Int. J. Biol. Chem. Sci. 1(2): 121-127, 2007

International Journal of Biological and Chemical Sciences

ISSN 1991-8631

http://indexmedicus.afro.who.int/Journals/Indexj.htm

Studies on the ecology and distribution of some medically important freshwater snail species in Bauchi State, Nigeria

H. N. NTONIFOR [1*] and J. A. AJAYI [2]

[1] *Department of Plant and Animal Sciences, Faculty of Science, University of Buea, South West Province, B.P. 63 Buea, Cameroon.*
[2] *Department of Zoology, Faculty of Science, University of Jos, Plateau State, Nigeria.*
[*] *Corresponding author, Tel: +237 75 21 31 56, E-mail: ngumnto@yahoo.com*

ABSTRACT

Two Local Government Areas in Bauchi State, Nigeria, harboring many snail infested water bodies were surveyed for the presence of intermediate host snail vector species for a period of 13 months. This study revealed five medically important snail species which were comprised *of Bulinus (Physopsis) globosus, Bulinus (Bulinus) truncatus, Bulinus (Bulinus) forskalii, Biomphalaria pfeifferi, and Lymnaea natalensis.* A significant fluctuation in relative abundance of these snails was observed with a peak at the beginning of the dry season. This peak was then followed by a decline during the rainy season resulting in almost the elimination of the snails in some sites and low numbers in others. It was equally observed that the snails had a water velocity, rainfall and temperature-dependent seasonal cycle with rapid increases in abundance during periods of favorable conditions. Snail-plant relationships and preferred substratum were also evaluated. Results obtained from this study are very vital for the planning of snail control in Bauchi State.

Keywords: Freshwater snails, Microhabitat preferences, Snail ecology, Snail distribution, Nigerian snail.

INTRODUCTION

Freshwater snails transmit a number of diseases amongst which are schistosomiasis, paragonimiasis, dicrocoeliasis and fascioliasis. Schistosomiasis affects about 200 million people (out of an estimated 2.200million people suffering from helminthiasis) and about 600 million others are at risk of infection in 76 countries in Africa, Latin America, the Middle East, South East Asia, and the Western Pacific Regions (WHO, 1996). In Nigeria, schistosomiasis is endemic with an estimated 11 million people infected (Iarotki and Davis, 1981). Chitsul et al. (2000) estimated that 101.28 million people are at risk of infection in Nigeria while 25.83 million people are actually infected. The surveillance of these freshwater snail borne diseases involves the identification of active and potential transmission sites. Most of these diseases are focally distributed with transmission influenced by several factors of which the intermediate host snail distribution is of great importance. It is well documented that intermediate host snails inhabit a wide range of natural habitats (Sturrock, 1993; Brown, 1994; Utzenger and Tanner, 2001; Rollinson et al, 2003; Phiri et al, 2007).. Often, man-made habitats such as irrigation canals, pools behind dams, ponds along roads, and ditches (temporal habitats) may become rapidly inhabited by these intermediate host snails, thus contributing to disease transmission (Akufongwe et al, 1995; Istifanus et al., 1996; Schall and Diniz, 2001; Oladejo and Ofoezie, 2006). To determine and implement successful public health interventions, an understanding of the ecology that determines the frequency, variation and geographical distribution of snail vector borne diseases and their transmission process is necessary.

The present study was undertaken to determine the snail population dynamics (identification, and distribution) and their transmission dynamics, and to relate the relative abundance of freshwater snails to the physico-chemical qualities of the water.

MATERIALS AND METHODS

Description of study area

Bauchi State is located in the North Eastern part of Central Nigeria between latitudes 9°5' N and 12° 6' N, and longitudes 8° 3' E and 11° 6' E. Its climate is tropical with two distinct seasons, a rainy season (mid March – early October) and a dry season (mid October – mid March). However, yearly variations may occur. Temperatures are generally high over the entire year with March and April being the hottest months (mean of 40.6 °C) while the coldest months are December and January (mean of 6.1 °C). During the dry season, pools of varying sizes (lakes, ponds, dams, ditches) are found in various parts of the State which serve as sources of water for domestic, recreational, occupational and socio-cultural purposes.

Snail Sampling

Preliminary surveys were made to locate 22 water contact sites from 10 villages in the study area. These villages included Bishi, Balanshi, Miri, Galambi and Geji (from Bauchi LGCA), and Tulu, Mundu, Rahuta, Nahuta, and Zalau (from Toro LGCA).

Sampling of snails was carried out twice monthly for 13 months using long-handed dip nets to scoop at each site for 30 minutes. Hand picking of snails attached to aquatic plants, bed-rocks and other objects was also done.

Rain boots and hand gloves were worn as precautions against infection during each snail search. Identification of the snail species collected was done using morphological and anatomical characteristics with reference to the standard keys of Brown and Kristensen (1992, 1993). Each species type was placed in a separate container and left over night in the dark (to render the snails completely inactive in the night for maximum cercariae shading the next day). Snails were subsequently placed in glass beakers (10 snails per beaker) containing 100 ml of dechlorinated tap water and exposed to sunlight for 30 minutes before examination for cercariae under a dissecting microscope. Individuals in batches that were positive for cercariae were separated and further examined individually in order to ascertain the number of snails that were shedding cercariae. Lugol iodine was used to immobilise and stain the cercariae for proper identification (Franksen and Kristensen, 1983).

Rainfall and water velocity

Monthly readings of rainfall were obtained from the weather station of the Bauchi meteorological station. Similarly, water velocity was measured by the use of a water current meter (Teledyne Gurley, USA, model N 0668) in centimetres/ second.

Water temperature and PH

Water temperature was measured in situ at each of the sites by the 2 minutes immersion of a 0-50 °C thermometer in water, and pH was similarly measured by in situ using a portable pH meter (model E 510).

Microhabitat Preference Study

The water depth and dominant substratum were recorded systematically along the study sites. The water depth was measured with a calibrated stick to the nearest 0.5 cm and the dominant substratum at the point of collection of snails recorded.

RESULTS

Five medically important snail species were collected in the study. These included *Bulinus (physopsis) globosus* and *Bulinus (Bulinus) truncatus* (intermediate hosts for urinary schistosomiasis), *Bulinus (Bulinus)* forskalii (intermediates host of the hybride, *Schistosoma intercalatum*), *Biomphalaria pfeifferi* (intermediate host for intestinal schistosomiasis) and *Lymnaea natalensis* (intermediate host of *Fasciola gigantica* that causes fascioliasis in cattle).

B. globusus was the most abundant and most widely distributed snail with a frequency of occurrence of 17 (77.27%) out of the 22 sites, followed by *Biomphalaria pfeifferi* which occurred in 13 (59.09%) of the sampled sites. *B. truncatus* occurred in 10 (45.45%) of the sites, *L. natalensis* occurred in 6 (27.27 %) of the sites, and the least of them was *B. forskalii* which was found only in 3 (13.64%) of the sampled sites.

Snail relative abundance

The highest number of snail species was encountered in ponds/dams. *B. forskalii* was encountered only in ponds while *Lymnaea natalensis* was mostly encountered in streams. *B. globosus, B. truncatus* and *B. pfeifferi* were most abundant in ponds, dams, ditches (temporal sites) than in rivers and streams (Table 1).

Fluctuations in snail populations

The density of snail populations encountered in this study showed considerable variation over time in each of the sites. The overall pattern observed was that the snail populations built up during the dry season (October-April), with peak densities during November-December. Infection rates of snails also followed the same pattern (Table 2). This corresponded to the period of low values of water velocity due to absence of rainfall. The period of maximum water velocity and rainfall (July - August) coincided with the period when few or no snails were recorded from the study area. Rainfall and water velocity were found to show negative correlation to the relative abundance of these snails (Figure 1).

Variations in maximum and minimum temperatures were appreciable. Maximum mean temperatures were recorded in the months of March-April, while minimum water temperature ranges occurred between the months of November-February which coincided with the period of peak relative abundance of the snail vectors. Water temperatures showed a negative significant correlation to snail relative abundance (Figure 2).

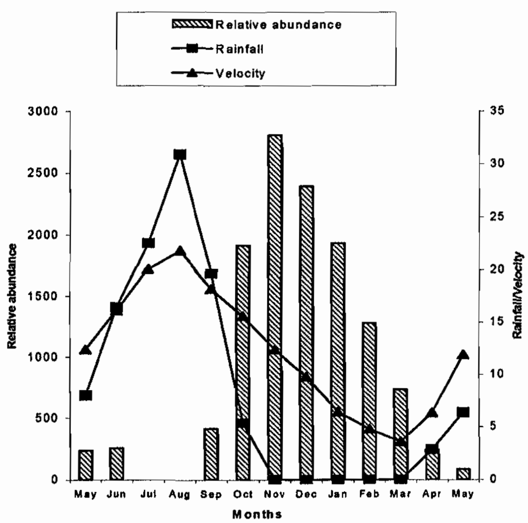

Figure 1: Monthly variations in rainfall, water current speed and relative abundance of *B. globosus* recovered from the study area.

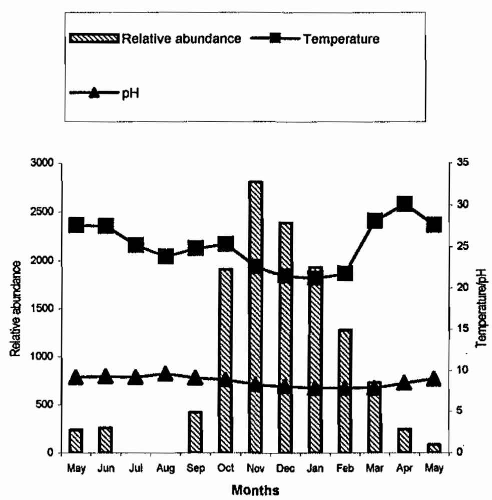

Figure 2: Monthly variations in temperature, pH and relative abundance of *B. globosus* recovered from the study area.

Table 1: Snail relative abundance in various fresh water bodies in Bauchi State.

Sampling site	Types of fresh water bodies	Relative abundance of each species				
		B. globosus	*B. pfeifferi*	*B. truncatus*	*B. forskalii*	*L. natalensis*
	Rivers	193	422	186	0	98
Toro	Stream	2473	928	684	0	280
	Dams/Ponds	3082	2516	1474	473	0
	Rivers	298	326	221	0	192
Bauchi	Stream	2119	358	982	0	309
	Dams/Ponds	3948	1815	1290	123	0
Total		**1221**	**6365**	**4837**	**596**	**874**

Table 2: Monthly variations in relative abundance and infection rate of some snail species in Bauchi State.

Month	*B. forskalii*		*B. pferifferi*		*B. truncatus*		*B. globosus*	
	Relative Abundance	**N° infected/ infection rate**	**Relative Abundance**	**N° infected/ infection rate**	**Relative Abundance**	**N° infected/ infection rate**	**Relative Abundance**	**N° infected/ infection rate**
May	0	0	83	7(8.43%)	201	15(7.46%)	207	15(7.25%)
June	0	0	89	9(10.11%)	230	16 (6.96%)	228	16(7.01%)
July	0	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0	0
September	0	0	107	12(11.21%)	311	29(9.32%)	319	49(15.36%)
October	36	0	862	157(18.21%)	645	106(16.43%)	1866	375(20.09%)
November	118	0	1075	192(17.86%)	893	148(16.57%)	2712	533(19.65%)
December	164	0	1168	185(15.84%)	705	123(17.45%)	2466	528(21.48%)
January	125	0	1236	201(16.26%)	485	57(11.75%)	1941	502(25.86%)
February	84	0	927	143 (15.43%)	620	73(11.77%)	1407	261(18.55%)
March	53	0	553	64 (11.57%)	434	42(9.68%)	727	108(14.86%)
April	17	0	169	22 (13.02%)	231	25(10.82%)	256	24(9.45%)
May	0	0	98	9 (9.18%)	81	10(12.35%)	83	9(10.97%)

Equally, the mean pH values recorded for the various sites appeared generally high which indicated high alkalinity for the snail infected sites. However, maximum pH values were obtained in August during which no snails were recovered. Values of pH were shown to have a significant negative correlation to the relative abundance of snail vectors at $P < 0.05$.

Microhabitat preferences

The dominant hydrophytes recorded in this study were dense mats of *Azolla* and thick blooms of the water lettuce (*Pistia stratiotes*) during the raining season. The preferred substratum by the snails consisted mainly of decomposing organic matter (plant detritus), bed rocks and sandy bottoms. All the *Bulinus* species and *Biomphalaria* preferred stagnant or slow flowing waters with shallow depths i.e. between 0-10 cm, while *Lymnaea natalensis* was restricted to mostly streams with depths ranging between 10-30 cm.

DISCUSSION

The snail vector species encountered in this study showed great seasonal variations in all the sites. Peak snail densities occurred at the beginning of the dry season with very few exceptions. These observations were very similar to those of other researchers in West Africa (Ndifon and Ukoli, 1989; Coulibaly and Madsen, 1990; Kela et al., 1990; Akufongwe et al., 1995; Utzenger and Tanner, 2001).

The principal factors which appear to govern the relative abundance of snail populations in Bauchi State are rainfall, water velocities, high temperatures and desiccation. Several researchers in different parts of the world have been able to demonstrate the usefulness of these parameters in the increase or decrease of snail populations (Declereq et al., 1999; Kloos et al., 2001; Sturrock, 2001; Oladejo and Ofoezie, 2006). In such cases, water current and ultimately rainfall may exert an indirect effect on snail populations through their effects on substratum and water plants. In the present study, rainfall was found to act mainly through flooding and subsequent flushing out of snails from their stream habitats or by the rapid elevation of water levels resulting in the snails remaining submerged in the ponds, dams and lakes.

Belot et al. (1993) observed that water current speed of 0.3 cm/sec appeared critical for snails and that vegetation density and water velocity were the strongest predictors of snail presence. Slow flow run-offs into the snail habitats were associated with the introduction of decomposing organic matters and micronutrients that were vital for the snails. Peak rainfalls were associated to thick blooms of *Azolla* and *Pistia* which covered the water surfaces, thus, creating unfavourable conditions for the snails. Cantrell (1981) associated the mortality of *B. globosus* to the dense growth of grass, *leesia.* Equally, Donelly and Appleton (1985) observed that populations of *B. pfeifferi* below a mat of floating *Ludwigia* temporally disappeared. In Bauchi state, high temperatures and desiccation due to absence of rainfall are the main reasons for the reduction in snail populations towards the end of the dry season. During this period, temperatures are very high thus promoting evapotranspiration with the temporal snail habitats drying out. Southgate et al. (2001) reported that mean daily temperatures of 30 °C or higher prevented the establishment of viable populations of *B. pfeifferi* in the Senegal River basin. Also, Belot et al. (1993), Kloos et al. (2001) and Phiri et al. (2007) observed fluctuations in snail numbers in some temporal habitats as a result of drought conditions. Although the mean temperatures did not rise to the maximum tolerance level in this study, increased mortality amongst snails was observed at some sites just before they finally dried out.

The pH value for all the sites that harbored snails ranged from 7.2-10.9. Although in this study it was observed that snails preferred alkaline habitats, it is most likely that pH does not seem to influence snail relative abundance when considered singly.

Results of the present study are very vital for the planning of snail control in Bauchi State. Such a campaign just at the unset of the rains (May) and at the end of the rainy season (October) could have a double advantage: most snails could be reached as all those that underwent diapause resume activity; secondly, the water volume is small enough, thus a control programme could be cost effective.

ACKNOWLEDGEMENTS

We are grateful to the health-coordinators of Bauchi Local Government Council Area and Toro Local Government Council Area of Bauchi State, Nigeria who provided us with some of their staff and vehicles for the snail sampling exercise.

REFERENCES

Akufongwe PF, Dondji B, Okwuosa VN, Dakul DA, Ntonifor HN. 1995. Observed disparity on Schistosome infection rates in field *Biomphalaria pfeifferi* (krause) between two Areas of the Jos Metropolis. *Parasite, 2:* 89-91.

Belot J, Geerts S, Diauf M. 1993. Observations on the population dynamics of snail hosts for schistosomes in the Delta of the Senegal River Basin. *Journal of Molluscan Studies,* **55**: 7-13

Brown DS. 1994. *Freshwater Snails of Africa and their Medical Importance* (2nd edn). Taylor and Francis Ltd: London; 609p.

Brown DS, Kristensen TK. 1992. *A Field Guide to African Freshwater Snails I (West African Species).* Danish Bilharziasis Laboratory: Chatollenlund, Denmark; 54 p.

Brown DS, Kristensen TK. 1993. *A field Guide to African Freshwater Snails II (West African Species).* Danish Bilharziasis Laboratory: Chatollenlund, Denmark; 55 p.

Chitsul L, Engels D, Monstresor A, Aavioli L. 2000. The Global Status of schistosomiasis and its control. *Acta Tropica,* **77**(1): 41-49.

Coulibaly G, Madsen H. 1990. Seasonal density fluctuations of intermediate hosts of schistosomes in two streams in Bamako, Mali. *Journal of African Zoology,* **104**: 212.

Cantrell MA. 1981. Bilharzia snails and water level fluctuations in a tropical swamp. *Oikos,* **36**: 226 – 232.

Declereq D, Vercruysse J, Piquet M, Diop M Ly, Gryseels B. 1999. The epidemiology of a recent focus of mixed *S. haematolbium* and *S. mansoni* infection around the "Lac guiers" in the Senegal River Basin, Senegal.. *Tropical and Geographical Medicine,* **51***:* 249 – 256.

Donelly FA, Appleton CC. 1985. Observations on the field transmission dynamics of *S. mansoni* and *S. matheei* in Southern Natal, South Africa. *Parasitology,* **91**: 281 – 290.

Franksen F, Christensen N. 1983. 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**: 181-220.

Iarotki LS, Davis A. 1981. The Schistosomiasis problem in the world. Results of a WHO questionnaire. *Bulletin of World Health Organisation,* **59**: 115-128.

Istifanus WA, Fabiyi JP, Ndifon GT. 1996. Observations on the fluctuations in populations of *Bulinus globosus* Morelet in natural habitats in the Bauchi Area, Northern Nigeria. *Nigerian Journal of Parasitology,* **17**(8) 214-218.

Kela SL, Istifanus WA, Okwuosa VN. 1990. The ecology and distribution of freshwater snails in Bauchi and Plateau states, Nigeria. *Revue d'Elevage et de Medicine Veterinaire des Pays Tropicaux,* **43** (2): 177 – 178.

Kloos H, Souz CD, Gazzinelli A, Filho BSS, Temba PC, Bethony J, Page C, Levis L. 2001. The distribution of *Biomphalaria* spp in different habitats in relation to physical, biological, water contact and cognition factors in rural areas of Minas Gerais, Brazil. *Memorias do Instituto Oswaldo Cruz.,* **96**: 57-66.

Ndifon GT, Ukoli FMA. 1989. Ecology of freshwater Snails in SouthWestern Nigeria. Distribution and habitats Preferences. *Hydrobiologia,* **171***:* 231-253.

Oladejo SO, Ofoezie IE. 2006. Unabated Schistosomiasis Transmission in Erinle River Dam, Osun State, Nigeria: evidence of neglect of environmental effects of development projects. *Tropical Medicine and International Health,* **11**(6): 843-850.

Phiri AM, Phiri IK, Chota A, Monrad J. 2007. Trematode Infections in Freshwater Snails and Cattle from the Kafue Wetlands of Zambia during a period of highest Cattle-Water contact. *Journal of Helminthology,* **81**: 85-92.

Rollinson D, Stothard JR, Southgate VR. 2003. Interactions between intermediate snail hosts of the genus *Bulinus* and schistosomes of the *Schistosoma haematobium* group. *Parasitology*, **123**: 65-72.

Schall V, Diniz MCP. 2001. Information and education on schistosomiasis control: an analysis of the situation in the State of Minas Gerais, Brazil. *Memorias do Instituto Oswaldo Cruz.*, **96**: 35-43.

Southgate VR, Tchuente LMT, Sene , Declereq D, Theron A, Jourdane Webster BL, Rollinson D, Gryseels B, Vercruysse J. 2001. Studies on the biology of schistosomiasis with emphasis on the Senegal River Basin. *Memorias do Instituto Oswaldo Cruz.*, **96**: 75-78.

Sturrock RF. 1993. The intermediate hosts and host–parasite relationships. In *Human Schistosomiasis*, Jordan P, Webbe G, Sturrock RF (eds). CAB Introductional: Wallingford; 33-85.

Sturrock RF. 2001. Schistosomiasis epidemiology and control: How did we get here and where should we go? *Memorias do Instituto Oswaldo Cruz.*, **96**: 17 -27.

Utzenger J, Tanner M. 2001. Microhabitat preferences of *Biomphalaria pferfferi* and *Lymnaea natalensis* in a natural and man-made habitat in Southeastern Tanzania. *Memorias do Instituto Oswaldo Cruz.*, **96**: 323-328.

WHO. 1996. Investigating in Health Research and Development. Report of the Ad. HOC committee on Health Research relating to future Intervention Options. World Health Organisation, TDR/Gen/96.1.