Diptera Community In The Littoral Zone Of A North East Arid Zone Lake (Lake Alau), Maiduguri, Borno State, Nigeria

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Abstract

The distribution of the Dipteran fauna of the littoral zone of Lake Alau in Maiduguri, Nigeria, were studied between January and June 2002. Dipteran samples were collected every 2 weeks from five different stations. Five groups of diptera organisms simulidae, chironomidae, centrapogo nidae, culicidae and chaoboridae were found in analyzable numbers. The diptera assemblage was dominated by chaoboridae, followed by chironomidae with the percentage compositions of 30.01% and 23.01% respectively. Ceratopogonidae has the least percentage composition of 13.66%. Significant difference in family composition were found in the lake, with chaoboridae being dominant. Climatic regime and the season appear to be the important key factors controlling the distribution of diptera in the lake.

Key words: Diptera, Littoral zone, Lake Alau

Introduction

Streams, lakes and ponds have several species of animals which are adapted to the physical factors operating on their occurrence and on their abundance (Anadu Akpan, 1986). Diptera are often a dominant component of the macroinvertebrate fauna of freshwater ecosystems and numerous studies predominantly in lentic systems have evaluated the role of abiotic and biotic interactions in structuring their communities (Waters, 1979, Huryn and Wallance, 1986, Blaustenin *et al.,* 1999).

The littoral zone of a lake is a highly complex area in which the abundance and species composition of the diptera community and that of submerged macrophyte community can vary greatly (Keast, 1984; Ward, Talbot and Steward, 1987; Cry and Downing, 1988; Hanson, 1990). Recent empirical studies indicate that the total abundance of diptera larvae, juveniles and adults is correlated with some habitat factors in the littoral zones such as macrophytes and weedbed (Rasmussen, 1988). Characteristics of Lakes such as thermal regimes, disturbances (e.g. the introduction of pesticides, irrigations) are known to have both direct and indirect effects on aquatic ecosystems (Lugthart et al, 1990). Although considerable research has focused on the ecology of macroinvertebrates, relatively little is known of the seasonal variation, species composition and tolerance of dipterans to specific environmental factors in the North east arid zone.

The aim of the present paper is to determine the species composition, distribution and density of the dipteran fauna of the littoral zone of Lake Alau in the North east arid zone of Nigeria.

Materials and Methods

Study areas: Lake Alau is one of the several tropical lakes in Africa, and it is the second largest lake in Borno-state, Nigeria. The reservoirs was created in 1987 by damming river Ngadda which takes its source from the Mandara Plateau. It is located between latitude 13^0N and 14^0N and longitude 11^0E and 13^0E. it is about 22km from Maiduguri along Maiduguri- Bama road, with a total surface area of $56km^2$. The reservoir was formed primarily for the provision of potable water for the Maiduguri metropolis as well as to irrigate over 8,000 ha of farm lands within and around the basin (CBDA, 1986).

The lake is located in the North eastern arid zone and the climate is sahelian with 2 distinct seasons. A rainy season (June to October) with mean annual rainfall of about 600mm and the dry season from November to May with March and April marking the driest period with intense heat. The dry season is proceeded by a period of hamattan with a very low temperature and cold dry hamattan wind between the months of November and February. (Bankole *et al.,* 1994).

For the purpose of this study, five sampling stations were chosen based on such factors as depth, volume of water, feasibility and the various activities taking place in and around the lake.

Station 1: Is located near the dam site, where the spill way and outlet area are situated. The reservoir at this station forms the pools of water where cars are washed, and serve as drinking spots for herds of cattles.

Station 2: Is located adjacent to the school of fisheries and is surrounded by thick vegetations consisting of both submerged and emergent macrophytes. It is one of the landing sites for fishermen. The run off from the canals from the school empties into this station.

Station 3: Is situated around the fishing village, close to the limit of reservation. The water body here is supported by a big long dyke which act as path way for farmers to cross to their farm lands. The station is located on a steep valley surrounded by gravels, large irrigation farms, and domestic activities like washing and bathing take place here.

Station 4: The biggest of all the station. It is the major fishing camp located behind Abari village. The bed widens considerably and is highly disturbed as there is a great deal of human interference like artisanal fishing, and fishermen paddling their canoe across and within the lake littering their fishing gears around the edges of the lake. There is numerous outcrops of rocks which appear within the water course sometimes forming barriers that create faster currents above the average flow rate (Bankole et al 1994).

Station 5: Is situated behind Bimari village. The only water path way that leads to Kulomari fishing camp and station 4. The littoral areas are dominated by human activities (e.g. sand diggers, artisanal canoe paddlers); as well as by burrow pits where sands have been dug out for construction purposes. The other sides consist of vegetable and cassava farms, cultivated using irrigation. The water here is fairly turbid.

Methodology: Samples were collected at 2-weekly intervals from January to June 2002. Samples were obtained from the habitats in the littoral zones of each stations i.e. Pool edges. Submerged macrophytes, submerged wood and fallen branches, soft sediments were sampled with a hand-dip net of diameter 320 x 250mm opening and 0.5mm mesh-size. The substratum was disturbed to dislodge the specimens while holding the collecting net facing the disturbed area, the samples collected were stored in labeled plastics.

Stones were moved by kicking with feet, over turned and scrubbed by rubbing with hands to collect the specimens. Fallen branches lying in water and submerged wood were removed and examined. Specimens found were collected with a pair of forceps (Chessman, 1995). Soft sediments were sampled with serrated cylindrical substrate sampler (38cm length, 15cm diameter). The sampler was worked into the mud 30cm deep before the specimens within the sampler were collected. The samples collected were kept in different labeled polythene bags.

All samples were preserved with 70% ethanol, and brought to the laboratory. Samples were washed through 0.14mm, 0.15mm, 0.16mm and 0.17mm pore sieves.

Larval forms were sorted under a wild M420 binocular microscope. All the organisms were sorted into taxonomic groups, identified to generic level by using available keys by Merritt and Cummis (1984), Filter & Manuel (1986) & Pennak (1989).

No attempt was made to separate the specimens according to habitats in this study. The data which include counts for organisms, were sorted into taxonomic groups and into stations. The geometric mean and standard error of total numbers were then determined for each collection data.

Dipteran community analysis was confined to the assessment of species abundance (density and frequency) and heterogeneity (Shannon & Weaver diversity, and Simpson's Similarity in dices) Ward (1992) using all the recorded dipteran species. One-way analysis of variance (ANOVA) was used to test for significant difference in species diversity and similarity among the stations. Percentage composition of dipteran was also calculated for every family in relation to months.

Differences amongst mean densities and number of families for the five sampling stations and for the months were analysed using the single factor ANOVA to test for significant differences in Diptera community. All effects in these statistical tests were considered significant if the $P<0.05$.

Results

A total of 5 families were identified from the samples. These are the simulidae, chironomidae, ceratopogonidae, culicidae and chaoboridae. Out of these II species were isolated.

The II species were all found to be common to all the stations studied. The range and the percentage composition of each family observed in the present study is shown in Table 1. The most abundant diptera collected was the family chaoboridae (30.22%), followed by chironomidae (23.11%) (see Table 1).

Table 2 shows the monthly mean (+SE) density and percentage compositions of each group studied within six months. It shows variations in species composition from January to June 2002. For example, the most abundant group in January was the family Simulidae, which had the mean value of 45 ± 0.06, followed by chaoboridae (32 ± 0.05); in February, chaoboridae was the most abundant family (49 ± 0.05), followed by the family simulidae (48 ± 0.05).

Table 1: Percentage composition and range (Nos.) of all Dipteran groups in the study station

Dipteran group family	*Range (Nos.)*	*Percentage composition %*
Simuliidae	5.0 – 27.0	18.22
Chironomidae	8 0 – 96.0	23.01
Ceratopogonidae	3.0 – 40.0	13.66
Culicidae	13.0 – 38.0	15.10
Chaoboridae	3.0 – 192.0	30.01
Total range	**3.0 – 192.0**	**100%**

The dipteran abundance increased in January and February consistently. However, all the diptera groups decreased steadily in abundance from March and April, i.e. in the hot dry months except the chaoboridae, which continued to increase from January to June. In May, there is also a slight increase in the abundance of dipteras groups compared with what were recorded in March and April, and this increase were continued up till June, (see Table 2). Some consistent seasonal patterns were observed in the study period. There were substantial reduction of diptera abundance in March and April, with the family ceratopogonidae and culicidae having the least mean values 14 ± 0.06 (SE) and 16 ± 2.0 in March and 16 ± 0.06 and 14 ± 0.08 in April respectively. However a gradual increase from May to June was observed for all dipteran groups.

The most abundant species encountered were *Chaoboridae anomalis, Mochlonyx . sp (Chapoboridae); Chironomus sp, Cryptochironomus sp* and *Tanytarsus balleaton (Chironomidae).* Table 3 shows the distribution and abundance of dipteran groups and their total density (number) in various stations.

From the total dipteran density sampled in all stations, it was found that they were more abundant in station 4 than all other stations studied, and that their abundance in station 4 was significantly different ($P < 0.05$) when compared to abundance in other stations. The Duncan multiple range test (DMRT) computed for the differences among families shows that the family Chaoboridae was significantly higher $P<0.05$ than all other families.

The result obtained from Shannon, Weaver's index calculated for differences among the species shows that *Chaoborus anomalus* was the dominant species with the value (1.05), this was followed by *Molonyx sp* with the value of 0.72., the next dominant to this was *Chironomus sp* with 0.52. The least dominant among the species studied was *Hydrobaenus pilipes.* Based on Shannon – Wever's Index (H) and Simpson, Similarity index, station 4 was significantly different ($P<0.05$) from all other stations. However, the difference in species diversity stations 1, 2 and 3 and similarities among stations 1, 2, and 3 was not significant ($P>0.05$) but were significantly different from station 5.

Discussion

Distribution of diptera assemblages in Lake Alau may be clearly related to some dominant environmental factors. Increase in abundance of dipteran groups in January and February coincide with the cold period and the flooding period that occurred in the lake. The prevailing cold hamattan wind could lower evaporation rates, coupled with the availability of enough water obtained in the littoral region which may support a complexity of

Table 2: Monthly mean (+SE), and percentage composition of dipteran family in Lake Alau

Date	*Dipteran Group (family)*	*Mean + SE*	*Percentage composition (%)*
January 2002	Simuliidae	45 ± 0.06	25.71
	Chironomidae	42 ± 0.50	24.0
	Ceratopogonidae	32 ± 0.40	18.28
	Culicidae	24 ± 0.80	13.71
	Chaoboridae	32 ± 0.50	18.28
February 2002	Simuliidae	48 ± 0.50	27.43
	Chironomidae	36 ± 1.01	20.57
	Ceratopogonidae	22 ± 0.60	12.57
	Culicidae	20 ± 0.92	11.43
	Chaoboridae	49 ± 0.50	28.00
March 2002	Simuliidae	21 ± 0.21	15.44
	Chironomidae	23 ± 0.62	16.91
	Ceratopogonidae	16 ± 0.41	11.76
	Culicidae	18 ± 0.32	13.23
	Chaoboridae	58 ± 3.0	42.65
April 2002	Simuliidae	22 ± 0.70	16.29
	Chironomidae	23 ± 0.01	17.03
	Ceratopogonidae	14 ± 0.60	10.37
	Culicidae	16 ± 2.0	11.85
	Chaoboridae	68 ± 2.5	44.44
May 2002	Simuliidae	24 ± 0.90	16.90
	Chironomidae	26 ± 0.20	18.30
	Ceratopogonidae	16 ± 0.40	11.26
	Culicidae	14 ± 0.80	9.86
	Chaoboridae	62 ± 0.2	43.66
June 2002	Simuliidae	37 ± 2.20	18.97
	Chironomidae	35 ± 0.10	17.90
	Ceratopogonidae	28 ± 0.01	14.35
	Culicidae	26 ± 0.50	13.33
	Chaoboridae	69 ± 0.70	35.38

biotic interactions. Richards (1984) observed that the presence of water in the littoral area of any lake or aquatic medium may have considerable effects on the faunistic structure and composition, because such habitats or medium will contain high quality food that can support large numbers of macroinvertebrates such as simulidae, chironomidae and ceratopogonidae. The increase in the mean numbers of these families during the period of this study supports his findings. It also shows that the effect of temperature recorded in Ward (1992) holds in these stations.

The distribution of diptera varies among stations with highest density in

Table 3: The total density (No of individual / 0.25m^2), distribution and diversity index of diptera groups in the study stations

	STATION					
Taxa	**1**	**2**	**3**	**4**	**5**	**Shannon's Index (H) per species**
Family: Simuliidae						
Hydrobaenus piipes	31	17	23	39	09	0.29
Paratendipes sp.	27	09	14	28	05	0.21
Family Chironomidae						
Chironomous sp.	30	24	44	96	18	0.52
lanytarsus balleatus	24	19	32	44	14	0.33
Cryptochironomus sp.	17	17	14	30	08	0.22
Family Ceratopogonidae						
Bezzia sp.	25	40	25	36	03	0.32
Probezzia sp	18	22	24	42	04	0.27
Family Culicidae						
Culex pipiens	21	30	19	34	18	0.30
Anopheles sp.	20	25	22	38	13	0.29
Family Chaoboridae						
Chaoborus anomalus	75	65	62	192	30	1.05
Molonyx sp	60	40	48	118	24	0.72
Total	**348**	**308**	**324**	**697**	**146**	
Shannon – Weiner's Index (H)	0.86	0.76	0.80	1.73	0.36	
Simpsons Index	0.529	0.507	0.516	0.762	0.262	

station 4. Various activities take place in station 4 such as, the presence of major fish market. The dead fish and the scales of fish also litter around the littoral zones of this lake. In addition, the decomposition of accumulated organic detritus as well as the presence of aquatic macrophyte could favour an abundant dipteran population when compared to other stations.

The abundance of chaoboridae in the hot dry months of March and April could be an indication that they are well adapted to the hot environment, and also of their ability to produce large number of eggs which can hatch out within a short period. The hot period may also increase the rate of the hatchability of these eggs. It is known that chaoboridiae larvae can survive for a considerable period in heat caused by high climatic regimes. They can also survive in low water levels and deoxygenated conditions (Ogbogu & Akuya, 2001). Aridity which Limits the amount of food available thus encouraging competition may have some effects on species abundance in this Lake. The influence of other factors like predation cannot be ruled out. Amphibians may be acting as predators in these stations. Numerous studies have shown that there are movements of fishes from channels to the littoral region to forage (Collier et al 1999, Rooke 1986, 1993). Thus reducing the Population of the dipterans as serving also as predators.

The abundance of diptera taxa in Lake Alau is low when compared with studies by Mbagwu (1989) who reported 7 taxa comprising of 20 species from Tiga Lake in Kano State. This may be due to the larger and more diverse littoral zone in that Lake, encouraging high faunal diversity.

The study of the dipteran community in Lake Alau has thrown more light on its distribution and the species composition. From the findings, the following conclusions can be made: (1) the dipterans are most abundant in the early rainy season, intermediate in the hamattan (January, February) and lowest in the dry hot season (March and April). (2) The Lake Alau contains species which belong to the dipteran groups. (3) The lake's characteristics such as thermal regimes may be affecting the densities of the dipteran groups.

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