B. foskalii* and *Gyraulus costulatus* Krauss 1848.

Mbezi pond
This is an oval shaped pond that covers about 100 m^2, located in Mbezi area just off Morogoro road. The pond serves for watering domestic animals, and is visited by aquatic birds throughout the year. The snail fauna collected comprised of *Bulinus globosus* Morelet 1866, *B. forskalii* and *Melanoides tuberculata* Muller 1774.

The stream at the University
This is an ephemeral stream that crosses through rice fields south of the playgrounds at the main campus of the University of Dar es Salaam. Only *B. forskalii* was obtained from this stream.

Methods
Snails were collected monthly from July 1996 to June 1997 from the five sites described above; Mindu dam in Morogoro, fish ponds at Ruvu NAFCO farms, natural ponds at Kinondoni and Mbezi and from a stream at the main campus of the University of Dar es Salaam (Fig. 1). Collection and transportation of snails to the laboratory at the University of Dar es Salaam was carried out as described by the Danish Bilharziasis Laboratory (1987).

In the laboratory, snails were isolated singly in 10ml beakers filled with conditioned water and exposed to strong artificial light (60 watts at one meter) for six to twenty four hours to stimulate shedding of cercariae. The beakers were inspected for presence of cercariae every four hours under a dissecting microscope.

The nomenclacture used for Tanzania species of freshwater snails was that proposed by the Danish Bilharziasis Laboratory (1987) for eastern Africa freshwater snails. Specimens were identified with the help of keys by Miller (1926), Nasir and Erasmus (1964), Dawes (1966), Frandsen and Christensen (1984) and literature available. Specimens were compared with existing descriptions of African cercariae and were classified as 'undescribed' if not closely corresponding to decribed species. Sufficient information on size, flame cell patterns, stylet shapes, collar spines counts etc. (Kigadye 1998) was collected in most cases to unambiguously recognize the cercariae, but time did not permit exhaustive description of all the morphological features of each species of cercariae recovered.

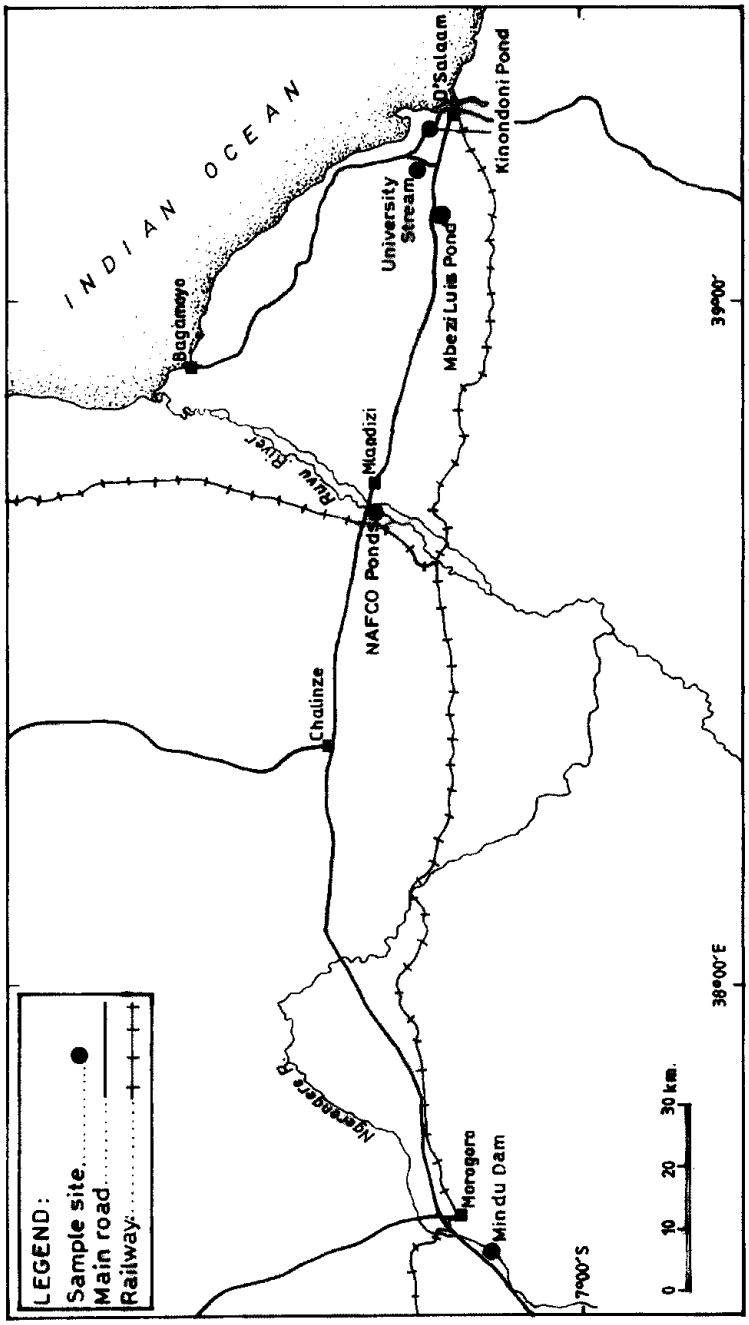

Figure 1: Sampling sites

RESULTS

A total of 9,424 snails were examined, of these 331 (3.5%) were infected by digenean trematodes. The global prevalence of natural infection in host snails were 10.3% in *Lymnaea natalensis* out of 832 snails, 8.2% (2053) in *Bulinus tropicus,* 2.4% (888) in *Bellamya capillata,* 2.1% (476) in *Gyraulus costulatus,* 2.1% (1312) in *Bulinus globosus,* 2% (397) in *Bulinus forskalii,* 1.2% (597) in *Cleopatra ferruginea,* 1.0% (286) in *Biomphalaria pfeifferi* and 0.8% (198) in *Bulinus nasutus*. No infection was found in *Melanoides tuberculata, Helisoma duryi* and *Lanistes stulhalmanni* (Table 1).

Table 1: Summary of snail collections

Habitat	***Host snail species***	**Number collected**	**Number infected**	**Prevalence (%)**
Kinondoni pond	*Lymnae natalensis*	832	86	10.3
	Gyraulus costulatus	476	20	2.1
	Bulinus forskalii	53	0	0
	Helisoma duryi	538	0	0
Mindu dam	*Bulinus tropicus*	2053	168	8.2
	Bellamya capillata	888	22	2.4
	Biomphalaria pfeifferi	286	3	1.0
	Bulinus forskalii	66	0	0
Ruvu pond	*Bulinus forskalii Cleopatra*	75	1	1.3
	ferruginea	597	7	1.2
	Bulinus nasatus	198	1	0.2
	Lanistes stulhamani	138	0	0
Mbezi pond	*Bulinus globusus*	1312	28	2.1
	Bulinus forskalii	97	1	1.03
	Melanoides tubercullata	1574	0	0
University stream	*Bulinus forskalii*	43	1	2.3
Total		9424	331	3.5

Table 2: Occurrence of cercariae in snail hosts from the Ruvu Basin

Habitat	Cercarial no.	Morphological Category	Snail host	Prevalence (%)/ No. of snails	Identification
Mindu dam	II	Furcocercaria (BAD)	*B. pfeifferi*	1.0 (286)	*S. mansoni Sambon, 1907*
	V	Furcocercaria (LPD)	*B. pfeifferi*	0.1(286)	Undescribed
	IV	Furcocercaria (BAD)	*B. pfeifferi*	0.1(286)	*Schistosoma sp*. (reptilian)
	VIII	Furcocercaria (BAD)	*B. tropicus*	0.04(2053)	*Cercaria sp*.nr. *ocellata* La Valette, 1855
	X	Echinostome	*B. forskalii*	1.5 (66)	*Cercaria sp*. nr. *decora* Fain, 1953
	XI	Echinostome	*B. tropicus*	0.25 (397)	Undescribed
	XV	Xiphidiocercaria	*B.capillata*	2.4 (888)	*Cercaria* sp. nr. *kunga* Fain, 1953

Table 2:	Cont.				
Ruvu ponds	VI	Furcocercaria (LPD)	*C. ferruginea*	0.25 (397)	Undescribed
	VII	Furcocercaria (BAD)	*B. nasatus*	0.5 (198)	*Schistosoma sp.* (avian)
	IX	Furcocercaria (LPM)	*C. ferruginea*	0.3 (597)	*Cercaria sp.* nr. *vivax* Sonsino, 1892
	XVII	Gymnocephalous	*C. ferruginea*	0.8 (597)	*Sphaeridiotrema sp.* nr. *globolus* Szidat, 1937
	XX	Parapleurolophocercus	*C. ferruginea*	0.1 (597)	Undescribed
Mbezi pond	I	Furcocercaria (BAD)	*B. globosus*	0.4 (1312)	*S. haematobium* Bilharz, 1852
	III	Furcocercous (BAM)	*B. globosus*	0.4 (1312)	Undescribed
	XII	Echinostome	*B. globosus*	0.8 (1312)	Undescribed
	XIII	Echinostome	*B. forskalii*	1.0 (97)	Undescribed
Kinondoni pond	XIV	Xiphidiocercaria	*L. natalensis*	10.4 (832)	Undescribed
	XIX	Tailless	*G. costulatus*	2.1 (476)	Undescribed
University stream	XVIII	Monostome	*B. forskalii*	2.3 (43)	Undescribed

The most prevalent cercariae were Cercaria no. XIV (10.4%) recovered from *L. natalensis* at Kinondoni pond and Cercaria no. XI (8.2%) from *B. tropicus* at Mindu dam. The least prevalent was Cercaria no. VIII (0.04%) from *B. tropicus* at Mindu dam (Table 2).

The two most prevalent cercariae (nos. XIV and XI) showed different seasonal patterns of prevalence in their respective hosts (Fig. 2). The prevalence of Cercariae no. XIV in *L. natalensis* from Kinondoni pond was erratic but generally high during the period from July-December 1996, crashed to 0 from January-March 1997, increased slightly during the rainy season (April-May 1997) and dropped to 0 in June 1997 (Fig 2).

The prevalence of Cercaria no. XI (an echinostome) in *B. tropicus* at Mindu dam was high from July-November 1996, reaching a peak in September 1996 (June-October, long dry season) (10.8%). Prevalence was low from December 1996 through January and February 1997 (short dry season), and dropped to 0 from March-May 1997 (rainy season) and started to increase again in June 1997 (Fig. 2).

No individual snail was infected with more than one species of Digenea (multiple infections). However, some populations of snails were infected by more than one species of Digenea. *B. globosus* population at Mbezi pond for instance, harboured two furcocercous cercariae (Nos. I & III) and one echinostome cercaria (No. XII) (Table 2). At Ruvu ponds, *C. ferruginea* was also infected by three species of digenean larvae (Cercaria no. IX, XVII and XX) but their distribution in time did not form a specific pattern as each individual cercariae was encountered once in a period of one year.

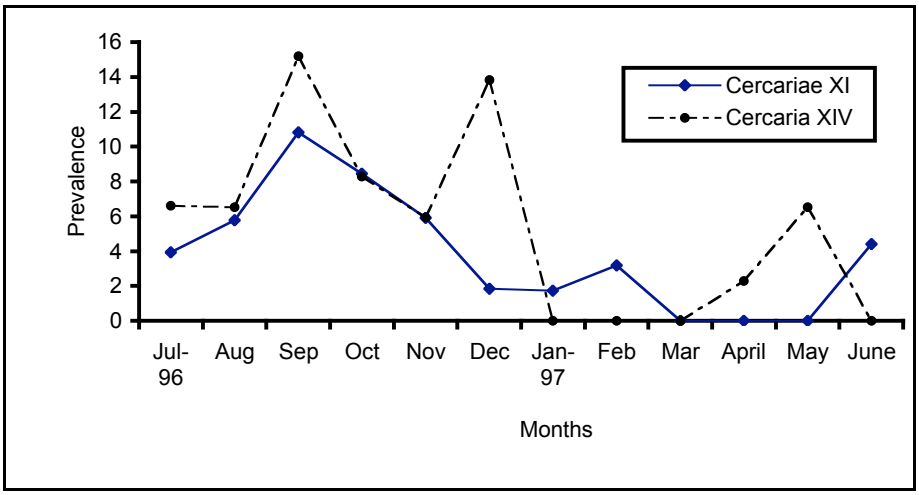

Figure 2: Monthly prevalences of Cercaria no. XIV in *Lymnae natalensis* from Kinondoni pond and Cercaria no. XI in *Bulinus tropicus* from Mindu dam.

DISCUSSION

Several studies on the occurrence of digenen larvae in their snail hosts has been undertaken in east and central Africa (Fain 1953, Vercammen-Grandjean 1960, Loker *et al*. 1980). The studies revealed many described and undescribed digenean species which varied spatially and in abundance. The results of the present study are compared with those of previous studies.

In Loker *et al.* (1980) one snail species *B. pfeifferi* yielded the greatest number of cercariae with 14 distinguishable cercariae, and the highest prevalence of infection was reported in *L. natalensis* (36.9%). In the present study the greatest number of cercariae occurred in *Bulinus forskalii* with five distinguishable cercariae while the highest prevalence of infection was recorded in *L. natalensis*. With the exception of *S. mansoni* and *S. haematobuim,* there was little similarity between the cercariae observed in the present study and those reported by Loker *et al.* (1980) in Mwanza Tanzania. The prevalence of the two cercariae in Mwanza was as follows: *S. mansoni* (4.1%), *S. haematobuim* (3.3%) while in the present study *S. mansoni* (1.0%) and *S. haematobuim* (0.4%). Loker *et al.* (1980) examined snails from non-lacustrine habitats in Mwanza area while in the present study snails were collected from the Ruvu basin about 800 km to the east of Mwanza.

In the present study, xiphidiocercariae were the most prevalent (10.4%) trematodes (Table 1). Similar results were obtained by Loker *et al*. (1980) in Mwanza region. The present study also recorded a low general prevalence (3.5%) of digeneans in their snail hosts. This is typical of infection by digenean larvae in snails (Loker *et al.* 1980, Anderson and May 1979, Esch and Fernandez 1993). Moreover, the results also showed considerable variation of prevalence and diversity of trematode fauna among the five habitats studied (Table 2). Several factors may explain this variation; all habitats sampled had distinct snail faunas, for example *L. natalensis* was found at Kinondoni pond only, and *B. pfeifferi* and *B. tropicus* at Mindu Dam only. Only *B. forskalii* occurred at four sites (Mbezi, Mindu, Ruvu and University of Dar es Salaam). Moreover, prevalence may also

vary on spatial dimensions as influenced by snail hosts, parasite life cycle, and nature and accessibility of habitats by infected definitive hosts (Smith 2001).

In the present study, higher prevalence levels were recorded during the dry season than in the rainy season. Other workers (Chandiwana *et al*. 1987, Vareyrynen et al. 2000) have reported seasonal variation of prevalence of digeneans in snails. High prevalence during the dry season has been attributed to the reduced water volume in conjunction with the increased density of snail hosts and intensified use of the habitat by definitive hosts (Sapp and Esch 1994).

This study has further confirmed the endemicity of schistosomiasis in the study area as many others have done (Rugemalila 1991). On the other hand, digeneans of veterinary importance e.g. *Fasciola hepatica* and paramphistomes were conspicuously absent even though their snail hosts *L. natalensis* and *B. globosus*, respectively, were among snails examined. This perhaps is not surprising, as pastoral activities are rare around the water bodies surveyed. Future changes in land use i.e. increased pastoral activities around the habitats may introduce digeneans of veterinary importance in these habitats.

The present study has established the occurrence of numerous species of digenean larvae in Tanzania. Nevertheless, much additional work is needed to elucidate the biology of the many trematodes species reported, and of other as yet undiscovered species in their snail hosts.

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REFERENCES

Anderson RM and May RM 1979 Prevalence of schistosome infection with molluscanpopulations: Observed patterns and theoretical predictions. *Parasitology* **79**: 63-94.

Baalawy SS and Moyo HG 1970 Studies on population dynamics of *B. (P) nasatus* and natural *S. haematobium* infection rates in relation to rainfall at Misungwi and Usagara Mwanza. *East Africa Medical Journal* **47**: 472-478.

Berrie AD 1970 Snail problems in African schistosomiasis. *Advances in Parasitology* **4**: 43-84.

Chandiwana SK, Christensen NØ, and Frandsen F 1987 Seasonal patterns in the transmission of *Schistosoma haematobium, S. mattheei* and *S. mansoni* in the highveld of Zimbabwe. *Acta Tropica* **44**: 433-443.

Danish Bilharziasis Laboratory 1987 A field guide to African freshwater snails. II. East African species: 51 pp.

Dawes B 1966 The Trematoda. Cambridge University Press London.

Esch GW and Fernandez JC 1993 A functional biology of parasitism: ecology and evolutionary implications. London, Chapman and Hall**.**

Fain A 1953 Contribution à l'étude des formes larvaires des trématodes au Congo Belge et spécialement de la larve de Schistosoma mansoni. *Méimoires Institut Royal Colonial Belge. Section des Science Naturelles et Medicales* **22**: 1-312.

Frandsen F and Christensen NØ 1984 An introductory guide to the identification of cercariae from African freshwater snails with special reference to cercaria of trematode species of medical and veterinary importance. *Acta tropica* **41**: 181-202.

Haas W 2000 Echinostomes as experimental models for biological research. In Fried B and Graczyk TK (eds) *The behavioural biology of echinostomes* Wallingford, CAB International.

Kasuku A, Christensen NØ, Monrad J, Nansen P and Knudsen J 1988 Epidemiological studies on *Schistosoma bovis* in Iringa Region, Tanzania. *Acta Tropica* **44**: 433-443.

Kigadye ESP 1998 *Studies on larval digeneans infecting fresh water snails*. MSc thesis. Department of Zoology and Marine Science, University of Dar es Salaam.

Loker ES, Moyo HG and Gardner SL 1980 Trematode-gastropod associations in nine non-lacustrine habitats in the Mwanza region of Tanzania. *Parasitology* 83: 381-399.

McCullough FS, Eyakuze VM, Msinde J and Nditi H 1968 Water resources and bilharziasis transmission in the Misungwi area, Mwanza district, northern Tanzania. *East Africa Medical journal* **45**: 295-308.

McCullough FS 1981 Biological control of the snail intermediate hosts of human spp: a review of the present status and future prospects. *Acta Tropica*: 5-14.

Miller HM 1926 Comparative studies on furcocercous cercariae. *Illinois Biological* 10: 1-112.

Nasir P and Erasmus DA 1964 A key to the cercariae from British Freshwater. *Journal of Helminthology* **XXXVIII**: 245-268.

Ogambo-Ongoma AH 1971 Field epidemiology of fascioliasis in Port Bell Uganda. *Bulletin of Epizootic Diseases of Africa* **19**: 341-351.

Rugemalila JB 1991 Schistosomiasis. In Mwaluko GMP, Kilama WL, Mandara MP, Murru M and McPherson CNL (Eds) Health and Diseases in Tanzania. London, Harper Collins Academic.

Sapp KK and Esch GW 1994 The effect of spatial and temporal heterogeneity as structuring forces for parasite communities in *Helisoma anceps* and *Physa gyrina*. *The American Midland Naturalist* **132**: 91-103.

Smith NF 2001 Spatial heterogeneity in recruitment of larval trematodes to snail intermediate hosts. *Oecologia* 127: 115-122.

Vaeyrynen T, Siddal R, Valtonen ET and Taskinen J 2000 Patterns of trematode parasitism in lymnaeid snails from northern and central Finland. *Annalels Zoologici Fennici* **37**: 189-199.

Vercammen-Grandjean P.H 1960 Les trematodes du Lac Kivu sud. Musee Royalde L´Afique Centrale, Tervuren. *Belgique-Annales-Novelle serie in 4°-Sciences Zoologique* **5**: 1-171.