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Research Article

ECOLOGY OF SCHISTOSOMA SNAIL VECTORS IN ADO-EKITI LOCAL GOVERNMENT AREA, EKITI STATE, NIGERIA

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ABSTRACT

A study on the ecology of snail hosts of *Schistosoma* was carried out in River Ogbesse and River Ureje in Ado - Ekiti Local Government Area, Ekiti State Nigeria between February 2009 and January 2010. Fourteen sampling stations were selected for the study. Stations 1-7 were located on River Ureje while Stations 8-14 were located on River Ogbesse. Each station was randomly sampled fortnightly every month for snail taxa composition, physico - chemical characteristics of water and vegetation cover. The data were analyzed using non-parametric statistical methods. A total of 2559 snails belonging to six species, five genera, three families and two subclasses were recorded in the two rivers. These were 446 (17.4%) specimens of *Bulinus globosus*, 122 (4.8%) *B. truncatus*, 264 (10.3%) *Potadoma freethi*, 1628 (63.6%) *Melanoides tuberculata*, 58 (2.3%) *Lanistes varicus* and 16 (0.6%) *Biomphalaria pfeifferi*. Two of the six snail species (*B. globosus* and *Biomphalaria pfeifferi*), which are established intermediate hosts of schistosomiasis were recovered from River Ureje only. Furcocercous cercaria was recovered from *Bulinus globosus* species. The relationship between snail vectors and aquatic macrophytes is discussed.

Keywords: Snail density, Schistosomiasis, Aquatic macrophytes, Ecology, Snail vectors, Physico-chemical properties.

INTRODUCTION

Snails have a wide range of importance to humans both economically and medically. A sizeable number, especially the aquatic forms of freshwater snails in tropical freshwater are known to be inevitable agents of trematode diseases of man and his domestic animals "as stated by Cowper (1959) and Brown (1994)". *Schistosoma spp.* that causes schistosomiasis disease uses several species of subclass Pulmonata as intermediate hosts. In Nigeria, schistosomiasis is a disease of considerable and growing importance due to inadequate portable water and activities related to water resource development schemes for irrigation, fishing, and hydro-electricity "as stated by Ofoezie (2002). This, in addition to natural habitats, sustains transmission in any water bodies where the intermediate host (bulinid snails) can find many suitable breeding sites. Similarly, aquatic vegetation and physical factors such as water current, temperature, turbidity, transparency and distribution of suspended solids, chemical factors such as ion concentration and dissolved gases in water as well as biological factors such as availability of food, competition and predator-prey interactions have been identified to affect the ecology of snails and other intermediate hosts of diseases, hence their focal and seasonal distributions (Ofoezie, 1999; Owojori *et al.*, 2006).

Having identified the importance of snail intermediate hosts in *Schistosoma* life cycle, an adequate knowledge of its ecology, bionomics and population dynamics will enhance an effective control strategy. Although human

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infection with *Schistosoma haematobium* has been reported in several areas in Nigeria (Ejezie and Ade-Serrano, 1981; Ozumba *et al*., 1989; Ofoezie *et al.*, 1999; Adewole *et al*., 2001; Olofintoye, 2004; Ugbomoiko, 2004; Owojori *et al.*, 2006), there is paucity of information in Ekiti State. And since ecological factors vary significantly from one ecological zone to the other and even from one water body to the other, there is therefore the need to identify important factors that can exacerbate the risk of *schistosoma* infection in these rivers in Ekiti State. Hence, this study aims at providing information on the current status of the ecology and distribution of intermediate host snails of *Schistosoma* in River Ogbesse and River Ureje at Ado Local Government area in Ekiti State, Nigeria, which will in turn provide an important background for planning and implementing effective control of schistosomiasis in the study area.

MATERIALS AND METHODS

Study area

The study was carried out in River Ogbesse and River Ureje both of which are located in Ado – Ekiti Local Government Area, Ekiti State. River Ureje is located between Latitudes $07^0 35^1$ and $07^0 40^1$ N and Longitudes $005^0 10^1$ and $005^0 15^1$ E (Figure 1) while River Ogbesse lies between Latitudes $07^0 30^1$ and $07^0 40^1$ N and Longitudes $005^0 15^1$ and $007^0 20^1$ E (Figure 2). Ekiti State is situated in the southwestern part of Nigeria. There are two climatic seasons in the state, a dry season from November to February and a rainy season from March to October. The annual rainfall is about 1150mm. Tropical forest exists in the south, while guinea savannah occupies the northern peripheries.

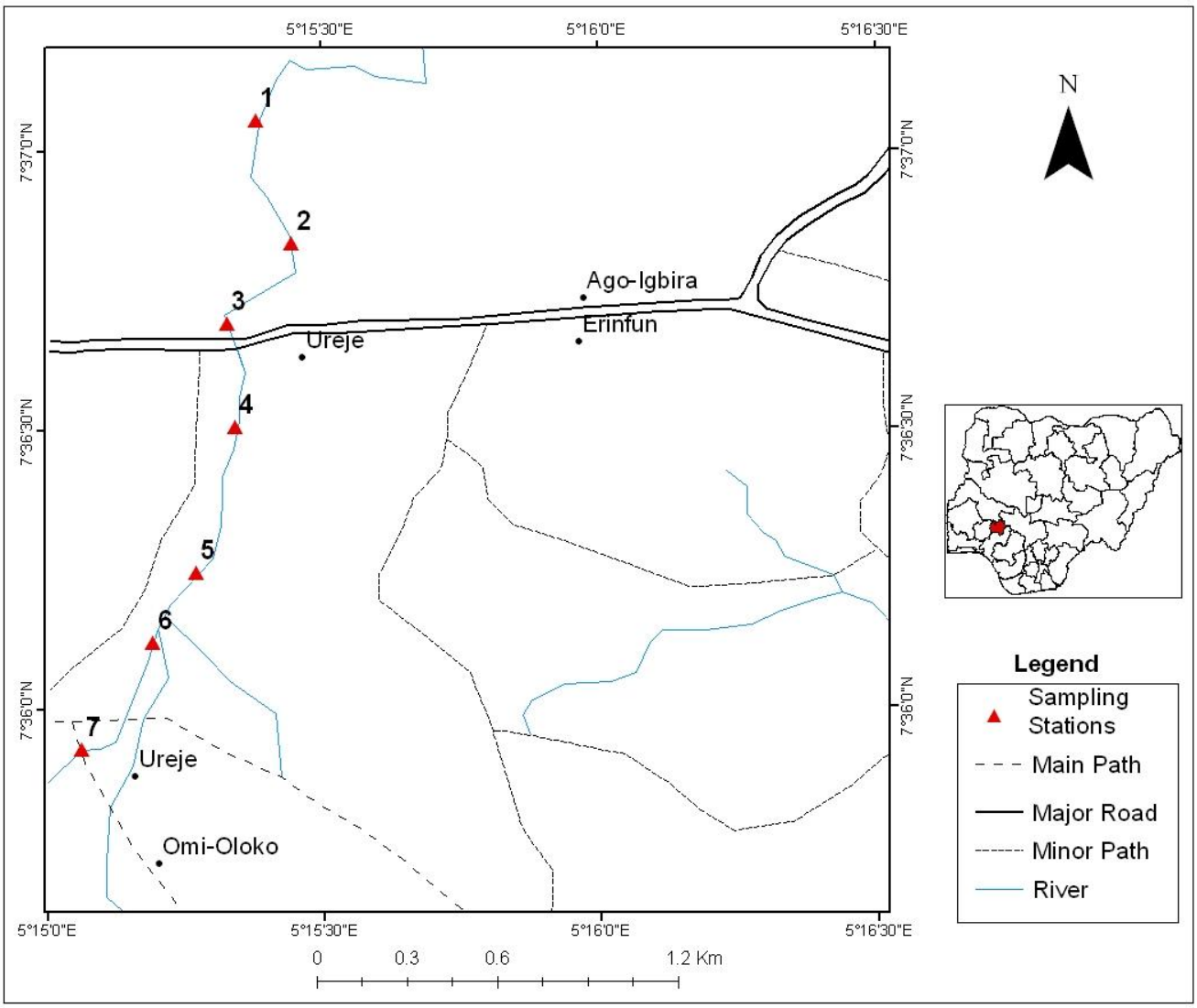

Figure 1. River Ureje at Ado-Ekiti Local Government Area, Ekiti State showing the sampling stations.

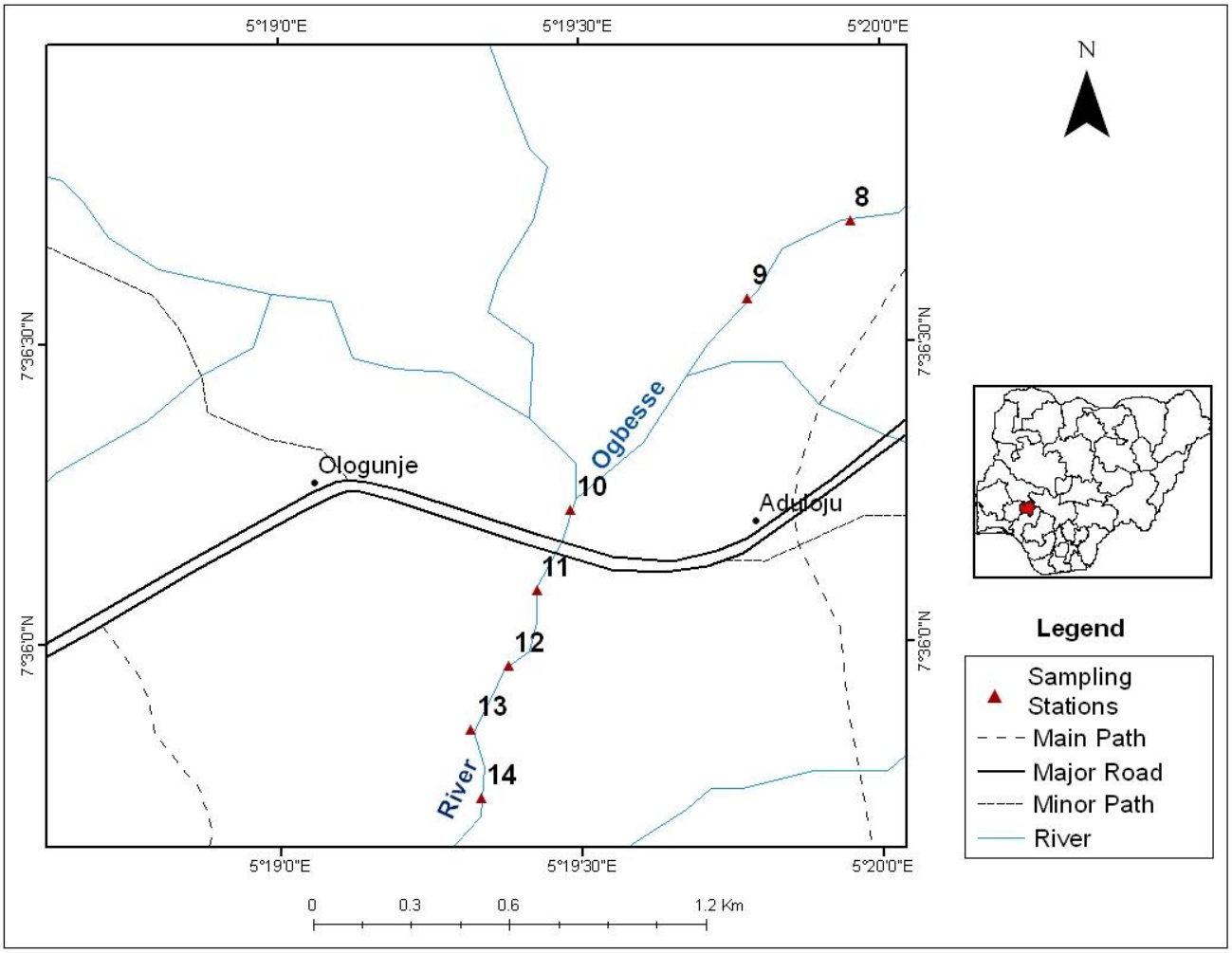

Figure 2. River Ogbesse at Ado-Ekiti Local Government Area, Ekiti State showing the sampling stations.

Sampling stations

Seven sampling stations were selected in each of the rivers based on the frequency of human visits at these stations. The stations in River Ureje were designated 1, 2, 3, 4, 5, 6, and 7 while those of River Ogbesse were designated 8, 9, 10, 11, 12, 13, and 14.

Snail sampling

Each of the fourteen sites was sampled twice every month for twelve months (February 2009-January 2010). Sampling in each site involved 30 passes of kitchen scoops supplemented by a manual search for 30 person-minute as stated by WHO (1985) and Ofoezie (1999). The 30 passes were thrown at about 1m distance along 20m stretch of each site. The scoop, attached to a 2m pole, was usually dragged from the 2m mark towards the researcher. Each scoop was thoroughly searched for snails. Snails that were found were transported to the laboratory in pre-labelled plastic containers containing damp and decaying leaves, covered with perforated lids. The snails were sorted and identified to species according to the method by Brown (Brown, 1994). All snails collected from each site were recorded as number of snails per site per month.

Physico-chemical properties of water

Surface water samples for determining physical and chemical factors were collected in 2L plastic containers. Dissolved oxygen (DO) samples were collected in a 250 ml light reagent bottles and was fixed by an addition of manganous chloride solution and Winkler's reagent (i.e. alkaline iodide) and titrated in 0.0125 N sodium thiosulphate . Biochemical Oxygen Demand (BOD_5) was determined in the same way except that the samples were collected in a dark reagent bottles and fixed after incubating in the dark for five days. Total alkalinity was determined by titration with standard sulphuric acid (N/50 H_2SO_4) using mixed indicators. pH and conductivity were determined using a pH comparator (Lovibond comparator) and an electric conductivity meter (Model 7020), respectively. Surface water temperature was measured directly with ordinary mercury in glass thermometer. Transparency and depth were determined with a Secchi disk attached to a calibrated cord.

Aquatic macrophytes

The macrophytes were monitored every month in each site for presence, coverage and relative association with snails. Coverage was determined by a rough estimate of the proportion of a site covered by each plant species. These were scored as 1 for < 5%, 2 for 6- 25%, 3 for 26-50%, 4 for 51-75% and 5 for > 75%. All types of each aquatic and marginal macrophytes found in each site were collected, properly labeled and deposited with the Obafemi Awolowo University Herbarium for identification.

Statistical analysis

Total sum of snails from each site was obtained to give each month's value. Differences in snail density between sites were determined using the Friedman two – way analysis of variance. The strength of correlation between snail density and environmental parameters were determined using spearman ranked order correlation coefficient.

The physico-chemical parameters of River Ureje and River Ogbesse were compared with the Friedman two way analysis of variance (Siegel and Castellan, 1988). Wilcoxon matched pairs signed-ranked test was used to determine the differences in monthly records between River Ureje and River Ogbesse.

RESULTS

Seasonal and spatial variation in snail density

A total of 2559 snails belonging to six species, five genera, three families and two subclasses were collected in River Ogbesse and River Ureje during this study. All the six species were found in River Ureje, while in River Ogbesse, only *Lanistes varicus* and some unidentified bivalves were found in all the seven sites investigated. Snails were focal in distribution, *Bulinus globosus*, the local intermediate host of *Schistosoma haematobium* was found in all sites although site S2 was the most densely populated.

All the species showed unimodal distribution with peak in March for the pulmonate snails; *Bulinus globosus*, *B. truncatus* and *Biomphalaria pfeifferi*, June for *L. varicus*, July for *M. tuberculata* and August for *P. freethi.*

Trematode infection in the snails

Trematode larvae were found only in *Bulinus* species. Out of the 400 bulinid snails (*B. globosus* and *B. truncatus*) examined over the period of this study, only 2 (0.5%) snail specimens were found infected with trematode larvae. The infected snails were specimens of *B. globosus* which were found in site S2. Infected snails were found only in January during the mid-dry season. The cercarial type found was the furcocercous cercaria.

Snail distribution in relation to physico-chemical factors

The median and range values of physico - chemical properties of water in the sampling sites are shown in Table 1. The results of chemical analysis of the water bodies are shown in Table 2.

Comparison of parameters using overall means among the seven sites on River Ureje and seven sites on River Ogbesse showed that DO, BOD_5 and conductivity were found to vary significantly between the two rivers. The results of the correlation analysis between physico - chemical parameters and snail densities in River Ureje are presented in Table 3. *B. globosus, B. truncatus* and *Biomphalaria pfeifferi* correlated positively with BOD_5 while only *B. truncatus* and *Biomphalaria pfeifferi* were found to be negatively correlated with DO. The prosobranch snails however did not correlate to any significant level.

Snail distribution in relation to aquatic vegetation

The strength of snail-plant association is summarized in Table 4. The most frequently encountered macrophytes are *Ludwigia repens, Panicum brevifolium, P. maximum* and *Aeschynomene americana* while *Ficus asperifolia* and *Lagenaria vulgaris* were the least frequently encountered. The most densely occurring macrophyte was *Ludwigia repens*. The schistosome snail vectors were correlated positively and significantly with 4 aquatic macrophytes which are *Ludwigia repens, Aspilia africana, Paspalum polystachyum, and Bambekia racemosa*.

Table 1. Median and Range values of the physic - chemical characteristics of water collected from seven sites (S1-S7) in River Ureje and (S8-S14) in River Ogbesse in Ado-Ekiti (February 2009-January 2010).

Para-meter	Water Temp (°C)	Depth (cm)	Transpa-rency (cm)	DO mg/L	BOD mg/L	pH	Conduc-tivity µScm¹	Alkalinity mg/L $CaCO_3$
S1	27 (22-30)	54 (26-101)	26 (17-55)	5.2 (4.2-5.6)	4.4 (4-5)	6.6 (6.25-7)	320 (234-384)	94 (90-95)
S2	27 (22-30)	99 (85-125)	45.5 (23-70)	4.9 (4.0-5.6)	4.4 (4-5)	6.6 (6.25-7)	318 (240-360)	94 (92-98)
S3	27 (22-29)	69 (45-121)	38 (19-66)	4.9 (4.2-5.6)	4.4 (4-4-8)	6.6 (6.25-7)	335 (240-390)	94 (92-96)
S4	27	40	29	4.9	4.5	6.6	326	94

	(22-30)	(30-90)	(15-55)	(4.4-5.6)	(4.2-4.8)	(6.25-7)	(234-386)	(92-96)
S5	26.5	68	37	4.9	4.5	6.6	330	94
	(22-30)	(33-100)	(20-51)	(4.4-5.6)	(4.2-4.8)	(6.25-7)	(268-386)	(92-96)
S6	27	47	23	5.0	4.5	6.6	321	94
	(22-30)	(23-80)	(15-36)	(4.4-5.6)	(4.2-4.9)	(6.25-7)	(230-374)	(92-98)
S7	27.5	56	25	5.0	4.5	6.6	321	94
	(22-30)	(42-77)	(18-36)	(4.4-5.6)	(4.2-4.9)	(6.25-7)	(230-374)	(92-98)
S8	27.5	40	30	3.8	3.0	6.35	265	94
	(25-29)	(29-73)	(24-45)	(3.4-4.2)	(2.6-3.4)	(6.25-7)	(240-310)	(92-96)
S9	26.5	38.5	18	3.6	2.7	6.45	280	96
	(25-28)	(18-74)	(12-38)	(3.6-4.0)	(2.6-3.0)	(6.25-7)	(240-300)	(90-100)
S10	27.5	18.5	17.5	3.7	2.8	6.65	270	96
	(25-30)	(17-20)	(14-20)	(3.6-4.8)	(2.4-3.2)	(6.25-7)	(260-280)	(90-100)
S11	27.5	53	26	3.8	3.0	6.45	260	96
	(25-29)	(18-75)	(18-40)	(3.6-4.2)	(2.6-3.2)	(6.25-7)	(240-280)	(90-100)
S12	27	46	25	4.0	3.0	6.75	275	96
	(26-28)	(26-95)	(20-45))	(3.8-4.4)	(2.8-3.4)	(6.25-7)	(260-300)	(90-102)
S13	27	44	30	4.2	2.8	6.75	335	96
	(25-29)	(10-96)	(10-48)	(3.6-4.4)	(2.4-3.2)	(6.25-7)	(244-410)	(90-102)
S14	27.5	43.5	26	4.0	2.8	6.75	325	96
	(26-30)	(10-97)	(10-46)	(3.8-4.4)	(2.6-3.0)	(6.25-7)	(244-390)	(90-102)

S - Indicates site where water sample was taken.

Table 2. The result of statistical analysis of temporal variation in some physico-chemical properties at seven sites in River Ureje and seven sites in River Ogbesse, Ado-Ekiti (February, 2009–January, 2010).

Physico-chemical properties	Independent tests of monthly records between 7 sites		
	RU	RO	RU and RO*
Water temperature (°C)	0.00	0.00	ns
Depth (cm)	0.00	0.00	ns
Transparency (cm)	0.00	0.00	ns
DO mg/L O_2	ns	ns	0.02
BOD mg/L O_2	ns	ns	0.02
pH	ns	ns	ns
Conductivity (μScm^{-1})	0.00	0.00	0.03
Alkalinity (mg/L $CaCO_3$)	0.00	0.00	ns

+Friedman analysis of variance

*Wilcoxon signed pair rank test

DO – Dissolved Oxygen

BOD_5 – Biochemical Oxygen Demand

RU – River Ureje

RO – River Ogbesse

RU and RO - Differences among overall means of sites from each river

ns – not significant

Table 3. Correlation coefficient matrix between snail species and pyhsicochemical - chemical properties of water in River Ureje, Ado-Ekiti, (February 2009–January 2010).

River Ureje	*B. globosus*	*B. truncatus*	*L. varicus*	*M. tuberculata*	*P. freeithi*	*B. pfeifferi*
pH	-0.558	-0.632	-0.632	-0.158	-0.474	-0.564
Water temperature (°C)	-0.440	-0.564	-0.673	-0.055	-0.436	-0.657
Depth(cm)	-0.018	0.036	0.429	0.250	-0.036	0.346
Transparency (cm)	0.100	0.396	0.649	0.198	0.306	0.468
DO(mg/L O_2)	-0.692	-0.927**	-0.556	-0.371	-0.630	-0.868*
BOD_5 (mg/L O_2)	0.775*	0.867*	0.394	0.158	0.512	0.843**
Alkalinity (mg/L $CaCO_3$)	0.464	0.414	0.180	-0.378	0.288	0.358
Conductivity (µScm-^{1})	0.382	0.126	0.234	-0.414	0.468	0.284

* Correlation is significant at the 0.05 level

** Correlation is significant at the 0.01 level.

DO = Dissolved oxygen.

BOD_5 = Biochemical oxygen demand.

Table 4. Correlation coefficient matrix between snail species and dominant aquatic macrophytes in River Ureje, Ado-Ekiti (February 2009–January 2010).

Aquatic macrophytes	*B. globosus*	*B. truncatus*	*L. varicus*	*M. tuberculata*	*P. freeithi*	*B.pfeifferi*
Calopogonium Mucunoides	0.930[a]	0.190	0.624	-0.445	0.470	0.495
Ficus asperifolia	0.609	0.068	0.941	-0.435	0.485	0.147
Panicum brevifolium	0.533	-0.216	0.636	-0.153	0.558	0.028
Panicum maximum	0.384	0.519	-0.248	0.339	0.310	0.417
Ludwigia repens	0.849[a]	0.682[b]	0.608[b]	0.200	0.365	0.837[a]
Tithonia diversifolia	-0.065	0.607 [b]	0.270	0.360	0.178	0.334
Aeschynomene americana	-0.786[a]	-0.292	-0.716[a]	0.379	-0.115	-0.482
Lagenaria vulgaris	0.609	0.068	0.941[a]	-0.435	0.485	0.147
Ageratum conyzoides	-0.525	-0.689[b]	-0.332	-0.069	-0.553	-0.659
Aspilia africana	-0.744[a]	-0.709 [a]	-0.362	0.207	-0.223	-0.712[a]
Euphorbia hyssopifolia	-0.632	-0.687[b]	-0.324	-0.164	-0.782	-0.594
Vignia racemosa	0.297	0.860[a]	0.441	0.370	0.281	0.609
Paspalum Polystachyum	0.730[a]	0.871[a]	0.125	0.227	0.289	0.948[a]
Bambekia racemosa	0.839[a]	0.754[a]	0.627	-0.006	0.482	0.804[a]

Significant levels: [a] $p<0.01$; [b] $p<0.05$.

DISCUSSION

This study has revealed the co-existence of the three pulmonate snail species - *Bulinus globosus*, *Bulinus truncatus* and *Biomphalaria pfeifferi*, all of which are known intermediate hosts of *Schistosoma*. *Biomphalaria pfeifferi* is host of *Schistosoma mansoni* in Nigeria (Cowper, 1973; Adewunmi *et al.,* 1990), *Bulinus globosus* and *B. truncatus* are known intermediate hosts of *S. haematobium* in Nigeria as stated by Adewunmi *et al.,* (1990) and other parts of Africa as stated by Doumenge *et al.,* (1987).

Most of the snails in River Ureje showed marked seasonal variation in density. Pulmonate species were more abundant in late dry season and tend to reduce in density in rainy season. The unimodal seasonal trend observed in this study agrees with the report of several workers from the southwest Nigeria (Hira, 1969; Hira and Muller, 1966; Owojori *et al.,* 2006 and Igwun, eastern Nigeria (Udonsi, 1990). However, it contradicts the bimodal seasonal trend observed by Ofoezie (1999) for *Bulinus globosus, B. forskalii, Lymnaea natalensis, Indoplanorbis exustus* and *Potadoma* species in Oyan reservoir. Generally, snail numbers increased in the dry season – but began to decline near the end of the dry season due to decrease in water level in the river. This is in agreement with the observation of Barnish (Barnish, 1982). In the dry season, water currents are expected to be low and offering a stable Ureje.

The density of these snails increased as aquatic macrophytes increased.

With reference to sites distribution, *Ludwigia repens* and *Aeschynomene americana* occurred in all the seven sites in River Ureje although, *Ludwigia repens* was more abundant.

The present survey shows that *L. repens* correlates significantly most with the snails ($p<0.01$) and positively with all the pulmonate snails. This conforms to the reports from many parts of Africa (Odei, 1973; Klumpp and Chu, 1980; Hillali *et al.,* 1985, Madsen *et al.,* 1988; Ofoezie, 1999; Owojori *et al.,* 2006). For instance, in Oyan Reservoir, *Impatience irvingii* significantly correlated with all snail species and especially *Indoplanorbis exustus*, a recently introduced species to the area (Ofoezie, 1999). In Opa Reservoir, *Ludwigia repens* correlated positively with *Bulinus globosus* (Owojori *et al.,* 2006). Similarly, in Lake Volta, Chu (1978) showed that eradicating *Ceratophyllum* weed will reduce the density of infected and uninfected *Bulinus* snails.

The fact that *L. repens* correlates significantly with the snails ($p<0.01$) and positively with all the pulmonate snails suggests that the aquatic plant may be important to the snails for breeding. Literatures have shown that leaves of floating plants protect snails from bright sunlight and high temperature (El-Gindy, 1960; Heineman, 1973; Odei, 1973); thus providing a breeding site for the snails. Also, according to Perlowagora-Szumlewicz (1958), oviposition is stimulated by the oxygen produced by the plant. In this study, *Ludwigia repens* served as an indicator plant for the presence of *B. globosus* in River Ureje which is the established intermediate host for urinary schistosomiasis in Ekiti State.

CONCLUSIONS

This study has established the occurrence of aquatic snails, some of which are known vectors of schistosomiasis as well as confirming the transmission of schistosomiasis in River Ureje, Ado-Ekiti, Ekiti State. It also revealed that snails are focal in occurrence and density. Moreover, the focal distribution of snails in River Ureje and River Ogbesse could be attributed to chemical properties of water such as Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD_5). In addition, the study has highlighted the importance of aquatic plants in snail distribution. It indicates that the presence of the aquatic macrophyte *Ludwigia repens* supports the occurrence of *Bulinus globosus* and suggests that its eradication may help in control of snails in the study area.

CONCLUSION

Conclusively, this study has provided an important background for planning and implementing effective control of schistosomiasis in Ado-Ekiti, Ekiti state Nigeria.

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