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

ABSTRACT

Freshwater snails are crucial in assessing the ecological status 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 the physicochemical parameters of the water body were analyzed on a monthly basis from April to September 2017 following standard protocols. Among the 1664 snails collected, 788 (47.94%) were *Lymnaea natalensis*, 492 (29.93%) were *Bulinus trophicus* and 364 (26.14%) were *Bulinus forskalii*. The study revealed monthly and spatial variation in the population of snails. Diversity and distribution of snails in Zobe Dam was influenced by pH, dissolved oxygen, conductivity and turbidity. Coefficient of correlation (r) between snail species and the physicochemical parameters of water such as dissolved oxygen, turbidity and conductivity had a strong positive correlation with all the three species while pH was found to have a weak positive correlation with only *Lymnaea natalensis*. In conclusion, *Lymnaea natalensis* was the most abundant in population of snails inhabiting Zobe Dam and the population of snail varied with the physicochemical parameters of the water body.

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

INTRODUCTION

Snails inhabit 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 *et al.,* 2006). 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, 1999). 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 (Yousif *et al*. 1998); physicochemical parameters such as temperature, nitrate level, pH, dissolved gases, alkalinity, calcium ions (Ekwunife *et al*., 2008; Garg *et al*., 2006), and biological factors such as abundance of macrophytes (food), competition and predator-prey interactions (Williams & John, 2011; Ofoezie, 1999).

Freshwater snails are part of many significant groups of ecological communities. They are found to be most beneficial economically and medicinally (Wosu, 2003). 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 angiostrongyliasis, clonorchiasis, fascioliasis, fasciolopsiasis, opisthorchiasis, paragonimiasis and the most common, schistosomiasis (bilharziasis) caused by parasite of the genus *Schistosoma,* a trematode (Abdel-Malek, 1958; Dida *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 (Kashifa *et al*., 2017).

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 (Abdulkadir *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 built 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 (Abaje *et al.*, 2014; Apollos *et al*., 2016).

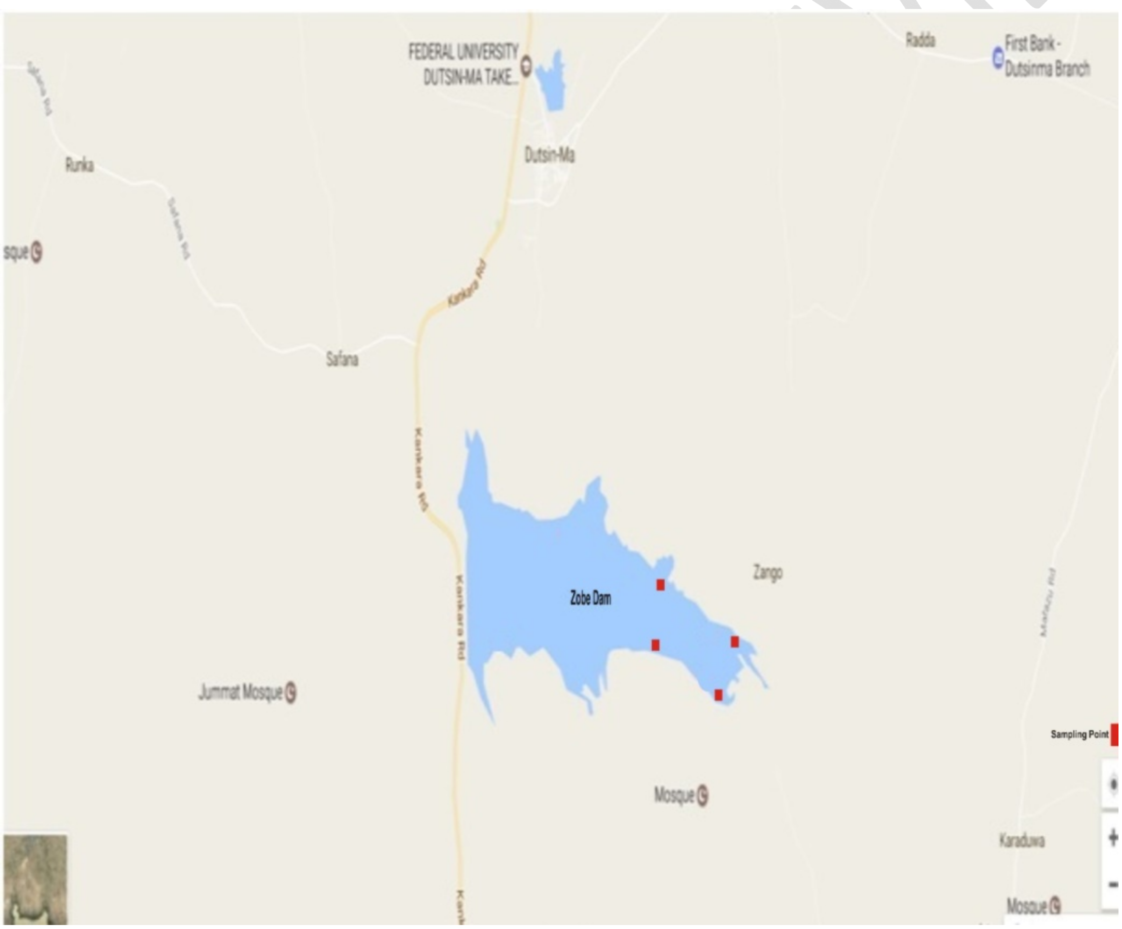

Figure 1: Map of Zobe reservoir showing the sampling points

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 and Identification

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, 2002). Snails were often seen near the edges of slightly deep waters or lodgedin 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 African freshwater snails of medical and veterinary importance (WHO, 1980), followed by separation of specimens into species which were then counted. Visual forms of the specimens were captured using an Android phone's camera.

Collection of Water Sample and Physicochemical Analysis

Water samples were collected in four plastic sample bottles (2 L) at points where snails were collected. 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. Physicochemical parameters of the water body were determined using methods described by Biswas (2011).

Statistical Analysis

Analysis of variance (ANOVA) was used to test for significant mean difference of physicochemical parameters during the months of sampling. Correlation analysis was carried out to test for relationship between species abundance and physicochemical parameters and Shannon index was used to calculate species diversity and Menhinick's index for species richness.

RESULTS AND DISCUSSION

The occurrence, diversity, and abundance of snails

A total of 1644 snails were collected during the sampling period, all belonging to the sub-class Pulmonata, of two (2) families and three (3) species. The family Planorbidae had the highest species composition of 2 and 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 had 23.42% 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 and September (late rainy season), This findings corresponds with Oloyede *et al.* (2016) who reported higher snail abundance in Spring during the late rainy season, while the least number of snails was found between April, 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

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 fluctuated 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 similar to the findings of Abalaka (2013).

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 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 (Ude *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 within World Health Organization standard for aquatic life (WHO, 1984).

The pH recorded in the Dam ranged from slightly acidic to highly alkaline and had a weakly positive relationship with the snail species (Table 4). This may support the findings of Garg *et al.* (2006), who reported a very weak and insignificant negative correlation between snail species and pH, suggesting that snails are independent of pH value fluctuations in water body. Although the findings of Spyra (2017) 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 Garg *et al.* (2009). All the snail species had a positive correlation with DO (Table 4), which finds support from Garg *et al*. (2006) 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±0.44l	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

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

Freshwater snails of the sub-class Pulmonata, belonging to the families Lymnaeidae and Planorbidae inhabit Zobe Dam. *Lymnaea natalensis, Bulinus trophicus* and *Bulinus forskalii* were the three species recorded during the period of study, with *Lymnaea natalensis* been the most abundant Population of these snails varied monthly and spatially, in relation to physicochemical parameters. The status of physicochemical parameters in the water body is favorable for the survival of freshwater snails and may support increase in their population. 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.

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