POPULATION DYNAMICS AND DSITRIBUTION OF FRESHWATER SNAILS IN ZOBE DAM, DUTSIN-MA, NORTH-WESTERN NIGERIA

ABSTRACT

Freshwater snails are crucial in assessing the ecological condition of water bodies beside their economic, public and veterinary health importance. Hence, ecological studies pertaining to their abundance, diversity and distribution become paramount. A total of 1664 freshwater snails were sampled in Zobe Dam and physicochemical parameters of the water body were analyzed monthly using standard methods, from April to September 2017. The snail species, total number were: *Lymnaea natalensis* 788(47.94%) and *Bulinus trophicus* 492(29.93%) and *Bulinus forskalii* 364(26.14%). The study revealed that the density of freshwater snails varied monthly and spatially and that the diversity and distribution in Zobe Dam were mostly influenced by pH, dissolved oxygen, conductivity and turbidity. Coefficient of correlation (r) between snail species and the physicochemical parameters of water sampled showed dissolved oxygen, turbidity and conductivity to have a strong positive correlation with all the three species while pH was found to have a weak positive correlation with only *Lymnaea natalensis.* Thus some of the physicochemical parameters of water have contributed hugely to the abundance, diversity and distribution of its snails.

Key words: Ecology, Zobe Dam, Freshwater, Snail, Resilience

INTRODUCTION

Snails inhabits almost every type of freshwater habitat and play salient role in the ecology of freshwater; serving as food for numerous other animals and feeds on vast amounts of algae and detritus (Elder and Collins, 1991), and in decomposition and recycling of nutrients in aquatic ecosystem. Damming of water has numerous social and economic benefits such as irrigation; fishing; transportation; tourism and power generation. However, damming of rivers and streams to build reservoirs gives rise to significant modifications in the natural ecology of the original water bodies (Owojori and Ofoezie, 2011). For instance, it creates new biotopes which are more conducive than previously for breeding of freshwater snails, including those that are of medical and veterinary importance (Ofoezie, 2011). Ecological investigations of freshwater snails have shown that the population dynamics and ecology of these animals depends on various factors such as the physical geography of a given region, land contours, soil composition, type of bottom soil sediment, hydrography, climate change (Yousiff *et al*. 1998); physicochemical parameters such as temperature, nitrate level, pH, dissolved gases, alkalinity, calcium ions (Kloos *et al*., 2001; Garg *et al*., 2009), and biological factors such as abundance of macrophytes (food), competition and predator-prey interactions (Williams and John, 2011; Ofoezie, 2012).

Freshwater Snails are part of many significant groups of ecological communities. They are found to be most beneficial economically and medicinally (Wosu, 2010). They add value to man as a source of food, jewelry, tools and even pets. Freshwater Snails play significant role in public and veterinary health (Supian and Ikhwanuddin, 2012). Some freshwater snails are vectors of diseases of humans and livestock, serve as the intermediate hosts for a number of infections such as helminthes diseases caused by trematodes (Abd El-Malek, 2011; Dazo *et al*., 2014). As primary consumers, freshwater snails form a critical link in the food web, converting microorganisms, plants, fungi, and decaying material into a usable food source for a vast number of species, including other invertebrates, fish, amphibians, reptiles, birds, and mammals (Williams and John, 2011). Freshwater snails are consumed by waterfowl, amphibians, turtles, and fishes such as sculpins and trout (Duncan, 2011).

Despite the important roles snails play in freshwater ecosystems and serving as vectors in transmission of deadly diseases to humans and animals, including fish, not much attention have been given to them in comparison to other freshwater organisms (Senghor *et al*., 2015). Because of their aesthetic and gastronomic significance, marine snails seem to receive more attention when compared to their freshwater counterparts that are drab coloured (Saupe *et al*., 2014). Though a few studies have been reported on Zobe dam Reservoir, information on the ecology of the freshwater snails in the reservoir is scanty. Hence, it is crucial to have investigated the population dynamics and distribution of freshwater snails, with emphasis on their diversity, distribution and abundance in Zobe Dam Reservoir, North-Western Nigeria.

MATERIALS AND METHODS

Study Area

Zobe Dam Reservoir is in the southern part of Dutsin-Ma Local Government Area of Katsina State, in the North-western part of Nigeria. It is an earth-fill structure with a height of 19 m and a total length of 2,750 m (UNEP 2005). The reservoir is located between latitude 12°20'34.62N to 12°23'27.48N and between longitudes 7°27'57.12E to 7°34'47.68E. The reservoir covers 4500 hectares of rocky land and during the rainy season stores 177 million cubic metres of water which is released downstream for irrigation and town water supplies. The reservoir was created for local irrigation of 8,000 hectares, power generation and water supply. Zobe reservoir has only two tributaries, River Karaduwa and River Gada in which the later river drains into the former river. The Reservoir was constructed in River Karaduwa and it span up to 2.7 kilometres flowing north westward to the Sokoto Basin. The run-offs from its catchment areas drain into the reservoir carrying-along agricultural waste and other organic matter especially during the raining season (Apollos *et al.*, 2016).

Figure 1: Map of Zobe reservoir showing the sampling points

Table 1: Sampling Points, GPS Location and Various Activities Performed at Each Point

Sampling point sediments	**GPS location**	**Human activities**
A	07°25′23.7″N, 03°51′26.6″E	Landing for canoes
B	07°25′22.9″N, 03°51′29.4″E	Irrigation and farming activities
C	07°25′30.4″N, 03°51′31.1″E	Fishing activities
D	07°25′34.2″N, 03°51′33.4″E	No human activities

Snail Sampling

The scooping net techniques and hand picking of snails were employed. Samples were collected with a long-handled snail sieve net (mesh size 3 mm – 4 mm) (Idris and Ajanusi, 2012). Snails were often seen near the edges of slightly deep waters or lodging in plant materials. The sieve net was dragged through the water thereby collecting snails clinging to the aquatic plants. Where sieve net could not be used, snails were handpicked with gloved hands and placed in specimen bottles. The sampling period lasted for ten minutes at each sampled point.

Snails collected from each point were kept in separate labeled specimen bottles containing 70 % ethanol as preservative. Subsequently, examination, identification and classification of specimens were done based on the published book by WHO on African freshwater snails of medical and veterinary importance (WHO, 1980), followed by separation of specimens into species which were then counted and the visual forms of the specimens were captured using an Android phone's camera.

Collection of Water Sample

Water samples were collected in four sample bottles at points where snails were collected using 2- liter plastic bottles. The sample bottles were properly washed with detergent, rinsed with distilled water and air-dried prior to sampling, subsequently, sampling bottles were then rinsed with sampled water just before sampling began.

To determine total hardness of water, 10 cm^3 of water sample was pipetted into a conical flask. 1 cm3 of buffer solution (NH4Cl) of pH = 10 and 3 drops of Erichrome' black -T indicator were added to the flask. The mixture was then titrated with 0.0IM EDTA (ethyl diammine tetra acetic acid) until the color changed from wine red to blue. The procedure was repeated three more times to obtain the average litre value.

The hydrogen ion concentration (pH) was measured using a digital pH meter (HARCH SENS ION). The meter was switched on and was allowed to warm for 5 minutes. It was then standardized with a buffer solution. The meter was then immediately introduced into the water sample and measurement was taken. The electrode was then rinsed with deionized water before taken another measurement.

Nephelometric method was used to determine the turbidity of the water sampled. The sample was mixed on centrifugal apparatus until solids were dispersed and allowed to settle at room temperature until air bubbles disappeared. The sample was poured into the turbidimeter tube and results were recorded from the instrument scale.

The total dissolved oxygen was determined using a pH meter, the programme menu of the pH meter was switched to total dissolved solid, 100 cm3 of the sample was measured into the beaker and the electrode was introduced into the sample. The results of the dissolved oxygen were displayed and recorded (Biswas, 2011).

The water depth was measured at each sampling point. A calibrated rope tied on a metallic object was lowered into the water; the depth at which the object touched the ground was recorded (Biswas, 2011).

The conductivity was determined using a conductivity meter, 100 cm3 of the water sample was measured into the beaker and the conductivity meter electrode was introduced into the sample and readings where recorded (Biswas, 2011).

The temperature was determined using a temperature meter, 100 cm3 of the sample was measured into the beaker and the electrode was introduced into the sample. The results of the temperature were displayed and recorded (Biswas, 2011).

Statistical Analysis

Analysis of variance (ANOVA), Correlation and Shannon index were used for the statistical analysis of data.

RESULTS AND DISCUSSION

The occurrence, diversity, and abundance of snails

A total of 1644 snails (sub-classes Pulmonata, 2 families and 3 species) were collected during the sampling period. The family Planorbidae had the highest species composition of 2; Lymnaeidae had 1 species. The three species, namely, *Bulinus forskalii, Bulinus trophicus* and *Lymnaea natalensis* were distributed at all sampling points, The spatial distribution of snails shows that sampling point B had the highest percentage of snail abundance of 26.40 % and richness with 3 'species; sampling point A had 26.15% with 3 species; sampling point D had 24.03% with 3 species, while sampling point C with 23.42% had the poorest composition with 3 species. .Observation of the monthly variation in composition and abundance of snail assemblages shows that representatives of Lymnaeidae were the most abundant snails throughout the sampling period. The highest abundance of snails was observed between July, August and September (late rainy season), This findings corresponds with Diab (2003) who reported higher snail abundance in Spring during the late rainy season, while the least number of snails was found between April, May and July (early rainy season). This agrees with El-Kady *et al*., (2000) who also recorded lowest number of snails during early rainy season (April and May).

Physicochemical parameter

The results of all the physicochemical parameters of the water sampled on monthly basis were: Temperature of the surface waters of Zobe reservoir generally increased and followed a similar pattern with an average of 28.12°C throughout the monitoring period. Dissolved oxygen (DO) concentration in the reservoir fluctuate during the study period, in all stations with an average of 7.39 mg/L over the monitoring period and ranged from 6.34 to 8.90 mg/L (Table 2). These values fell within the recommended range for aquatic life production (,Viveen *et al*,.2014).

The pH of the water sampled generally followed a similar pattern during the period of study. Among all stations, pH generally averaged about 6.87 throughout the monitoring period and monthly ranged from 6.41 to 7.32 (Table 2). Occasionally, measures of pH were relatively uniform throughout the stations. In August, an average pH of 7.76 was at its highest whereas an average lowest pH of 6.79 was recorded in April, Throughout the monitoring period, measures of pH at all stations were within the limits of EU and WHO standards for both freshwater and aquatic life (Ugwu *et al*., 2011; Chapman and Kimstach, 2006)..

The highest average turbidity of 1.35 cm was recorded in the month of August which coincides with the peak of the raining season. Whereas, the lowest value of 0.29 cm was recorded in April (Table 2). Ajayi, (2006) observed that the favorable range of Secchi-disc transparency for aquaculture in the tropics is within the range of 0.30 to 0.60 cm. Thus the turbidity of the water in the reservoir is above the normal standard. However, natural turbidity of the water is largely dependent on the underlying geology and soils within the surrounding watershed. The mean total hardness of the reservoir water was 50.71 mg/l, while the highest value recorded was 63.03 mg/L. These values were in consistence with WHO standard for aquatic life (WHO 1984).

The pH recorded in the Dam ranged from slightly acidic to highly alkaline and furnished a weakly positive relationship with the snail species, (Table 4). However, a very weak and insignificant negative correlation between snail species and pH recorded by Garg et al. (2009) suggests that snails were found to be independent of fluctuations with respect to pH value. The findings of Martins-Silva and Barros (2001) revealed that acidic pH is unfavorable to the occurrence of snail. Snail species, however, exhibited a negative correlation with water temperature. Dutta and Malhotra (1986) and Malhotra *et al*., (1996) also recorded a positive correlation between snails and temperature, while a negative correlation between temperature and snail species was noticed by Ricker (2002). All the snail species had a positive correlation with DO (Table 4), which finds support from Garg *et al*. (2009) that appreciable numbers of snails thrive under very high oxygen conditions. The results obtained in this survey revealed a positive correlation of snail species with transparency (Table 3) which agrees with the findings of (Sharma *et al*., 2013).

Species diversity calculated between the early rainy season and late rainy season showed that late rainy season had more diverse species than the early rainy season. This finding agrees with that of Kazibwe *et al*. (2006) which reported that freshwater snails are herbivores and are more abundant during the late rainy seasons (Table 4 and 5). Same number of species were present in the early and late rainy season both having species richness of 0.1 but the late rainy season has higher number of individual species (Table 6).

Table 2: Mean ± SD of the Physico–chemical Parameters of Water in Zobe Dam Reservoir with Months

Parameters	**April**	**May**	**June**	**July**	**August**	**September**	**p-value**
pH	6.80±0.23	6.79±0.21	6.87±0.14	7.13±0.37	7.76±0.64	6.95±0.37	0.7981
Temperature	30.74±0.08	30.74±0.08	30.11±1.57	29.39±0.44	26.43±33	26.69±0.92	1.3542
Dissolved Oxygen	6.83±0.50	6.83±0.50	7.00±0.62	7.15±0.51	7.78±0.35	7.41±0.46	0.4287
Total Hardness	63.03±2.00	63.03±2.00	60.09±1.67	52.42±1.63	52.9±1.18	51.23±0.78	8.6435
Turbidity	0.29±0.03	0.29±0.04	1.00±0.05	1.05±0.05	0.91±0.14	1.39±0.46	9.8821

Table 3: Correlation Coefficient (r) Between Snail Species and Physico-chemical Parameters with months

Species	**pH**	**Temperature**	**Dissolved Oxygen**	**Conductivity**	**Total Hardness**	**Turbidity**
Bulinus forskalii	0.0798	-0.7124	0.4825	0.6845	-0.6530	0.6317
Bulinus trophicus	0.0798	-0.9697	0.9219	0.6819	-0.7166	0.5917
Lymnaea natalensis	0.2782	-0.8301	0.6588	0.5505	-0.8351	0.5917

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Table 4: Species Diversity for Early Rainy Season (April-June) using Shannon index,

Species	Number of individuals(n)	**pi**	**ln pi**	**pi ln pi**
B.forskalii	118	0.203	-1.60	0.325
B.trophicus	171	0.295	-1.20	0.354
L.natalensis	291	0.502	-0.70	0.351
Total	580	0.735	3.50	1.030

Table 5: Species Diversity for Late Rainy Season (July-September) using Shannon index,

Species	Number of individuals(n)	**pi**	**ln pi**	**pi ln pi**
B.forskalii	246	0.231	-1.50	0.347
B.trophicus	321	0.302	-1.20	0.362
L.natalensis	497	0.467	-0.80	0.374
Total	1064	1.00	3.50	1.083

Table 6: Species Richness using Menhinick's index (D)

SPECIES	EARLY RAINY SEASON	LATE RAINY SEASON
B. forskalii	118	246
B. trophicus	171	321
L. natalensis	291	497
TOTAL	580	1064
Species richness(D)	0.1	0.1

Conclusion

The physicochemical parameters in Zobe Dam are favourable for the thriving of snails, and this will lead to increase in their abundance. This study has identified various factors such as Dissolved oxygen, conductivity and pH as important factors that determine the abundance and distribution of snail species in Zobe Dam.

References

.Apollos TG, Raji A, Modibbo U (2016) Seasonal Variation of Water Quality Parameters of Zobe Reservoir Dutsinma Katsina State, Nigeria. Hydrol Current Res 7: 261. doi: 10.4172/2157-7587.1000261

Abaje, I.B., Sawa, B.A. & Ati, O.F. (2014). Climate Varia-bility and Change, Impacts and Adaptation Strategies in Dutsin-Ma Local Government Area of Katsina State, Nigeria. *Journal of Geography and Geology,* 6 (2), 103-112.

Ajayi O (2006) A guide to primary productivity in fish pond management. Innovation Technology Nigeria.

Chapman, D. and Kimstach, V. (2006): Selection of water quality variables. In: Chapman, D. (ed.). Water quality assessments. Chapman and Hall, London, pp 65-122.

Cheesbrough, M. Parasitological Tests: examination of urine for Schistosoma haematobium eggs. In: District Laboratory Practice in Tropical Countries, low price edition part 1, ISBN: 0521665485, Cambridge, United Kingdom: Cambridge University Press, pp. 178-309 (1998).

Dike, A. Prevalence of Schistosoma haematobium infection in a Neglected Community, South-western Nigeria. International Journal of Health Research, 2(2):149-155 (2009).

Duncan,,(2011). Parasite influences on host life history: Echinostoma revolutum parasitism of Lymnaea elodes snails. Oecologia , 115, 188–195.

Elder, J.F. and Collin, J.J. (1991). Freshwater mollusks as indicators of bioavailability and toxicity of metals in surface water system. *Rev. Environ. Conta. Toxicol*. 123:37-79.

Eyo, J.E., Odoh, G.E. and Achife, A. Variations in the physico-chemical parameter of a natural Tropical Rainforest Lake. Bio-Research, 6(2):371-374 (2008).

Garg RK, Saksena DN, Rao RJ (2006b). Assessment of physicochemical water quality of Harsi Reservoir, District Gwalior, Madhya Pradesh. J. Ecophysiol. Occupat. Health 6: 33-40

Karimi, G.R., Derakhshanfar, M. and Paykari, H. Population density, trematodal infection and ecology of Lymnaeasnails in Shadegan, Iran. Arch Razi Ins., 58:125-129 (2004).

Kloos C.A., Ozumba, N.A., and Eneanya,(2011) C.I. Studies on the biology and population parameters of Bulinus globosus and Bulinus truncatus in the laboratory. Nigeria Journal of Parasitology, 29(1):11-14

Nwogu, Isaac Moses (2001). Water Analysis Commercial Water Samples. Unplished B.Sc. Thesis, Ahmadu Bello University Zaria. p46-50.

Nwosu, M.C., Nsofor, C.I. and Okeke J.J. Studies on the Ichthyofaunal Assemblages of some natural lakes in Anambra State, Nigeria. Natural and Applied Sciences Journal(www.naasjournal-ng.org.),10(2):(2009).

Ofoezie, I. E. (1999). Distribution of freshwater snails in the Man-made Oyan Reservoir, Ogun State, Nigeria. Hydrobiologia 416:181-191.

Mohamed, A. H., Ahmad, A. M. and Heba, M. F. (2011). Population dynamics of freshwater snails (Mollusca: Gastropoda) at Qena Governorate, Upper Egypt. Acad. J. Biolog. Sci., 3(1):11-22.

Omudu, E. D. and Iyough, A. (2005). Ecological studies of the gastropod fauna of some minor tributaries of River Benue in Makurdi, Nigeria. Animal Research International, 2(2):306-310.

Onyema, I.C. and Nwankwo, D. I. (2006). The epidemic assemblage of a polluted estuarine creek in Lagos, Nigeria. Poll. Res, 25(3):459 – 468.

Owojori, O. J., Asaolu, S. O. and Ofoezie, I. E. (2015). Ecology of freshwater snails in Opa Reservoir and Research Farm Ponds at Obafemi Awolowo University Ile-Ife, Nigeria. Journal of Applied Sciences, 6(15):3004-3015

Supian and Ikhwanuddin, I. (2012). Freshwater snails of Niger-Cem Nkalagu, Eastern Nigeria: Observations on some demographic aspects of the Schistosome transmitting Bulinids. Animal Research International, 1(2):120-124 (2004).

Supian, Z. and Ikhwanuddin, A. M. (2002). Population dynamics of freshwater mollusks (Gastropod: *Melanoides tuberculatus*) in Crocker Range Park, Sabah. ASEAN Rev. Biodiv. Environ. Conserv. 1:1-9.

United Nations Environment Programme. Division of Technology, Industry, and Economics. Economics and Trade Unit (2005). Integrated assessment of the impact of trade liberalization: a country study on the Nigerian rice sector. UNEP/Earthprint. p. 81. ISBN 92-807-2450-9.

Wosu, I.O. (2003). Commercial snail farming in West Africa: a guide. Ap Express Publishers Ltd, Nsukka.

World Health Organization. (1980). A Practical Guide to the Identification of Freshwater Snails.