Sahel Journal of Life Sciences FUDMA (SAJOLS)
March 2024 Vol. 2(1): 252-263
ISSN: 3027-0456 (Print)
ISSN: 1595-5915(Online)
DOI: *https://doi.org/10.33003/sajols-2024-0201-031*

Research Article

Influence of Physicochemical Parameters on Abundance, Distribution and Diversity of Freshwater Snails in Bakolori Reservoir

Timothy Auta[1] and *Sani Alhaji Tukur[1,2]

[1]Department of Biological Sciences, Faculty of Life Sciences, Federal University Dutsin-Ma, Katsina State, Nigeria

[2]Department of Applied Sciences, School of Science and Technology, Abdu Gusau Polytechnic Talata Mafara, Zamfara State, Nigeria

***Corresponding Author's email**: tukurasani@gmail.com/+2348067747804

Received: 16th February, 2024 **Accepted**: 20th March, 2024 **Published**: 31st March, 2024

ABSTRACT

Freshwater snails are part of the larger class of animals with shells known as mollusks. Freshwater, marine, and terrestrial snails make up the biggest group of mollusks, with well over 50,000 different species. The diversity, number, and distribution of freshwater snail species have been the subject of numerous study reports. This study was conducted over four months, from August to November, at three sample stations (I, II, and III) and in the Bakolori Reservoir. During the duration of the study, the sampling procedures were conducted every two weeks. Using the Shanon-Weiner and Simpson's similarity indices, the diversity of snail species was examined. *Acathina fulica* was the most abundant snail species, *Pomacea bridgesii was the least abundant, P. bridgesii was the most diverse species, and Littorina littorea was the least diversified species, according to the study.* The Pearson correlation was able to show that Total Dissolved Solid, pH, Dissolved Oxygen, and Biological Oxygen Demand had strong positive correlations and that TDS and Temperature had strong negative correlations. It also revealed that there was a strong positive correlation between pH, DO, and BOD, Total Solid and *Littorina littorea,* and Transparency had a strong positive correlation with *Acathina fulica*. TDS, temperature, BOD, and *A. fulica* were found to positively correlate using principal component analysis. Do was found to positively correlate with *L. littorea,* turbidity, conductivity, and *Pomacea bridgesii*, transparency and pH were positively correlated, and total suspended solids were positively correlated with neither.

Keywords: Aquatic Ecosystem; Biodiversity; Ecology; Environmental Biology; Species Richness

Citation: Auta, T. and Tukur, S.A. (2024). Influence of Physicochemical Parameters on Abundance, Distribution and Diversity of Freshwater Snails in Bakolori Reservoir. *Sahel Journal of Life Sciences FUDMA*, 2(1): 252-263. DOI: *https://doi.org/10.33003/sajols-2024-0201-031*

INTRODUCTION

A range of environmental factors influence the ecology of snails, including biological factors like food availability, competition, and predator-prey interactions; physical factors like temperature, water current, turbidity, transparency, and the distribution of suspended solids; and chemical factors like ion concentration and water dissolution (Owojori *et al*., 2006; Charles *et al.,* 2022).

Due to weather conditions like rain and drought, it was discovered that the distribution of snails was restricted in the majority of environments. Because of this, certain species may not colonize particular settings but may be common in other regions that are equivalent (Adekiya *et al.*, 2019; Charles *et al.*, 2022). Thus, research into the environmental variables influencing the distribution of snails in freshwater ecosystems is imperative (IUCN, 2001; Charles *et al.,* 2022). Twelve percent of West Africans are deemed vulnerable, according to Igbinosa *et al.* (2015). As per Charles *et al.* (2022) freshwater snails are among the aquatic organism groups that are most vulnerable to extinction. Therefore, it makes sense to look at how the climate impacts the snail population. The past eight decades have seen a sharp decline in the variety and quantity of snails, especially those inhabiting streams and rivers. It has been reported that over sixty species of freshwater snails are thought to be extinct, and that the decline in freshwater snail populations started in the early 1900s (Strayer DL, 2014; Charles *et al.,* 2022).

Most freshwater snail species evolved in saltwater conditions, while others made the shift from terrestrial to freshwater habitats. Snails usually play a significant part in the ecology of freshwaters because they feed a wide variety of animals and graze on an abundance of algae and debris. They are necessary for rivers' regular ecological processes. Their unusual names, such as rough hornsnail, interrupted rocksnail, knob mudailia, pagoda slitsnail, plesnail, banded mystery snail, and many more, often hide their true value as indicators of water quality and food supplies for other aquatic species (Paul *et al.,* 2019).

Freshwater snails are essential to complex ecological relationships (Kelly, 2019). Freshwater snails possess diverse physiological and metabolic processes, as well as distinctive morphological features, which contribute to their ecological significance and diversity (Okafor and Nyange, 2014; Charles *et al.,* 2022).

MATERIALS AND METHODS

Study Area

The Bakolori Reservoir was completed in 1978, and by 1981, the reservoir had filled to capacity (Yahaya, 2002). The reservoir is located on the Sokoto River, a tributary of the Rima River, which in turn feeds the Niger River. The Bakolori Irrigation Project receives water from the Reservoir (Hartenbach & Schuol, 2005). The Bakolori Reservoir is located in Nigeria at (120 30’43’’N 6011’0’’E). Farmers in the downstream floodplains needed to release a lot of water prior to the growing season, with lower flows afterwards as they engaged in flood recession agriculture. Because Reservoir operators were unaware of this need, they released insufficient water at the wrong times. Flood recession agriculture required farmers in the downstream floodplains to release large amounts of water prior to the growing season and to use smaller flows thereafter. Reservoir operators released too little water at the wrong times because they were ignorant of this need. Peak flows were substantially decreased by the Reservoir, as were the depth, length, and scope of floods downstream during the rainy season (AReservoirs 1993; AReservoirs & William 2000). There was less water available for agriculture overall since a large body of water in a hot, dry region evaporates quickly (Yahaya, 2002).

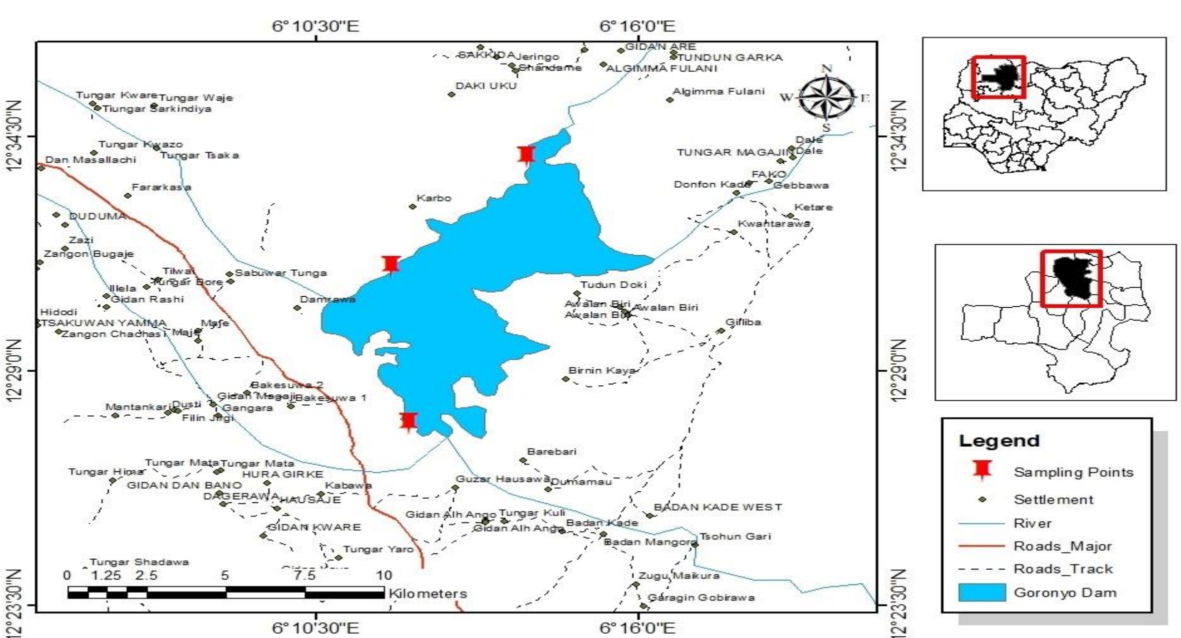

Figure 1. Map showing Sampling Points at the Downstream of Bakolori Reservoir

Water Sample Collection
A standard protocol for water sampling which includes locating the proper site, collection and shipping protocols were adopted during the study period.

Physicochemical Parameters Analysis
Water physicochemical parameters, including the following, are determined every two weeks: The water temperature in the field was measured using a digital multithermometer (model no. ST9283B), as reported by UWW (2018). pH was measured in the lab using a pH meter (model no. PHS 25). Using gravimetric techniques taken from the international standard practical handbook published by Gupta (2014), TDS, TSS, and TS were measured in the laboratory. In the lab, a conductivity meter with model number DDS307W was used to measure the water's conductivity. According to Gupta (2014) and Abdulkadir, *et al*. (2013), water transparency was achieved by using a sacchi disc with calibrated cord. Water action volunteers adopted the transparency-turbidity conversion scale in 2008 (WAV, 2008), and it is used to analyze the turbidity of water. WAV, (2008). Dissolved Oxygen Meter (model no.: INE-JPSJ-605F) was used to analyze DO and BOD.

Snail Sample Collection
Cross-sectional analysis of freshwater resources. The method used to get snail samples was hand picking and scoop net collection, as detailed by Alhassan *et al.* 2020. Throughout the course of the following four months, the sample collection was conducted once every two weeks, or biweekly (August-November). Three locations for sampling were chosen downstream of the Reservoir. The collection was kept up to date from 8:00 am to 12:00 pm, during which time the snails emerged to forage for food (Salawo & Odaibo, 2014).

Samples Handling and Preservation
The snails were previously handled in pre-labeled containers filled with moist cotton, covered with a perforated lid, and transported to the laboratory where they were separated according to two criteria: the color of the shell (black, white, or golden) and the morphology of the shell (aperture, broad shell, as adopted by Salawo & Odaibo, 2014).

Species Physical Identification
A large shell or an opening occupying more than half of the body, as taken from Salawo & Odaibo (2014), and the shell colors—Black, White, and Golden—were used to determine the phenotypic identity (Okon *et al.,* 2013). After recording the sampling sites and months, each recognized species was tallied.

Study of the Snail Diversity
The Shannon-Wiener Index (H') was employed as a method to determine the distribution and evenness of snail species diversity. This indicator is the most widely used one in ecological research.
Values can vary from 0 to 5, with 1.5 to 3.5 being the typical range. It was computed as follows:

$$H' = -\sum\left[\left(\frac{n_i}{N}\right)\times\ln\left(\frac{n_i}{N}\right)\right]$$

Where N is the overall number of individuals (or amount) for the location, ln is the natural log of the number, and ni is the number of individuals (or amount; for example, biomass) of each species (the ith species).
The relative abundance of each species of snail was ascertained using the Similarity Index.
The numbers go from 0 to 1, where a higher number denotes more resemblance. It was computed as follows:

$$Sim = \frac{2\sum nc}{\sum n1 + \sum n2}$$

Where n1 is the species of site 1, n2 is the species of site 2, and nc is the common species between sites.
When using cover, the similarity between each species is just three covers.

Data Analysis
With the use of the Statistical Package for Social Science (SPSS), principal components analysis (PCA), and ANOVA, this study aimed to ascertain the snail species abundance, distribution, and biodiversity in and around Bakolori Reservoir in addition to a few water physicochemical parameters. Additionally, it sought to examine the relationships between and among these parameters and the snail species abundance, distribution, and biodiversity.

RESULTS
This section presents the findings from a study on the changes in physicochemical parameters that affect the abundance, distribution and diversity of freshwater snails in the Bakolori Reservoir reservoir in Talata Mafara Local Government Area, Zamfara State, Nigeria.

Monthly Snail Species Diversity Index in Bkolori Reservoir
When diversity and similarity indices were analyzed, *P. bridgesii* showed the most diversity (0.3562) in August, while *A. fulica* showed the lowest (0.2359). *P. bridgesii* had the lowest diversity (0.3502) in September, whereas *A. fulica* showed the most (0.3679). In October, *A. fulica* had the most diversity (0.1777) and *L. littorea* the lowest (0.1537). In November, *P. bridgesii* had the highest diversity (0.3310) and *L. littorea* had the lowest (0.3090). *P.*

bridgesii had the lowest similarity index (0.4200) and *A. fulica* the highest (0.8300). All presented in Table 1.

Snail Species Diversity Index according Sampling Stations in Bakolori Reservoir

The results indicate that *A. fulica* had the lowest diversity in station I (0.2780), *P. bridgesii* the highest (0.3670), *A. fulica* the lowest diversity in station II (0.2703), *P. bridgesii* the highest (0.3662), *L. littorea* no diversity in either station, *L. littorea* only present in station I (0.0000), and *P. bridgesii* the lowest (0.4244) and *A. fulica* the highest (0.8300) in terms of station-wise (Table 2).

Sampling Points, GPS Locations and Major Human Activities Performed at each Station

Three separate locations within the lake were used to gather samples: Rice farming, fish farming, fruit farming, and animal husbandry are the main human activities at Station I (12'23'30''N - 6'10'30''E); Station II (12'29'0''N - 6'10'30''E) was primarily used for anthropological activities, such as rice, sugarcane, fruit, cassava, and sorghum farming. Station III (12'34'30''N - 6'16'0''E) was primarily used for human activities, such as sugarcane, fishing, sorghum, rice, cassava, and occasionally fruit farming and laundry. All presented in table 3.

Physicochemical Parameters Concentrations in Bakolori Reservoir

Table 4 presents an overview of the mean and standard deviation of the water's physicochemical parameters concentrations at the Bakolori Reservoir reservoir.

Physicochemical Parameters Concentrations in Bakolori Reservoir with Sampling Months

Table 5 displays the average monthly values of the Bakolori Reservoir's physicochemical characteristics. Notably, there were significant differences in TDS (p = 0.0270), TSS (p = 0.0200), and TS (p = 0.0410) between the sampling months. Water temperature was found to be lower in November and higher in September. Conductivity was found to be lower in August but higher in October, turbidity was found to be lower in October and higher in August, and water transparency was found to be lower in September, October, and November but higher in August. Water pH, DO, and BOD were found to be lower in August and higher in October.

Physicochemical Parameters Concentrations in Bakolori Reservoir with Sampling Stations

When physicochemical parameter values were compared between sampling sites, no significant mean difference was found for any of the parameters (p>0.05). Water temperature was found to be lowest in station I and highest in station II and III (sharing equal level), DO and BOD were found to be lowest in station II and highest in station I, TDS was found to be highest in station III and lowest in station I, TSS was found to be lowest in station III and highest in station I, and water transparency was found to be lowest in station I & II (sharing equal level) and highest in station II (Table 6).

Correlation Coefficient of Physicochemical Parameters in Bakolori Reservoir

A very strong positive correlation was found between TDS and pH (r= 0.565**), DO and BOD (r= 0.706**), and BOD and temperature (r= 0.683**). A very strong negative correlation was found between TDS and temperature (r= -0.635**), while a very strong positive correlation was found between pH and DO (r= 0.648**) and BOD (r= 0.659**) (Table 7).

Correlation Coefficient of Physicochemical Parameters and Snail Species in Bakolori Reservoir

Water transparency and *A. fulica* showed a very significant positive association (r= 0.618**), whereas water TS and *L. littorea* showed a substantial negative correlation (r= -0.418*). Each of the items in Table 8.

Table 1: Shannon-Wiener Index (H') and Similarity Indices of Monthly Snail Species Diversity in Bakolori Reservoir

Snail Species	August	September	October	November	Similarity Index
A. fulica	0.24	0.37	0.18	0.32	0.83
P. bridgesii	0.36	0.35	0.15	0.33	0.42
L. littorea	-	0.37	0.11	0.31	0.75

Table 2: Snail Diversity Indices across the Sampling Stations in Bakolori Reservoir

Snail Species	Station I	Station II	Station III	Similarity Index
A. fulica	0. 28	0. 27	-	0.83
P. bridgesii	0.37	0.37	-	0.42
L. littorea	-	-	0.00	0.75

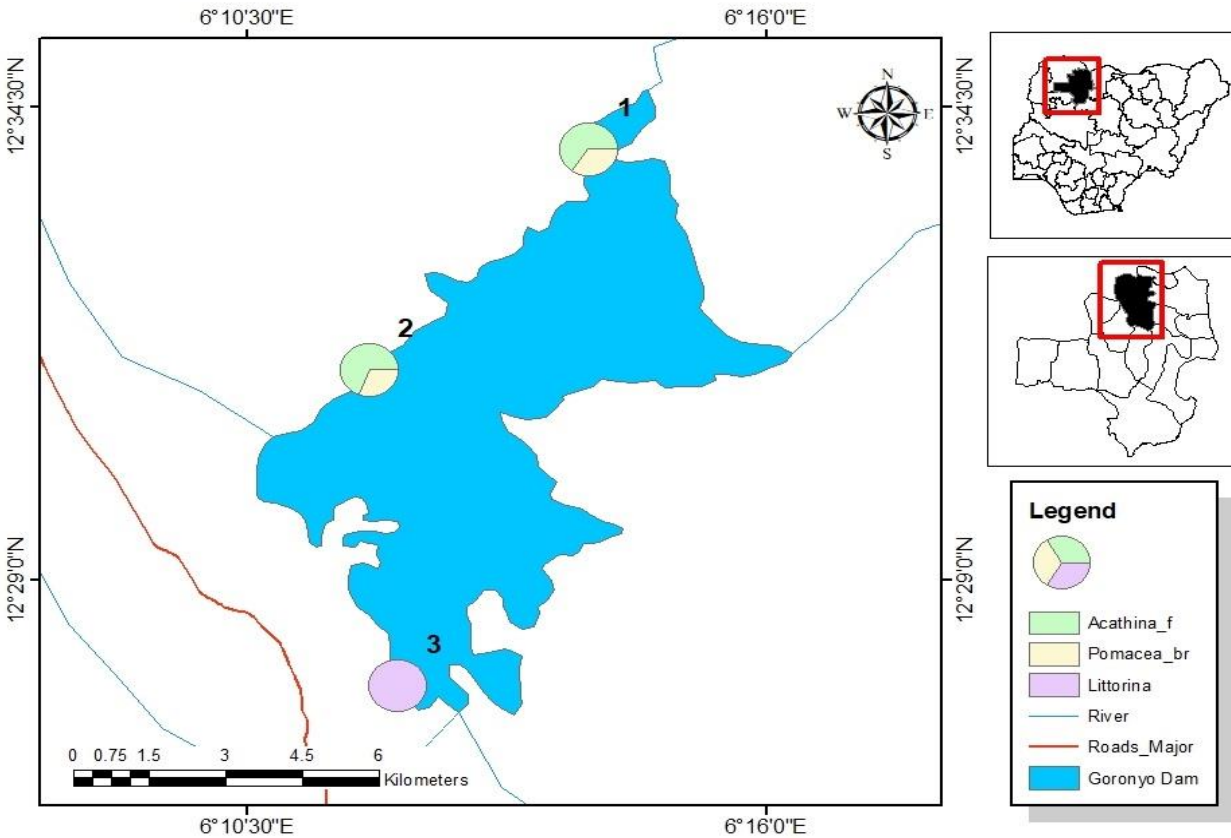

Figure 2. Spatial and Temporal Distribution of Snail Species across the Sampling Stations in Bakolori Reservoir

Table 3. Sampling Points, GPS Locations and Major Human Activities Performed at each Station

Sampling points	GPS location	Human activities
Station I	12’23’30’N-6’10’30’E	Rice farming, Fish farming, fruit farming and livestock rearing.
Station II	12’29.0’N-6’10’30’E	Rice farming, sugarcane farming, fruit farming, cassava farming and guinea corn farming
Station III	12’34’30’N-6’16’0’N	Sugarcane farming, fish farming, guinea corn farming, rice farming, cassava farming and a rarely fruit farming as well as laundry

Table 4. Summary of Physicochemical Parameters Concentrations of Bakolori Reservoir

Parameters	**Mean±S.D**	**Range Values**	
		Minimum	**Maximum**
pH	8.42±.58	8.00	10.00
Water Temp. (^oC)	27.67±2.75	22.00	34.00
Conductivity (µS)	155.89±87.73	65.00	323.00
DO (mg/l)	5.00±10.70	0.00	46.00
BOD (mg/l)	2.92±6.99	0.00	30.00
Turbidity (NTU)	138.04±64.93	80.00	301.00
Transparency (cm)	0.04±0.20	0.00	1.00
TDS (mg/l)	0.81±1.84	0.00	7.00
TSS (mg/l)	0.72±0.76	0.00	2.00
TS (mg/l)	479.17±265.77	100.00	800.00

Table 5. Mean Monthly Physicochemical Parameters Concentrations of Bakolori Reservoir

Parameter	August	September	October	November	P-Value
pH	8.00±0.00	8.33±0.52	8.67±0.52	8.67±0.82	0.1410
Temperature (°C)	28.17±0.75	29.33±0.52	27.33±1.86	25.83±4.75	0.1560
Conductivity (µS)	103.50±65.10	192.00±70.15	203.00±83.12	125.00±103.25	0.3360
DO (mg/l)	0.50±0.55	1.17±.10	4.67±0.52	13.67±19.82	0.1150
BOD (mg/l)	0.00±0.00	0.33±0.82	3.0000±1.27	8.33±13.00	0.1350
Turbidity (NTU)	164.17±67.71	145.00±67.08	97.17±24.42	145.83±82.19	0.3360
Transparency (cm)	0.17±0.41	0.00±.00	0.00±0.00	0.00±0.00	0.4130
TDS (mg/l)	0.23±0.41	0.00±0.00	0.33±0.52	2.67±3.08	0.0270
TSS (mg/l)	1.70±0.79	0.33±0.52	0.50±0.84	0.83±0.7528	0.0200
TS (mg/l)	625.00±117.26	333.33±287.52	325.00±292.83	633.33±186.19	0.0410

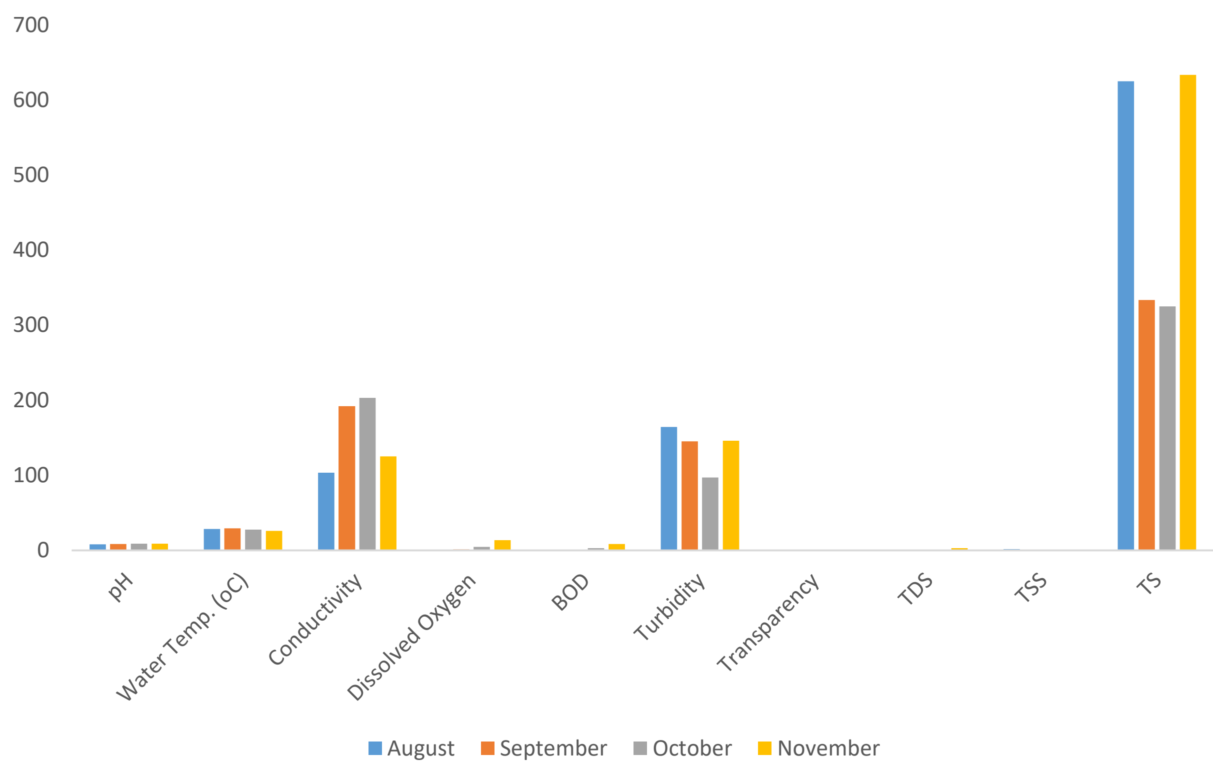

Figure 3: Mean Monthly Physicochemical Parameters Concentrations of Bakolori Reservoir

Table 6. Mean Samplimg Station Physicochemical Parameters in Bakolori Reservoir

Parameter	Station I	Station II	Station III	P-value
pH	8.38±0.74	8.50±0.54	8.38±0.52	0.8940
Water Temp. (°C)	26.50±2.78	28.75±2.92	28.75±2.92	0.2700
Conductivity (µS)	187.63±100.00	121.00±83.07	159.00±76.38	0.3270
DO (mg/l)	7.63±15.60	2.00±1.93	5.38±10.52	0.5920
BOD (mg/l)	4.88±10.27	0.75±1.39	3.13±6.58	0.5160
Turbidity (NTU)	130.13±77.17	146.63±65.56	137.38±58.65	0.8880
Transparency (cm)	0.00±0.00	0.13±0.35	0.00±0.00	0.3850
TDS (mg/l)	0.55±1.40	0.88±1.73	1.00±2.45	0.8890
TSS (mg/l)	0.90±0.84	0.75±0.71	0.50±0.76	0.585
TS (mg/l)	481.25±206.91	550.00±256.35	406.25±334.28	0.578

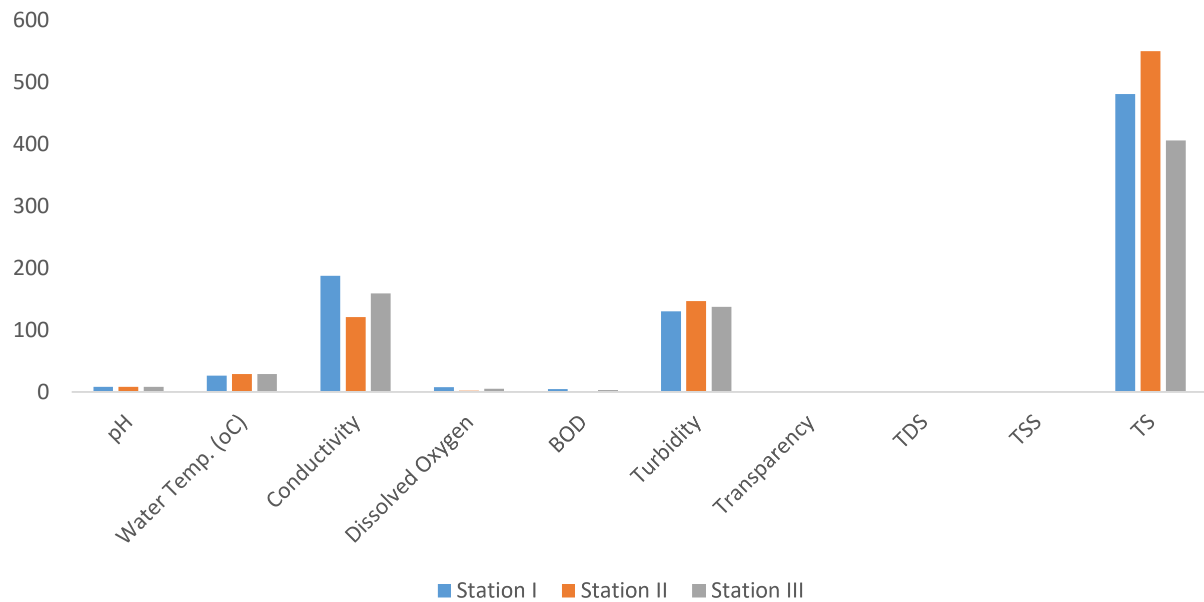

Figure 4. Mean Sampling Station Physicochemical Parameters in Bakolori Reservoir

Table 7. Correlation Coefficient of Physicochemical Parameters in Bakolori Reservoir

	TDS	TSS	TS	Trans p.	Cond.	Turbidity	pH	Temp.	DO
TSS	-0.139								
TS	0.303	0.034							
Transparency	-0.094	0.080	0.097						
Conductivity	0.078	-0.407	-0.270	-.0179					
Turbidity	-0.247	0.095	0.142	-0.059	-0.465				
pH	0.565**	-0.115	-0.068	-0.152	0.122	-0.381			
Temperature	-0.635**	-0.194	0.002	0.026	-0.169	0.087	-0.398		
DO	0.706**	0.167	0.098	-0.080	-0.114	-0.274	0.648**	-.551	
BOD	0.683**	0.163	0.101	-0.089	-0.092	-0.280	0.659**	-.550	.994

** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed)

Table 8: Pearson Correlation Coefficient of Physicochemical Parameters and snail spp in Bakolori Reservoir

	TDS	TSS	TS	Transp.	E.C	Turbidity	pH	Temp.	DO	BOD
A. fulica	-0.217	0.177	0.063	0.618**	-0.298	0.023	-0.258	0.157	-0.233	-0.237
P. bridgesii	-0.168	0.213	0.025	-0.072	-0.404	0.086	-0.166	0.144	-0.176	-0.170
L. littorea	-0.136	-0.226	-0.418*	-0.090	0.249	-0.208	0.166	0.296	-0.043	-0.014

**Correlation is significant at the 0.01 level (2-tailed); *Correlation is significant at the 0.05 level (2-tailed)

DISCUSSION

Notable conclusions regarding the variety, abundance, and distribution of freshwater snails were obtained from an ecological study carried out in the vicinity of Bakolori Reservoir in Zamfara State, Nigeria. During the study period, all snails that were collected, representing three different species, were recorded. When the diversity and similarity indices were analyzed, *P. bridgesii* showed the most diversity (0.3562) in August, while *A. fulica* showed the lowest (0.2359). *A. fulica* displayed the most diversity (0.3679) in September, while *P. bridgesii* had the lowest (0.3502). *L. littorea* had the lowest diversity (0.1537) and *A. fulica* the greatest (0.1777) in October. In November, *P. bridgesii* had the highest diversity (0.3310) and *L. littorea* had the lowest (0.3090). *A. fulica* (0.8300) had the highest similarity value, while *P. bridgesii* (0.4200) had the lowest. Station-wise, *P. bridgesii* showed the maximum diversity (0.3670), whereas *A. fulica* showed the lowest (0.2780) in station I. *L. littorea* recorded no diversity in either station, while *A. fulica* had the lowest diversity (0.2703) or *P. bridgesii* the greatest (0.3662). Exclusive host *L. littorea* (0.0000) was Station I. *A. fulica* (0.8300) had the highest similarity index, while *P. bridgesii* (0.4244) had the lowest. This work is consistent with other investigations on freshwater snails conducted in Nigeria and other African nations. The study area's *Acathina fulica* dominance is in line with reports from Okeke *et al.* (2016) in Awka, Nigeria, and Silver et al. (2022), who rank *A. fulica* as the most invasive species of snail. The coexistence and interaction of *A. fulica* and *P. bridgesii* are similar to research done in China by Dong *et al.* (2011), which focused on the influence of ecological factors on species composition. The variance in distribution and abundance between sampling stations and months aligns with the varied ecological dynamics documented by several researchers in Nigerian water bodies, including Dogara *et al.* (2020), Sanu *et al.* (2020), and Tela and Usman (2021). The most common species was found to be *Acathina fulica*, which produced diversity index values of 0. 2780 and 0. 2703, respectively, based on large numbers of observations across stations I and II. This finding implies that these particular conditions were favorable to *A. fulica*'s growth. On the other hand, station III, which only included *Littorina littorea,* demonstrated a unique pattern, with a high variety index count of (0.0000). Comparing station III to the other two stations, this demonstrates a limited prevalence of *L. littorea.* During the study period, it is noteworthy that *L. littorea* was not present in stations I or II. Changes in habitat preferences, environmental conditions, or biological interactions amongst snail species could all be responsible for this distribution pattern. Station III-specific characteristics could have an impact on *L. littorea*'s unique existence there. It is important to remember that environmental factors have a significant impact on snail dispersion when comparing our results with those of earlier research. Comparable patterns of exclusivity and domination have also been documented in earlier research on freshwater snail species, including those by Ibrahim et al. (2023), Tadena E. (2023), vexinath, A. (2022), Abdulkadir *et al.* (2013), Amawulu and Assumpta (2021), and Danjuma *et al.* (2023). These differences highlight the intricate interactions between ecological elements that shape snail groups in various watery settings. More investigation and comparison studies may shed more light on the processes underlying these distribution patterns. Important information about the ecological dynamics of freshwater snails in the Bakolori Reservoir was obtained from the diversity and similarity indices. The observed differences in diversity and similarity between various species and sample locations help us better comprehend the intricate relationships that exist within this ecosystem. *P. bridgesii* showed the maximum diversity in August, whereas *A. fulica* showed the lowest. September saw a change in this pattern, with *A. fulica* showing the greatest diversity and *P. bridgesii* the lowest. October and November showed more variations, with *P. bridgesii* and *L. littorea* fluctuating in their status as the least and most diverse species, respectively. It is possible to attribute these differences to competitive interactions, seasonal variations, or habitat preferences. *A. fulica* and *P. bridgesii* showed greater and lower similarity, respectively, according to the similarity index, which supported these results. This reveals that while *A. fulica* shows a greater degree of similarity with the other species, *P. bridgesii* varies from them more profoundly. When these findings were compared to previously published research, studies by Auta *et al.* (2018), Atsuwe *et al.* (2019), Ronakl and Ogorode (2021), Amawulu and Asumpta (2021) and Obisike *et al.* (2022) from various tropical regions indicated comparable patterns in freshwater snail groups. However, it's important to note that this study brings unique insights into the particular ecological conditions of Bakolori Reservoir, contributing valuable data to the broader understanding of freshwater snail populations in the region. Upcoming research could further explore the factors influencing these variations and their implications for the overall aquatic ecosystem. The variations in diversity and similarity observed in this study are consistent with the complexity of snail ecology, highlighting the need for context-specific investigations.

Water pH, DO, and BOD were observed to be lower in August and higher in October; water temperature was observed to be lower in November and higher in September; conductivity was observed to be lower in August but higher in October; turbidity was observed to be lower in October and higher in August; and water transparency was observed to be lower in September, October, and November but higher in August. The mean monthly values of the physicochemical parameters of Bakolori Reservoir revealed that TDS ($p=0.0270$), TSS ($p=0.0200$), and TS ($p=0.0410$) significantly different among the sampling months, which group Sunday et al. (2019), Mukaribu and Mu'azu (2023) in the same study area and Alhassan *et al.* (2020), Salawo & Odaibo (2014), Abdulkadir *et al.* (2013), Beekam *et al.* (2020), and Aminu M. U. (2020).

The physicochemical parameters in Bakolori Reservoir exhibited a very strong positive correlation between TDS and pH, DO, and BOD, as well as a strong negative correlation with temperature. The pH also demonstrated a very strong positive correlation between DO and BOD. Moreover, there was a very strong positive correlation between water transparency and *A. fulica*, and a strong negative correlation between water TS and L. *littorea*.

PCA stands for principal components analysis. After being extracted, five eigenvalues larger than zero were examined. The 78.38% variance was found to be caused by the five eigenvalues. PC1 coupled (water temperature, BOD, TDS), PC2 coupled (water transparency, pH, TSS, and A. fulica), PC3 coupled (nothing), PC4 coupled (conductivity and turbidity), and PC5 coupled (DO and L. littorea) are the components in the matrix. In a rotating matrix, the following are coupled: PC1 (temperature, BOD, *A. fulica*, TDS), PC2 (DO and *L. littorea*), PC3 (conductivity, turbidity, and *P. bridgesii*), PC4 (pH and water transparency), and PC5 (TSS only). The analysis confirmed dramatically ecological interactions between biotic and abiotic components of the fresh water ecosystem given an insight to ecological dynamics. The study Adhered to Charles *et al.* (2022). Further study may bring more in-depth understanding of fresh water ecology in the area.

CONCLUSIONS

According to this study, *A. fulica*, *P. bridgesii*, and *L. littorea* were the snail species found in the Bakolri Reservoir from August to November 2023. *A. fulica* was the species with the greatest abundance, *P. bridgesii* the least, *P. bridgesii* the most distributed and diverse, and *L. littorea* the least distributed and diversified. The Bakolori Reservoir's physicochemical characteristics varied across sampling stations and between months. Variations in physicochemical conditions impact the variety, quantity, and distribution of snail species. TDS increases are inversely correlated with water body temperature, but they do so in tandem with increases in pH, DO, and BOD. The water body's DO and BOD increase in direct proportion to the water body's rising pH level.

Certain physicochemical characteristics of the Dam reservoir had an impact on the variety, abundance, and distribution of snail species. For example, *A. fulica* was directly correlated with water transparency, whereas *L. littorea* was inversely correlated with water temperature.

ACKNOWLEDGMENT

The authors thank everyone who helped make this study project a success, no matter how small.

REFERENCES

Abdulkadir, F. M., Maikaje. D. B. and Umar, Y.A. (2013). The Influence of Physicochemical and Ecological Factors on the Distribution of Freshwater Snails in Manchok Water Intake in Kaduna State, Nigeria. *Nigerian Journal of Chemical Resear. 18.*

Adams, W. (2000). "Downstream Impacts of Dams" (https://web.archive.org/web/20120225071601/http://oldwww.wii.gov.in/eianew/eia/dams%20and%20development/kbase/contrib/soc195.pdf) (PDF). Thematic Review I.1. World Commission on Dams. Archived from the original (http://oldwww.wii.gov.in/eianew/eia/dams%20and%20development/kbase/contrib/soc195.pdf) (PDF) on 2012-02-25. Retrieved 2010-01-22.

Adams, W.M. (1993). "Development's deaf ear: Downstream users and water releases from the Bakolori Dam, Nigeria". *World Development, 21*(9): 1405–1416.doi:10.1016/0305-750X (93)90121-O (https://doi.org/10.1016%2F0305-750X%2893%2990121 -O)

Adekiya, T.A., Aruleba, R.T., Oyinloye, B.E., Okosun, K.O. and Kappo, A. P. (2019). The effect of climate change and the snail-schistosome cycle in transmission and bio-control of schistosomiasis in Sub-Saharan Africa. *Int J Environ Res Public Health. 17*(1):181. DOI: 10.3390/ijerph17010181

Alhassan, A.B., Abidemi, A., Gadzama, I.M.K., Sha'aba, R.I., Wada, Y.A. and Kelassanthodi, R. (2020). Distribution and diversity of freshwater snails of public health importance in Kubanni Reservoir and weir/sediment trap, Zaria, Nigeria. *Journal of Environmental and Occupational Health, 10*(1): 1–9. 10.5455/jeoh.20190704093531

Amawulu, E. and Assumpta, N. (2021). Ecology and Species Composition of Fresh Water Snails in Amassoma Community and Niger Delta University Campuses, Bayelsa State, Nigeria. *Open Journal of Ecology, 11*: 86-93. doi: 10.4236/oje.2021.111008.

Aminu, M.U. (2022). Physicochemical parameters of water in earthen ponds and concrete water storage reservoirs in Bakolori Irrigation Project, Zamfara State, North Western Nigeria. *International Journal of Fisheries and Aquatic Studies, 10*(6): 93-100. DOI: https://doi.org/10.22271/fish.2022.v10.i6b.2752.

Atsuwe, T.S., Chikwendu, J.I. and Obisike, V.U. (2019). Survey of Fresh Water Snails in Vandeikya Local Government Area, Benue State Nigeria. *Asian Journal* *of Research in Zoology, 2*(3): 1–8. https://doi.org/10.9734/ajriz/2019/v2i330066.

Auta, T., Alkali, H.E. and Michael, E.A. (2018). Population Dynamics, Diversity and Distribution of Freshwater Snails in Zobe Dam, Dutsin-Ma, North-Western Nigeria. *Asian Journal of Environment & Ecology, 8*(4): 1-7.

Beekam, K.O., Pieter, B., Seid, T. M., Mesfin Y., Geremew M. A., Argaw, A. and Peter, L.M.G. (2020). Environmental and biotic factors affecting freshwater snail intermediate hosts in the Ethiopian Rift Valley region. *et al. Parasites & Vectors, 13:292* https://doi.org/10.1186/s13071-020-04163-6.

Charles, O.O., Daniel, E., Chike, O.C., Felix, A.A., Kingsley, C.O., Samuel, E.U., Chigozie, D.E. and Eyo, J. (2022). Physicochemical Changes and Abundance of Freshwater Snails in Anambra River (Nigeria) during the Rainy Season. DOI: 10.2478/eces-2022-0013 *ECOL CHEM ENG S., 29(*2):169-18.

Danjuma, M., Saadu, H. and Tsagem, M.M. (2023). Diversity of Mussels and Snails as Bio-indicators in the Littoral Zone of Some Selected Water Reservoirs in Katsina State, Nigeria. *Best Journal of Innovation in Science, Research and Development, 2*(8):50–65. Retrieved from https://www.bjisrd.com/index.php/bjisrd/article/view/508.

Dogara, M.M, Balogun, J.B., Muhammad, A., Abu, P., Ringim, A.S., Zakari, A. and Bashir, M.M. (2020). Abundance and Distribution of Freshwater Snails in Warwade Dam, Dutse, Jigawa State, Nigeria. *NTBA/FUD/031/19.* See discussions, stats, and author profiles for this publication at: https://www.researchgate.net/publication/344694777. Conference Paper · October 2020.

Dong, S., Shentu, X., Pan, Y., Bai, X., Yu X., and Wang, H. (2011). Evaluation of Genetic Diversity in the Golden Apple Snail, *Pomacea canaliculata* (Lamarck), from different Geographical Populations in China by inter Simple Sequence Repeat (ISSR). *African Journal of Biotechnology, 10*(10): 1777-1783.

Gupta, A.D. (2014). Hand Book of Water, Air and Soil Analysis. Published March, 014. Publication at: https://www.researchgate.net/publication/282777928. Uploaded by Dr. Anand Dev Gupta on 12 October 2015.

Hartenbach, A. and School, J. (2005). "Bakolori Dam and Bakolori IrrigationProject – Sokoto River, Nigeria" (http://www.eawag.ch/research_e/apec/seminars/Case%20s tudies/2005/051031_Bakolori%201.pdf) (PDF). Eawag aquatic research institute. Retrieved 2010-01-10.

Ibrahim, Y., Auta, T. and Sadauki, M.A. (2023). Physicochemical Condition of Jibia Reservoir Inhabited by A Freshwater Snail, *Belamya crawshayi*. *Sahel Journal of Life Sciences FUDMA, 1*(1):39-44. DOI: https://doi.org/10.33003/sajols-2023-0101-005.

Igbinosa, B.I., Izegaegbe, J.I., Okafor, F.C. and Uhunwangho, D.A. (2015). Ecological Survey of Freshwater Ecosystems of Ovia, Edo State Nigeria for Gastropod Molluscs. *J Sust Dev., 8*:257-69.

Kelly, R. M. (2019). Comparison of Biogeography Patterns of Two Freshwater Snails - *Physa acuta* and *Helisoma cf. trivolvis*. A Thesis submitted to the Faculty of the Graduate School of the University of Colorado in partial fulfillment of the requirement for the degree of Master of Science Department of Museum and Field Studies. 2019.

Kelly, R.M. (2019). Comparison of Biogeography Patterns of Two Freshwater Snails - *Physa acuta* and *Helisoma cf. trivolvis.* A thesis submitted to the Faculty of the Graduate School of the University of Colorado in partial fulfillment of the requirement for the degree of Master of Science Department of Museum and Field Studies.

Mukaribu, M. and Mu'azu, A.U. **(**2023*)*. Assessment of Seasonal Variations in the Physicochemical Parameters of Bakolori Dam, Zamfara State, Nigeria. *International Journal of Science for Global Sustainability***.** *IJSGS, 9*(1).

Obisike, V.U., Dike, M.C. and Enwereji, E.E. (2022) Freshwater Snails of Public Health Importance in Canals in Okigwe Imo State Nigeria: Their Infectivity and Implications for Control. *International Journal of Health Statistics, 1*(1):21-28.

Okafor, F.C. and Nyang, I. (2004). Freshwater snails of Niger-Cem Nkalagu, Eastern Nigeria: Observations on Some Demographic Aspects of the Schistosome Transmitting Bulinids. *Anim Res Int., 1*:120-4

Okeke, J.J., Samuel, C.E., Mogbo T.C., Ezeonyejiaku, D.C., Otikpa C.A, Okoye C.O and Asolo, C. H. (2016). A Study on the Diversity of Snail Species within Nnamdi Azikiwe University Awka. *Research Journal of*

Agriculture and Environmental Management Vol. 5(7): 207-212.

Okon, B., Ibom, L.A. and Njume, G.N. (2013). Genetic Differentiation between the Black Skinned and White Skinned Snails *(Archachatina marginata)* using random amplified polymorphic DNAs. 5038 *Afr. J. Biotechnol. Researc*h paper, Department of Animal Science, University of Calabar, Calabar, Nigeria. Accepted 31 July, 2013. Corresponding author. E-mail: blessedbassey4destiny@yahoo.com. Tel: +234 08034183263.

Owojori, O.J., Asaolu, S.O. and Ofoezie, I.E. (2006). Ecology of Freshwater Snails in Opa Reservoir and Research farm Ponds at Obafemi Awolowo University Ile-Ife, Nigeria. *J App Sci., 6*:3004-15. DOI:10.3923/jas.2006.3004.3015

Paul, D. (2019). Freshwater Snail Biodiversity and Conservation. Sustaining America's Aquatic Biodiversity. Publication 420-530 (CNRE-76P).*Johnson, Research scientist, Tennessee Aquarium Research Institute, Cohutta, Ga.* www.ext.vt.edu. Produced by Virginia Cooperative Extension, Virginia Tech, 2019.

Ronald, W.I.A. and Ogorode, I.O. (2021). Species Richness and Diversity of Terrestrial Molluscs in Gashaka Gumti National Park, Taraba State, Nigeria. *FUW Trends in Science & Technology Journal, 6*(2): 654 – 659.

Salawu, O.T. and Odaibo, A.B. (2014). The bionomics and diversity of freshwater snail's species in Yewa North, Ogun State, Southwestern Nigeria *©2014 Institute of Parasitology, SAS, Kosice. DOI 10.2478/s11687-014-0250-7.* HELMINTHOLOGIA, 51, 4: 337 – 344, 2014.

Sanu, K.M., Istifanus, W.A., Musa, M.S. and Mao, P.S. (2020). The Diversity of Freshwater Snail Fauna in Kiri Dam, Adamawa State, North Eastern Nigeria. *GSC Biological and Pharmaceutical Sciences, 11*(2), 099–104. https://doi.org/10.30574/gscbps.2020.11.2.0118

Silva, G.M., Thiengo, S.C., Sierpe Jeraldo, V.L., Rego, M.I.F., Silva, A.B.P., Rodrigues, P.S. and Gomes, S.R. (2022). The Invasive Giant African Land Snail, *Achatina fulica* (Gastropoda: Pulmonata): Global Geographical Distribution of this Species as Host of Nematodes of Medical and Veterinary Importance. *Journal of Helminthology, 96*, e86 DOI: https://doi.org/10.1017/S0022149X22000761

Strayer, D.L. (2014). Understanding how Nutrient Cycles and Freshwater Mussels (Unionoida) affect One Another. *Hydrobiology, 735*:277-92. DOI: 10.1007/s10750-013-1461-5

Sunday, M., Wyasu, G. and Moses, T.Y. (2019). Physicochemical and Bacteriological Quality of Water Collected from Dams and Rivers along Gold Mining Sites in Zamfara State. *Science World Journal, 14*(1).

Tadena, E. (2023). Environmental research of land snail diversity at a selected rice field in lower Katingawan. *World Journal of Environmental Research. 13*(2):14-22. https://doi.org/10.18844/wjer.v13i2.9026

Tela, M. and Usman, A. (2021). Abundance and Diversity of Snails in Relation to Physicochemical Parameters along Kwadom Stream, Gombe State, Nigeria. *Asian Journal of Fisheries and Aquatic Research, 14*(6):1–6. https://doi.org/10.9734/ajfar/2021/v14i630310.

UCN. (2001). Red List Categories and Criteria. IUCN: Gland; 2001. ISBN: 9782831706337; 2831706335. Available from: https://portals.iucn.org/library/node/7977.

UWW, (2018). Stream Side Science temperature instructions (great for laminating) and using with a group.Sites, Data and Techniques. Utah Water Watch. 2018 Utah State University Extension.

Vexinath, A. (2022). 15 Different types of snails: picture, chart and facts. https://outforia.com/author/alex-vexinath/). Last updated on: March 18, 2022.

WAV. (2008). Transparency conversion chart (watermonitoring.uwex.edu/wav/monitoring/sheets .html). Water action valunteers. Accessed on 10th October 2023 at 12:46 pm.

Yahya, M.K. (2002). "Development and Challenges of Bakolori Irrigation Project in Sokoto State, Nigeria" *Nordic Journal of African Studies, 11*(3): 411–430.