Direct Research Journal of Public Health and Environmental Technology
Vol. 9(1), Pp. 53-60, April 2024
ISSN: 2734-2182
DOI: https://doi.org/10.26765/DRJPHET10041258
Article Number: DRJPHET10041258

https://journals.directresearchpublisher.org/index.php/drjphet

Evaluation of the Distribution and Abundance of Ostracods in Jabi Lake, Abuja, Nigeria

Olubanjo, O.A.*, and Idowu, R.T.

Department of Biological Sciences, University of Abuja, Abuja, FCT, Nigeria.
Corresponding author email: seyi_olu2006@yahoo.com

Received 2 March 2024; Accepted 29 March 2024; Published 8 April 2024

ABSTRACT: The study examined the distribution and abundance of ostracods in Jabi Lake, Abuja, Nigeria, over a two-year period from January 2017 to December 2018. A total of 1734 individuals from 11 species across three families were encountered. The Cyprididae family dominated, with Ilyocytheridae being the least common. The species abundance demonstrated a *Heterocypris salina* > *Heterocypris incongruens* > *Potamocypris villosa* > *Herpetocyris chevreuxi* > *Trajancypris sp.* > *Heterocypris intermedia* > *Candona neglecta* > *Candona candida* > *Ilyocypris bradyi* > *Koencypris ornate* pattern. The distribution of species richness and diversity was Station 5 > Station 2 > Station 1 > Station 4 > Station 3, which might be attributed to varying levels of human intervention. The study found that eurytopic taxa were prevalent in the lake, indicating that they had a wide range of habitats; nevertheless, efforts must be taken to mitigate the impacts of anthropogenic perturbations in some of the tested stations in order to improve the community structure of ostracods at Jabi Lake.

Keywords: Ostracods, Jabi Lake, Distribution, Abundance, Anthropogenic Perturbations

Citation: Olubanjo, O.A. & Idowu, R.T. (2024). Evaluation of the Distribution and Abundance of Ostracods in Jabi Lake, Abuja, Nigeria. Direct Res. J. Public Health and Environ. Technol. Vol. 9(1), Pp. 54-60. https://doi.org/10.26765/DRJPHET10041258.

INTRODUCTION

Freshwater is such an important and local resource for people; this ecosystem has probably suffered more devastation than any other set of habitats. They are highly specie-rich and many are highly threatened (Hambler and Canney, 2013) for reasons not far-fetched. It may be contaminated by particles discharged during mining, smelting and industrial manufacturing (Pearce, 1996). Freshwater ostracods are small, bivalve crustaceans found virtually in all aquatic habitats. Their carapace is made up of low magnesium calcite that fossilizes well in lake sediments, preserving information about the post-lake environment. Butlin *et al.* (1998) described the taxon ostracoda as one that exhibits a high taxonomical diversity and an extensive fossil record product of an easily fossilized calcite bivalve carapace (Griffiths and Holmes, 2000). Ostracods have many different shapes. The most common shapes in the freshwater ostracods are ‘’kidney or bean’’ shape, elliptical, trapezoidal, triangular and sub-triangular or elongated (Karanovic, 2009). Their utility in some regions is limited especially where little is known about their modern ecological preferences. Previous research has shown that ostracods are sensitive to changes in water variables such as temperature, conductivity, pH, and depth, as well as substrate type, aquatic macrophyte cover and energy level of the environment (Onyedineke, 2000; Horne *et al.,* 2002, Smith 1993). A limited number of studies have been conducted on Ostracods in various parts of Nigeria. Ajayi (1981) focused on the freshwater ostracoda of Ikpobe River, Imoobe (1992) studied the Jamieson River, Onyemaobi (2015) conducted research on ostracods in Maiduguri ponds, Onyedineke (2000) studied ostracods in Benin River, and Victor and Fernando (1981) also contributed to the body of knowledge. Despite these efforts, there remains a lack of comprehensive information on the diversity of ostracods in Nigeria, particularly in the north central region. As a response to this gap, the present study was undertaken to evaluate the abundance and distribution of ostracods in Jabi Lake, situated in Abuja, Nigeria.

MATERIALS AND METHODS

Study area

Abuja is the capital city of Nigeria. It lies in the central part of Nigeria, in the Federal Capital Territory (FCT; created 1976). Abuja lies at 1,180 feet (360 metres) above sea level and is located on 9° 4' 20.1504'' N and 7° 29' 28.6872'' E. one of the major lakes that provide ecosystem services to the people of the city of Abuja is Jabi Lake. Jabi Lake is a water body formed from a man-made earth dam that *was* initially created to provide water to the residents of Abuja. The Lake is located between the Jabi and Kado Districts of Abuja, within the Federal Capital Territory of Nigeria. It is located within Latitude: 9°4'38"N and Longitude: 7°25'18"E. The source of the lake is a natural stream which was dredged (embanked) to serve human activities within the environs such as fishing, subsistence farming, recreation etc. Large volume of water flowed from the stream through many communities and to the present location of Jabi Lake.

The vegetation in the lake is extremely variable depending on prevailing climate condition. There is a delicate balance between available moisture and vegetation cover (Thomas *et al*., 1991). The lake is a multidirectional water body with shrubs and shady trees which provides cover for biodiversity along the fringes of the lake. The vegetation comprises of fringing, floating, submerged and emergent plants. Water hyacinths (evasive weeds) as well as the giant grass are also found floating in some parts of the lake. However, the lake is currently surrounded by a big shopping mall and residential houses, and is subjected to recreational activities. It is thus considered as a close basin for different types of drainages in the city of Abuja. The lake is also an important source of fishing activities in the district but subject to high levels of pollution from domestic drainage and raw domestic sewage. The drainage contaminated wastewater into the lake is a great health risk due to the possibility of large number of pathogens and antibiotic products being discharged into the water body daily (Matouke, 2019).

Since the Lake is known to have supported the farming, fishing, domestic and recreational activities of the local communities around it, any deterioration in the quality of water in the lake will have very crucial negative impact in the livelihoods of local communities and also the ecology of the macro- and micro-invertebrates in the lake (Ogoko and Sylvester, 2020).

METHODOLOGY

Simple randomized block design was adopted to locate the sampling stations of the study. Five sampling stations were selected across the lake. The selection was based on the distinct anthropological activities occurring at each site to provide for a wide coverage of the impacts of the various activities around the lake. Duration of sampling was for 24 months on a monthly basis. Station 1 is known as the Downstream Area. It is located near the dam's spillway and discharge region. Characterized by moderate human activities such as laundry, swimming, and fishing. Station 2 is referred to as the Stagnant Pool Area. It is next to Station 1. There is a boat wreck and a huge amount of refuse dump at this point. The water is stagnant and brownish in colour. Little or no human activity occurs in this area. Station 3 is located in the Upstream Area of the lake side. It is the prominent centre for recreation around the lake side. It is also a converging point for canoe peddlers, speed boat drivers, artisanal fishermen and women. The water here is fairly shallow. Station 4 is referred to as the Shallow Pool Area of the lake. There is a mark of boat terminus at the site. The water is shallow in depth. It is fairly polluted, especially with the existence of some trash dumps. Station 5 is known as the Midlake Area since it is located midway down the lake's shoreline. It has the least anthropogenic activity of any station; it is bordered by highly populated trees and shrubs, as well as heavy vegetation composed of both submerged and emergent macrophytes, with runoff from the surrounding area draining into this site.

Ostracod sampling

Sediment samples were collected from the water body forth nightly from January 2017 to December 2018, using a standard Sediment semi-scoop net (350 x 350mm wide and 250um mesh size) with handle. The sediment samples were preserved in five 200ml capacity sampling bottles from the five sampling stations respectively. The specimens collected were fixed at the sites with 70% Ethanol in sampling bottles of 200ml following the procedure of Idowu *et al.* (2018).

In the laboratory, samples were washed under tap water and filtered through three standard-sized sieves (0.25, 1.00, 1.50 mesh size) and were then stored in 70% Ethanol. The sieves were arranged accordingly with the sieve of mesh size 0.25mm under the other two sieves. Sorting was done using a compound microscope (Model Olympus BH2). Species identification was done after individuals were mounted in lactophenol solution on slides. Species identified with soft body parts and carapace structures were classified based on the systematic descriptions of Broodbakker and Danielopol (1982) and Meisch (2000). The determination of ostracods abundance was determined by using the Shannon Wiener and Simpson diversity indices while the Margalef and Menhinick indices were used to determine species richness. The Pielou index accounted for the evenness of the species present across the five stations in Jabi Lake.

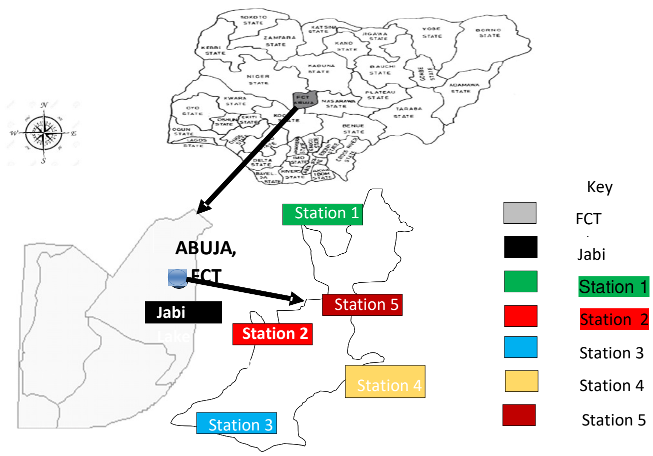

Figure 1: Map of Jabi Lake showing the five sampling stations.

Table 1: Monthly Ostracod Percentage Composition and Abundance in Jabi Lake .

Months	C. Candida	C. negleta	H.salina	H.Incon Gruens	Koen Cypris	Traj ancypris sp.	H.Inter media	H. chevreuxi	P. Villosa	I. bradyi	I. gibba	Total
Jan. 17	0%	0%	8.14%	1.08%	0%	0%	0%	0.67%	0%	0%	0%	2.25%
Feb. 17	0%	0.86%	5.12%	6.50%	0%	0%	0.74%	2.01%	1.65%	0%	2.2%	2.88%
Mar. 17	3.45%	0.00%	8.84%	6.86%	0%	0%	0.00%	0.00%	2.20%	4.69%	2.22%	3.98%
Apr. 17	2.30%	0.00%	5.58%	9.75%	0%	0%	1.48%	2.01%	1.10%	1.56%	1.11%	3.58%
May '17	2.30%	0.86%	4.88%	19.49%	0%	0%	2.22%	3.36%	1.10%	1.56%	1.11%	5.19%
Jun. 17	6.90%	6.90%	8.60%	0.00%	5%	23.6%	7.41%	7.38%	5.49%	3.13%	5.56%	7.27%
Jul. 17	6.90%	7.76%	9.30%	5.42%	13.3%	8.33%	7.41%	9.40%	7.14%	12.50%	10.00%	8.30%
Aug. 17	11.49%	12.07%	10.00%	6.50%	21.7%	11.11%	9.63%	13.42%	9.34%	15.63%	16.67%	10.90%
Sept. 17	5.75%	1.72%	2.33%	3.25%	10.0%	6.25%	5.93%	5.37%	7.69%	6.25%	5.56%	4.61%
Oct. 17	3.45%	1.72%	1.16%	0.36%	6.7%	3.47%	4.44%	2.01%	4.95%	0.00%	0.00%	2.19%
Nov. 17	1.15%	3.45%	0.70%	0.36%	3.3%	0.69%	2.96%	1.34%	2.75%	1.5%	1.11%	1.44%
Dec. 17	5.75%	8.62%	0.47%	1.08%	8.3%	0.00%	2.22%	1.34%	0.55%	1.56%	3.33%	2.02%
Jan. 18	0.00%	0.86%	3.95%	1.81%	0.0%	0.00%	0.00%	0.00%	5.49%	0.00%	0.00%	1.90%
Feb. 18	0.00%	2.59%	2.33%	3.61%	0.0%	0.00%	0.00%	1.34%	6.04%	0.00%	0.00%	2.08%
Mar. 18	3.45%	0.86%	2.09%	2.53%	0.0%	0.00%	1.48%	0.00%	5.49%	1.56%	2.22%	2.02%
Apr. 18	0.00%	0.00%	1.40%	2.53%	0.0%	0.00%	1.48%	2.01%	3.30%	0.00%	1.11%	1.44%
May '18	3.45%	1.72%	3.02%	3.61%	0.0%	1.39%	3.70%	2.68%	2.20%	3.13%	1.11%	2.65%
Jun. 18	5.75%	6.03%	4.19%	4.69%	3.3%	4.86%	5.93%	6.04%	5.49%	4.69%	4.44%	4.96%
Jul.18	6.90%	11.21%	5.35%	6.50%	3.3%	6.25%	8.15%	9.40%	7.14%	4.69%	6.67%	6.81%
Aug. 18	11.49%	12.93%	6.98%	7.22%	16.7%	9.72%	9.63%	13.42%	9.34%	6.25%	6.67%	9.17%
Sept. 18	9.20%	9.48%	3.49%	3.97%	1.7%	9.03%	7.41%	10.74%	4.95%	7.81%	7.78%	6.11%
Oct. 18	4.60%	5.17%	0.70%	1.08%	1.7%	6.94%	5.93%	2.68%	2.75%	17.19%	16.67%	4.04%
Nov. 18	3.45%	3.45%	0.47%	0.72%	1.7%	4.86%	4.44%	1.34%	2.20%	3.13%	3.33%	2.08%
Dec. 18	2.30%	1.72%	0.93%	1.08%	3.3%	3.47%	7.41%	2.01%	1.65%	3.13%	1.11%	2.13%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

These index methods for assessing ostracods diversity and richness were previously employed by Idowu *et al* (2018).

Statistical analyses

Analysis of Variance (ANOVA) was used to determine if there was statistical difference in the parameters across the stations at $p < 0.05$ using Statistical Package for Social Sciences (SPSS). The standard deviation of the monthly averages of all data collected was calculated using Excel Statistical Tool-Pac.

RESULTS

Monthly Ostracod composition and abundance in Jabi Lake

Table 1 shows the specie composition and abundance of ostracods found and collected between January 2017 and December 2018. A total of 1,734 ostracods belonging to three families and 11 species *were encountered during the study. Out of the 11 species encountered, 7 species (Heterocypris salina, Heterocypris incongruens, Koencypris ornate, Trajancypris*

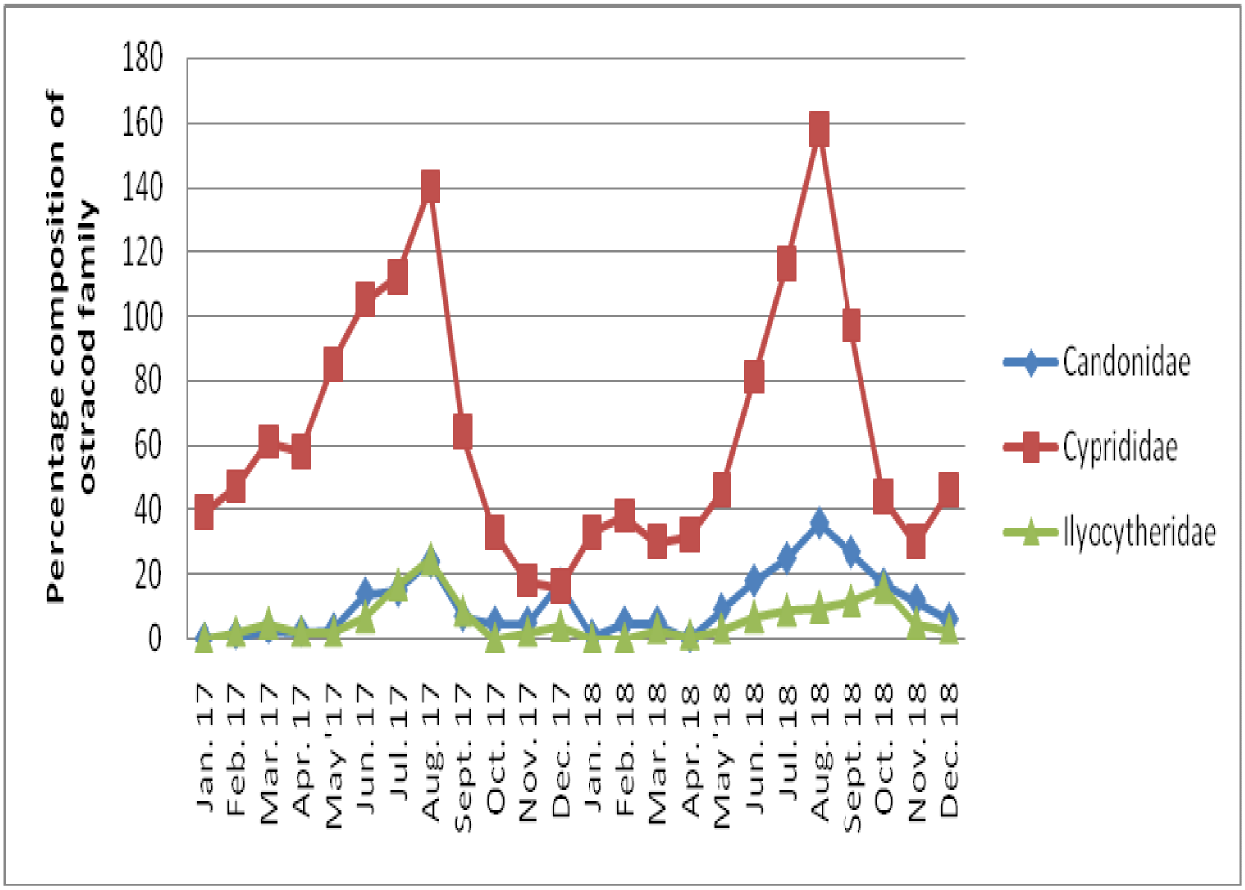

Figure 2: Monthly Ostracod family composition and abundance in Jabi Lake.

sp., Heterocypris intermedia, Herpetocypris chevreuxi and Potamocypris villosa) belong to the family Cypricidae while 2 species (*Candona candida and Candona negleta*) belong to the family Candonidae. The other 2 species (*Ilyocypris bradyi and Ilyocypris gibba*) belong to the family Ilyocytheridae.

In terms of individual species abundance, *Heterocypris salina* which was 24.8% of the total individual ostracods collected, was the most abundant of the 11 species, followed by *Heterocypris incongruens* which was 16% of the total ostracod organisms collected. The least abundant specie was *Koencypris ornate* which was 3.5% of total ostracod organisms collected, followed by *Ilyocypris bradyi* which was3.7% of the total organisms collected during the study.

In all, the highest number of ostracods by month (10.9%) was obtained in August 2017 while the least number of ostracods (1.44%) was recorded in November 2017 and April 2018 respectively.

With the exception of *H. salina and H. incongruens* which were collected in very high number from the month of January to April in both years, other ostracod species recorded low occurrence from January to May, followed by a sharp increase in the occurrence of most of the specie from the month of July to September in both years. Few ostracods were collected from November 2017 to the month of February 2018.

Monthly Ostracod family composition and abundance in Jabi Lake

Figure 2 shows the ostracods family composition and abundance during the study. Out of the three ostracods families encountered during the study, family Cyprididae recorded the highest number of individuals collected (79%), followed by Candonidae (13%).

The family Ilyocytheridae recorded the least number of individual ostracods collected (8%) during the study. Ostracods belonging to the family Candonidae and Ilocytheridae were absent in the month of January 2017 while family Cyprididae recorded 2.55% individual ostracods. Family Ilyocytheridae was not found in January and February 2018 while family Candonidae was absent in April 2018.

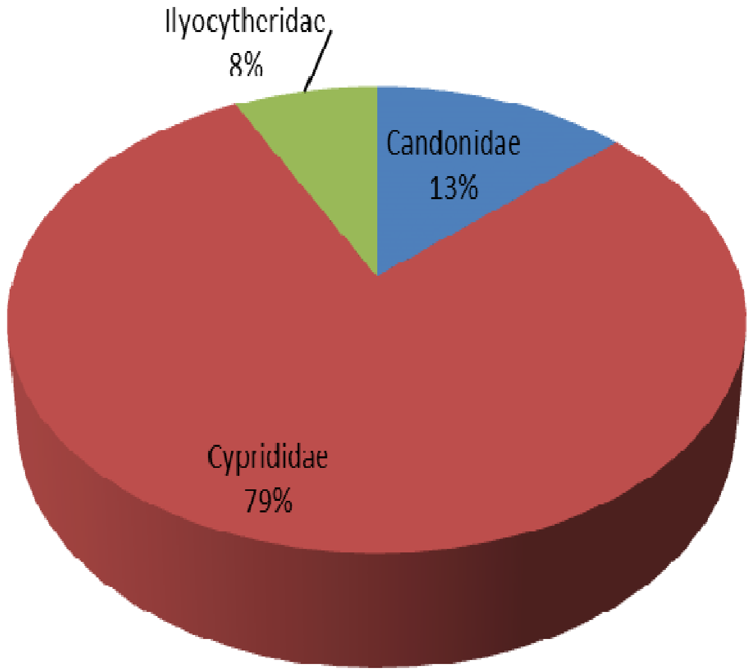

Figure 3: Ostracod families' percentage composition and abundance in Jabi Lake.

However, the family Cyprididae was found throughout the 24 months in good numbers during the study. The three families showed a sharp increase in the number of individual ostracods collected between the months of July and September in both years.

Ostracod families percentage composition and abundance in Jabi Lake

Figure 3 presents the percentage composition and abundance of the three ostracod families encountered in Jabi Lake during the study. It shows that the family Cyprididae (79%) was the largest and most abundant ostracod family found across the 5 stations in the lake, followed by the family Candonidae (13%). The smallest and the least abundant ostracod family encountered during the study was family Ilyocytheridae (8%).

Ostracod species composition and abundance in Jabi Lake

Table 2 shows the percentage composition and abundance of ostracod species in Jabi Lake during the study. The table shows that *Heterocypris salina* had the highest percentage composition (24.80%) and was the most abundant specie, followed by *Heterocypris incongruens (16%). Ilyocypris bradyi* (3.7%) and *Koencypris ornate* (3.5%) had the least and second to the least percentage composition respectively. *Ilyocypris bradyi* was the least abundant species during the study.

Ostracods families/species composition and distribution across the 5 Stations in Jabi Lake

Table 3 presents the composition and abundance of ostracod families and species in each of the 5 stations sampled in Jabi Lake during the study. In Station 1, the most abundant species were *Potamocypris villosa* and *Heterocypris salina* while the abundant specie was *Candona candida*.

Heterocypris salina was also the most abundant specie in Stations 2 (29.1%) and 3 (40%) where the least abundant specie were *Koencypris ornate* and *Ilyocypris gibba* respectively. On the other hand, *Heterocypris incongruens* was the most abundant specie in Station 4, the specie with the least number of occurrences in that station was Ilyocypris bradyi. In Station 5, the most abundant specie was *Heterocypris incongruens* while the least abundant species were *Koencypris ornate* and *Ilyocypris bradyi*.

Table 3 shows that Station 5 recorded the highest number of ostracods (35.6%) followed by Station 2 (26.53%) while Station 3 showed the least number of ostracods (9.29%) during the study. It also shows that C.

Table 2: Percentage Composition and Abundance of Ostracod Species.

Family/Species	Total Number Collected	Percentage Composition per species (%)	Percentage Composition per family (%)
Candonidae	200		12
Candona candida	82	5.0	
Candona neglecta	118	6.7	
Cyprididae	1,273		79
Heterocypris salina	319	24.8	
Heterocypris incongruens	277	16.0	
Koencypris ornate	62	3.5	
Trajancypris sp.	129	8.3	
Heterocypris intermedia	135	7.8	
Herpetocyris chevreuxi	149	8.6	
Potamocypris villosa	202	10.5	
Ilyocytheridae	154		9%
Ilyocypris bradyi	64	3.7	

Table 3: Ostracods families/species composition and distribution across the 5 stations in Jabi Lake.

Family/Species/ Stations	ST 1	ST 2	ST 3	ST 4	ST 5	TOTAL
Candonidae						
Candona negleta	63.9%	48.4%	100.0%	74.1%	54.0%	59.0%
Candona candida	36.1%	51.6%	0.0%	25.9%	46.0%	41.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Cyprididae						
Heteroocypris intermedia	14.2%	10.6%	8.9%	11.5%	9.7%	10.6%
Cypridopsis chevreuxi	13.5%	11.7%	9.6%	7.2%	13.0%	11.7%
Trajancypris sp.	0.0%	7.0%	5.9%	12.9%	15.8%	10.1%
Potamocypris villosa	24.3%	15.4%	14.1%	19.4%	13.2%	15.9%
Heterocypris salina	24.3%	29.1%	40.0%	18.7%	20.1%	25.1%
Koencypris ornate	0.0%	4.5%	5.9%	9.4%	5.1%	4.9%
Hete rocypris incongruens	23.6%	21.8%	15.6%	20.9%	23.1%	21.8%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Ilyocytheridae						
Ilyocypris gibba	62.1%	55.3%	47.1%	86.7%	59.7%	60.2%
Ilyocypris bradyi	37.9%	44.7%	52.9%	13.3%	40.3%	39.8%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

candida was absent in Station 3 while *Trajancypris sp.* was not found in Station 1. Table 3 also shows that ostracods belonging to the families Candonidae and Ilyocytheridae were generally fewer in number across the 5 stations compared to the species belonging to family Cyprididae.

Ostracods diversity and abundance by Station in Jabi Lake

Table 4 shows the diversity indices of ostracod species in the 5 stations in Jabi Lake. Station 5 had the highest Margalef Index (1.789) and Menhinic Index (0.7657) respectively which indicates that Station 5 had the highest ostracod richness. It also shows that Station 3 with Margalef index (1.492) and Menhinic index (0.4425) had the least ostracod richness among the 5 stations.

The Simpson diversity index of Station 5 (0.4465) and its Shanon-Wenner index (2.368) shows similar pattern with Station 5 having the highest ostracod diversity while Station 3 with Simpson index (0.8322) and Shanon-Weinner index (2.056) respectively had the least ostracod diversity among the 5 stations sampled during the study.

DISCUSSION

The ostracod family was dominated by the Cyprididae family which was represented by seven (7) species out of the total 11 species encountered. This is in line with the fact that cypridadae are the most diverse group of freshwater ostracods (Robin *et al.,* 2011), they represent about 50% of the known species of freshwater ostracods (Martens *et al.,* 2008). Their abundance may be attributed to their drought-resistant eggs, mixed/parthenogenetic reproduction, and capacity to swim. These biological characteristics prepare them to create successful radiations in these environments (Horne and Martens, 1998). The second most encountered family was the Candonidae family which represents around 25% of all known species of freshwater ostracods and most of the genera in the family are endemic to a single zoogeographic region (Martens

Table 4: Diversity Indices of Ostracod species in the 5 Stations.

	RICHNESS INDICES		DIVERSITY INDICES		EVENNESS INDICES
	MARGALEF	MENHINICK	SIMPSON	SHANNON(H)	PIELOU (J)
STATION1	1.574	0.6167	0.8721	2.121	0.9267
STATION2	1.631	0.7093	0.8734	2.224	0.8406
STATION3	1.492	0.4425	0.8322	2.056	0.7813
STATION4	1.556	0.5129	0.8650	2.066	0.8774
STATION5	1.769	0.7857	0.8845	2.268	0.878

et al., 2008). More than 75% of the species in this family are endemic to the Palearctic realm. This fact, coupled with their being poor swimmers could explain their relative lower abundance in the lake. They are known to be pollution tolerant (Mezquita *et al.,* 1999), which maybe the reason behind their high abundance in the relatively highly perturbed station 3. The least encountered family was the Ilyocytheridae which was represented by 2 species.

Ostracods are more abundant in species richness in the southern part of the lake perhaps reflecting differences in lake morphology. The southern part is much shallower than the northern part. This could be the reason why stations 2 and 5 had more species or are richer in species than stations 1, 3 and 4. The southern part is characterized by trees close to the lake. Species preferring such environments are *Heterocypris incongruens and Candona candida.*

In the course of the study, some ostracods carapaces were found occasionally. This may indicate that some might have died and were being carried to deep sites into the lake sediment. The ability to reside in deep water may be a means to avoid predation by fish. The dominance of *Heterocypris salina and Heterocypris incongruens* in all the five stations among the ostracods species in this study confirms the dominant positions of these two species among freshwater ostracods species in arid areas (Jocque *et al.,* 2006). *Candona negleta, Heterocypris incongruens, Heterocypris salina* and *Koencypris ornate* are eurytopic taxa (Altınsaçlı *et al.,* 2014) and they have been reported in nutrient rich, eutrophic and polluted waters (Altınsaçlı and Griffith, 2002; Altınsaçlı 2004).

The diversity indices of species assessed using the Simpson and Shannon Wiener in addition to the Margalef and Menhinic indices indicated a higher ostracods species richness and diversity in station 5 with the least in station 3 In sum, in terms of species richness and diversity showed a Station 5 > Station 2 > Station 1 > Station 4 > Station 3 pattern, perhaps as a reflection of their respective levels of anthropogenic perturbation (Smith and Delorme, 2009). The Jaccard similarity shows that 30% of the species found during the study can be found in all the stations sampled indicative of a fairly even distribution of species across the sampled stations.

Conclusion

This study revealed 1734 individual ostracods made up of 11 species from 3 families. The family dominance in the lake showed a Cprididae > Candonidae > Ilyocytjeridae pattern while the species dominance pattern was Heterocypris *salina > Heterocypris incongruens > Potamocypris villosa > Herpetocyris chevreuxi > Trajancypris sp. > Heterocypris intermedia > Candona neglecta > Candona candida > Ilyocypris gibbis > Ilyocypris bradyi > Koencypris ornate*. The distribution of ostracods appears to be concentrated on the southern flank of the lake suggesting a preference for shallower depths by the species encountered where there are better nutrient cycling possibilities and hence food availability. The study indicated that the freshwater ostracods species are dominated by eurytopic taxa (ability to live in a wide variety of habitats and tolerate a wide range of environmental conditions) and some specialist species with (in general) limited geographical distributions and species which fall in between both extremes.

REFERENCES

Altınsaçlı S. (2004). Investigation on Ostracoda (Crustacea) Fauna of Some Important Wetlands of Turkey, Pakistan Journal of Biological Sciences, 7 (12):2130-2134.

Altınsaçlı S. and Griffiths, H.I. (2002). A review of the occurrence and distribution of the recent non-marine Ostracoda (Crustacea) of Turkey, Zool. in the Middle East. 27:61-76.

Altınsaçlı, S., Altınsaçlı S. and Pacal, F.P. (2014). Species composition and distribution of ostracods (Crustacea, Ostracoda) in some lakes and lagoons (Kocaeli and Sakarya, Turkey). Journal of Entomology and Zoology Studsies 2 (5): 182-192.

Ajayi, T.R., (1981). Statistical analysis of stream sediment data from the Ife-Ilesha area

of southwest Nigeria, In: A.W. Rose and H. Gundlach (Editors), Geochemical Exploration 1980. J. Geochem. Explor., 15: 539–548.

Broodbakker N.W and Danielopol D.L. (1982). The chaetotaxy of Cypridacea (Crustacea, Ostracoda) limbs: proposals for a descriptive model. Bijdr Dierkd 52: 103–120.

Butlin, R.K., I. Schon and H.I. Griffiths. (1998). Introduction to reproductive modes. In: K. Martens (Ed.), *Sex and parthenogenesis. Evolutionary ecology of reproductive modes in non-marine ostracods*. Backhuys Publishers, Leiden: 1-24.

Griffiths, H.I. and J.A. Holmes (2000). *Non-marine ostracods and Quaternary palaenvironments*. Quaternary Research Association, Technical Guide 8, London: p.188.

Hambler, C. and Canney, S.M. (2013). Conservation, 2nd edition. Cambridge University Press, UK.

Horne, D.J., Cohen, A. and Martens, K.. (2002). Taxonomy, Morphology and Biology of Quaternary and Living Ostracoda. In: J.A. Holmes & A.R. Chivas (Eds), The Ostracoda: Applications in Quaternary Research, Geophysical Monograph 131. American Geophysical Union, Washington, DC: 5-36.

Idowu, R.T., Onyemaobi, M.E. and Ali, F.A. (2018). Palaeo-Limnological Study of Ostracods in Ephemeral Ponds in North East Arid Zone, Nigeria. *Elixir Biosciences 121 (2018) 51542-51548*. Available online at *www.elixirpublishers.com (Elixir International Journal).* Department of Biological Sciences, University of Abuja, Nigeria.

Jocque, M. (2006): Faunistics of ephemeral rock pools in South eastern Botswana. Arc Hydrobiol 165: 415-43.

Karanovic, I. (2009). Four New Species of Gomphodella De Dikker, with a phylogenetic analysis and key to the Living Representatives of the Sub-family Timinaseviibae (Ostracods) crustaceans, 82: 1133-1176.

Martens, K., Schön, I., Meisch, C. and Horne, D.J. (2008). *"Global diversity of ostracods (Ostracoda, Crustacea) in freshwater"*. In Estelle V. Balian; Christian Lévêque; Hendrik Segers; Koen Martens (eds.). Freshwater Animal Diversity Assessment. Developments in Hydrobiology. *Springer*. *doi*:*10.1007/s10750-007-9245-4*. *ISBN 978-1-4020-8258-0*.

Matouke, B.B. (2019). Lead (Pb 2+) causes chlorophyll related changes and oxidative damage in Chlorella ellipsoids (Chlorophyceae. Brazilian Journal of Biological Sciences, 2019, Vol. 6, No. 14, p. 605-613. ISSN 2358-2731. https://doi.org/10.21472/bjbs.061412.

Meisch, C. K. (2000). Freshwater Ostracoda of western and central Europe. Spektrum Akademischer Verlag, Herdelberg, Berlin: 522 pp. Molecular Phylogenetics and Evolution 54:542–552.

Mezquita, F., Hernandez, R. and Rueda, J. (1999). Ecology and distribution of
ostracods in a polluted Mediterranean river. Palaeogeogr Palaeocl 148: 87–103.

Ogoko, E.C. and Sylvester, A.O. (2020). Investigation on the quality of Water from Jabi Lake in Abuja, Nigeria. *J. Chem. Soc. Nigeria*, Vol. 45*, No. 5, pp 881-889 (2020).* Department of Pure and Applied Science, National Open University of Nigeria, Abuja.

Onyedineke, N.E. (2000). A New Species of the Genus Parastenocypris (Ostracoda) from Nigeria. Department of Zoology, Edo State University, Ekpoma. Crustaceana 73 (4): 385- 391.

Onyemaobi, M. E. (2015). Ecological Studies in Ostracods in Maiduguru Metropolis. M.Sc Thesis, Department of Biological Science, University of Maiduguri.

Pearce, J.A. (1996). A User's Guide to Basalt Discrimination Diagrams. In: Wyman, D.A., Ed., Trace Element Geochemistry of Volcanic Rocks: Applications for Massive Sulphide Exploration, Geological Association of Canada, Short Course Notes, Vol. 12, 79-113.

Robin J. S., Horst J. and Ichiro O. (2011). "Recent Cyprididae and Ilyocyprididae (Crustacea: Ostracoda) from Lake Biwa, Japan, including a summary of the lake's ostracod fauna". Zootaxa. 2874: 1–37.

Smith, A. (1993). Lacustrine ostracods as hydrochemical indicators in lakes of non-central United States. *J. Paleolimnol.,* 8: 121-134.

Smith. A.J. and Delorme LD. (2009). Ostracoda In: Thorp JH, Covich AP. Ecology and classification of North American freshwater invertebrates, Academic Press, San Diego,2009, 725-771.

Thomas, D.B., Edwards, K.A., Babab, R.G. and Hoggs, I.G. (1991). Runoff erosion and conservation in a representative catchment in Morchakos district, Kenya. Pages 42-52. In Elgu, U. (ed) *Tropical Agriculture Hydrology*, John Wiley, Manchester.

Victor, R. and Fernando, C.H. (1981). Freshwater Ostracoda of the genus Chrissia Hartmann, 1957 and *Stenocypris Sars,* 1889 from Malaysia, Indonesia and the Philippines. Mitt. Hamburg zool. Mus. Inst., 78: 151-168.