MOLLUSCAN POPULATION OF AN AFRICAN ARID ZONE LAKE

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ABSTRACT

The species composition, abundance and distribution of molluscs population together with some physico-chemical variables from five different stations in the littoral region of lake Alau, Maiduguri; Borno state, were studied from October 2001 to September 2002. Three patterns of seasonal abundance were found, maximal abundance during the rainy season (July -September), moderate abundance during the harmattan season (November – February) and minimal abundance in the dry hot season (March - June). Significant differences in species composition and abundance of the molluscs were found between stations studied. The total number of organisms recorded was 3368 comprising of 1924 Bivalves and 1544 Gastropoda. 8 families were recorded which includes Bithyniidae, Hydrobiidae, Lymnaeidae, Physidae, Valvatidae, Viviparidae, Sphaeridae and Unionidae while 15 species were observed in this study. The predominant families in terms of total number collected from all stations Sphaeridae and Unionidae recording 1006 and 933 organisms with the percentage compositions of 29.86% and 27.7%. The least was from the families Lymnaciidae with total number of 116 and 3.44% as the percentage composition. The abundance of the molluscs was positively and significantly correlated at 5% confidence with temperature (r = 0.675), dissolved oxygen (r = 0.832), phosphate (r = 0.528).

Keywords: Molluscs, Littoral Region, Abundance, Unionidae

INTRODUCTION

The Phylum Mollusca inhabits permanent water bodies across a large range in Africa. Previous work includes studies by Appleton (1974, 1977) on the Mollusca composition of pond and river in South Africa, Babiker *et al.* (1985) on the snails of irrigation system in Sudan, Woolhouse and Chandiwana (1989) on River Zimbabwe snail composition, Akuforgwe *et al,* (1995) Mollusca of Jos dam, Imafidon, (1991); and Omudu and Iyough (2005) on River Benue Mollusca. These studies suggest that the population dynamics of the phylum was greatly affected by the water chemistry.

Idowu (2004) observed that shallow Lake often with a well developed littoral vegetation are often more productive than deep lakes and particularly in the tropics, they are important source for fisheries and other aquatic fauna products. The biology of molluscs has a status which allows a great deal of environmental exploitation because of its relationship with its environment such as being commercial important as source of income, nutrients for certain organism, as well its ability to exist as host of certain parasites of man (Dussart, 1977). These and certain other relationship have greatly necessitated the need for study of the organism. In this paper ecological studies of population dynamics of molluscs in Lake Alau are reported. The data include the study of some physical chemical characteristic as well as relationship between molluscs abundance and these variables.

MATERIALS AND METHODS

Lake Alau is one of the several tropical lakes in Africa, and it is the second largest lake in Borno state, Nigeria. Lake Alau was created in 1987 by damming river Ngadda about 22 km from Maiduguri, along Bama road. It is located between latitude 13^{o} N and 14^{o} N, and longitude 12^{o} E and 13^{o} E. It has a total surface area of 56 km^2 (CBDA, 1986, Bankole *et al.,* 1994). Being located in the north – east arid zone, the climate is Sahelian with three distinct seasons. The rainy season starts from June to October, the harmattan season with dry cold wind from November to February and dry hot season with extreme temperature from March to May. It has a mean depth of 9.5 m, temperance of about 0.48 m, total alkalinity of 38.4 mg/l (Idowu, 2004; Idowu *et al.,* 2004).

The study was carried out for over a 12 months period from October 2001 to September 2002. Five stations were chosen for this study based on accessibility, fishing activities, irrigation and drinking spot for animals. The description of each station is as descried in Idowu *et al*., (2004).

The stations were sampled fortnightly using 0.2 x 0.2 m scoop with a mesh size 2 x 2 mm. Fabricated serrated edge cylindrical bucket of diameter 50 cm and 30 cm height were also used in collection of samples. Each station was sampled in blocks of 10 m lengths. The samples were sorted in the Department of Biological Sciences Laboratory, University of Maiduguri into macro and micro samples using a sieve of 9 meshes per cm.

Each specimen was identified to species level using the keys of Mocas (1959), Brown (1970), Pennak (1978), Fitter and Manuel (1986). The relative abundance and dominance of each group was obtained by direct ratio comparisons using Sorenson diversity index (Margalef, 1982); Shannon (1948) Index as modified by Wilhm (1975) was used to characterize the integral richness and the eaves of distribution.

Qualitative and quantitative data on selected water quality were measured during each visit to the sites. These include water temperature, depth, dissolved oxygen, pH, water current, biochemical oxygen demand (BOD) and conductivity (Boyd, 1979; Apha, 1989). All data on the physical, chemical and biological studies were assessed for normality and homogeneity of variance. Correlation coefficient in relation to gastropod distribution was determined. Data collected for gastropod were subjected to two - way analysis of variance (ANOVA) and F - LSD

RESULTS

The mollusc population in Lake Alau comprised of 2 classes (Gastropoda and Bivalva), 8 families and 15 species (Table 1). Gastropoda had 6 families and 9 species, while Bivalva had 2 families and 6 species respectively. Sphaeridae and Unioniidae had the highest species composition. Hydrobiidae and Valvatidae had 2 species each. All other families i.e. Bithyniidae, Physidae, Vivparidae has a species each.

Most of these species were distributed in all the station except *Lampris radiates, viviparous species,* and *Bithynia tentaculata*, that were not found in stations 1 and 2. *Valvata sincera* was also absent in station 2 and 3. All other families were represented in all the stations, except Bithyniidae, Vivpariidae and Unionidae (Table 1).

The percentage composition calculated for each family shows that Sphaeridae had 29.86%, followed by Uniondae (27.7 %), Bithyniidae (10.90 %) and Physidae (9.85%) respectively. There were no significant difference ($P > 0.05$) between Sphaeridae and Unionidae. No significant difference ($P < 0.05$) was also observed between Bithyniidae and Physidae.

The distribution of molluscan population in relation to stations (Table 2) showed that station 4 had the highest number of species composition (15 species) and all the species were present in this station. The percentage composition in relation to stations showed that station 4 had 48.9% followed by station 5 with (17.5 %), with 14 species. Station 2 had 8.7% with 11 species (Table 1 and 2).

The Sorenson's index of similarity between stations showed the degree of similarity in this order, station 4 (89.96) higher than station 5 (76.66) and stations 3, 1 and 2 with 69.28, 58.50 and 52.72 similarities respectively. No significant difference ($P > 0.05$) was observed between molluscan similarities of stations.

The monthly variation in the population and abundance of Mollusca classes showed that Gastropoda were the most abundant group, and were dominant in all the months except between July and September.

Highest population abundance was observed between July and September (rainy season) which was significantly different ($P < 0.05$) from all other months. A drastic decline in total abundance of both classes was observed between February and May (dry hot season). However, there was an increase in the total numbers collected from October to January (Harmattan season). The seasonal variations showed 3 periods i.e. population increase (October to January). Maximal abundance (June to September) and population decrease (February to May). Gastropoda and Bivalva were found to exhibit the same seasonal periodicity, with marked differences in the relative abundance of species in the various months.

The physicochemical parameters of the five sampling stations are summarized on Table 3. Water temperature varied between 25.05 ± 0.4^{o} C and 27.24 ± 0.12^{o} C, the current was between 19.62 ± 0.30 cm/sec. The highest mean value for transparency was 0.42 ± 0.03 m, while 0.26 ± 0.01 m was the lowest. The dissolved oxygen varied between 5.15 ± 0.03 mg/l and 6.35 ± 0.05 mg/l.

The result of the correlation coefficient calculated between selected physicochemical characteristics and molluscs abundance showed a significant positive correlation with water temperature (0.675), dissolved oxygen (0.832). pH (0.710), current 0.528 and conductivity 0.899 (Table 4).

DISCUSSION

The seasonal variations of molluscs population may provide hints as to the extent of environment perturbation as the populations were proportionally higher in the rainy season and harmattan season. The same strong and pronounced seasonality of macroinvertebrates was observed by Dejoux *et al*, (1971) and Mbagwu (1993) in lake Chad and Tiga respectively. Also, discernable seasonal changes have been recorded in sub tropical Lake Sibaya (Hart, 1993), and Okomu forest reserve sanctuary in Nigeria Ogbeibu *et al.* (1995).

Climatic regime has long been known to explain variation in distribution pattern of aquatic invertebrates including molluscs, and thus community structure at global taxa. It was observed that mollusc fauna were higher in the rainy season especially for Gastropoda. It is likely that the rainy periods which give organisms more opportunity to colonize different habitats contribute to the abundance. The cooler and wetter environment may simply be a more suitable environment for the species

The abundance of gastropod in lake Alau may be due to the types of aquatic habitats in and around the Lake. It is also possible that Gastropoda abundance is a consequence of difference in protection and avoidance from the predators. It is unlikely that fish affect Gastropod distribution in lake Alau.

The overall composition and abundance of mollusc family and species in this study varied both spatially and temporally in response to selected physical chemical factors of the aquatic environment.

Table 1: Molluscan distribution in relation to stations in Lake Alau

Phylum	Class	Family	Species	Station				
				1	2	3	4	5
Mollusca	Gastropoda	Bithynidae	*Bithynia tentaculata*	-	-	+	+	-
		Hydrobiidae	*Potamopyrgus jenkinsi*	+	+	-	+	+
			Hyfrobiidae immatures	+	+	+	+	+
		Lymnaciidae	*Lymnae truncatula*	+	+	+	+	+
			Lymnae palustris	+	+	+	+	+
		Physidae	*Physelia species*	+	+	+	+	+
		Valvatidae	*Valvata lewisi*	+	+	+	+	+
			Valvata sincera	+	-	-	+	+
		Viviparidae	*Viviparous species*	-	-	+	+	+
	Bivala	Hydrobiidae	*Pisidium casternum*	+	+	+	+	+
		Physidae	*Pisidium nitidum*	+	+	+	+	+
		Sphaeridae	*Sphaerum nitidum*	+	+	+	+	+
		Unionidae	*Unio species*	+	+	+	+	+
			Elliptia campalanata	+	+	+	+	+
			Lampris radiate	-	-	-	+	+
Total	2	8	15	12	11	12	15	14

Key: - Absent, + Present

Table 2: The total abundance and percentage composition of Mollusca families collected in relation to station in Lake Alau

Taxa	Stations					Total Collected	Percentage composition
	1	2	3	4	5		
Bithynidae	-	-	106	260	-	366	10.90
Hydrobiidae	63	50	25	100	45	283	8.40
Lymnacidae	10	13	10	48	35	116	3.44
Physidae	46	30	22	200	34	332	3.85
Valvatidae	10	15	18	55	35	133	3.95
Viviparidae	-	-	46	88	65	199	5.9
Sphaeridae	136	168	150	390	162	1006	29.86
Unionidae	39	20	162	500	212	399	27.70
Total	304	296	539	1641	588	3368	100
% /station	**9.02**	**8.78**	**16.0**	**48.7**	**17.5**		**100**

Table 3: Physico-chemical parameters in relation to stations in lake Alau

Parameters	1	2	3	4	5
Temperature (°C)	25.25 ± 0.18^{b}	25.05 ± 0.14^{b}	27.24 ± 0.19^{b}	27.24 ± 0.12^{a}	25.13 ± 0.00^{b}
Current (cm/sec)	26.71 ± 0.30^{b}	25.46 ± 0.27^{b}	25.08 ± 0.36^{b}	25.10 ± 0.28^{b}	19.62 ± 0.22^{a}
Transparency (m)	0.36 ± 0.01^{b}	0.33 ± 0.02^{b}	0.35 ± 0.01^{b}	0.42 ± 0.03^{a}	0.26 ± 0.01^{c}
PH	6.79 ± 0.05^{b}	6.97 ± 0.02^{b}	6.83 ± 0.02^{b}	7.29 ± 0.05^{b}	6.59 ± 0.01^{b}
Dissolved oxygen (mg/l)	6.15 ± 0.05^{a}	6.35 ± 0.05^{a}	5.18 ± 0.02^{b}	6.32 ± 0.01^{a}	5.15 ± 0.03^{b}
Biochemical Oxygen Demand(mg/l)	4.34 ± 0.32^{a}	4.30 ± 0.28^{a}	4.45 ± 0.50^{q}	5.03 ± 0.33^{a}	5.31 ± 0.25^{a}
Conductivity (ohms/cm	131.45 ± 0.75^{b}	128.45 ± 0.52^{b}	119.42 ± 0.83^{a}	115.47 ± 0.75^{a}	118.47 ± 0.16^{a}

Table 4: Correlation Coefficient for selected physical and chemical parameters and mollusc abundance in lake Alau

Physical/ chemical Parameters	Correlation Coefficient "r" $P < 0.05$
Water temperature	0.675
Dissolved oxygen	0.832
Phosphate	0.648
Ph	0.710
Current	0.528
Conductivity	0.899
BOD	

The overriding influence of the temperature, current, dissolved oxygen, conductivity, biochemical oxygen demand (BOD) in distribution and abundance can explain the significant lower numbers observed in all stations between February and June. The effect of the rainy season between July and September may have increased feeding habitat and access to breeding. The various ecological requirements and also water quality parameters affected the spatial distribution and abundance. Various physical chemical factors collectively have an effect on the abundance of molluscs under condition. Okafor (1990) explained how rainfalls affect the quality of the habitat making it suitable or unsuitable for the molluscan population and abundance.

The seasonal pattern of the total mollusc abundance is consistent with the observation of Obureke (1980), Okafor (1990), Omudu and Iyough (2005). This seasonal dynamic is attributed to seasonal periodicity of the quality and quantity of edible, competition, resumption of normal metabolic activities, by those that have gone through period of adverse conditions, interaction as well as climatic changes in the natural environment. The distribution and abundance of the molluscan population in lake Alau may also be attributed to the availability of food, shelter and oviposition sites. This agrees with Whitton 1975, Omudu and Iyough (2005) that water bodies rich in organic and silt matter are known to support thriving populations of macroinvertebrates. The dominat species encountered in this study i.e. *Hydrobidae immature*, *Lymmae palustrism Physelia species.; Valvata lawisi, Pisidium casertanum, Pisidium nitidum Sphaerum nitidum, unio species* and *Eliptia campalanata* were encountered in all the station surveyed.

The correlation coefficient value between the selected physical and chemical parameters and the molluscs abundance showed significant correlation. This agrees with the findings of Imafidon (1991), Agi (1995), Okafor and Ngang (2004) that fresh water molluscan populations thrive well on environment with good high water qualities.

In conclusion, the temperature appears to be the most important factor influencing the development and distribution of molluscs in the lake Alau. Its effect may be direct in presenting optimum conditions for chemical activities for molluscan population, and indirect in distribution within the habitats. Arad *et al*. (1992, 1993), Okafor (1991), Idowu *et al.* (2005) suggested that climate and microhabitats are the main determinants of species resistance to desiccation, availability, distribution and abundance of molluscs in fresh water environment. The present study suggests that these factors may likewise play important roles in their distribution.

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