

Original Article

MONITORING SEASONAL CHANGES IN ENVIRONMENTAL VARIABLES AND CHIRONOMID DIVERSITY AT SHIRORO LAKE, NIGER STATE, NIGERIA

Auta. Y. I*., Arimoro. F. O., Mohammed, A. Z., and Ayanwale, A. V.

Applied Hydrobiology Unit, Department of Biological Sciences, Federal University of Technology, Minna, Niger State, Nigeria.

Submitted: February, 2016; Accepted: April, 2016; Published: June, 2016.

ABSTRACT

Freshwater chironomids are considered to be ideal bioassay organisms since they spend most of their larval stages in surface sediments. This study was carried out with the aim of identifying taxa assemblages and analyzing their response to water quality parameters in Shiroro Lake. Chironomid larvae samples were collected in three stations along tributary of Shiroro Lake using the kick sampling technique over a six-month period (August, 2013 to January, 2014). A total of 14 Chironomid species comprising 480 individuals were collected with richness at individual station ranging from 3 to 10 taxa. Two Chironomid taxa; *Chironomus* (a) spp and *Dicrotendipes* spp were preponderant and present in all the three stations. The most abundant taxon was *Chironomus* (a) spp with relative abundance of (56%) followed by *Polypedilum* spp (10%) and *Ablabesmyia* spp (8%). Taxa richness calculated as *Margalef* index did not show any significant difference ($p > 0.05$) among the sampling stations. Similarly, diversity indices (*Shannon-Wiener*, *Simpson dominance indices*) did not detect any significant difference between the stations examined. Lower values of diversity and evenness indices were recorded at station 3. Water quality parameters showed that Sodium (0.001-0.58mg/g) and Potassium (2.9-3.51 mg/g) levels in the water were considerably high as a result of anthropogenic activities in the catchment. Other parameters such as Dissolved Oxygen (2.1-5.6 mg/l), Biochemical Oxygen Demand (1.0-9.6mg/l), Conductivity (25-135 μ S/cm), pH (6.4-8.11) and Transparency (92-188cm) indicate that the water body is increasingly polluted. Canonical Correspondence analysis (CCA) was adopted for the analysis of environment and biota data indicated that *Chironomus* sp., *Polypedilum* sp., *Clinotanypus* sp., *Ablabesmyia* sp. and *Dicrotendipes* sp.

showed a positive relationship with most of the environmental variables. Since chironomid larvae are tolerant to poor water quality conditions, they should be considered as indicators of pollution in Shiroro Lake, Niger State.

Key words: Environmental variables, *Chironomid* Larvae, Abundance.

*Corresponding Author: auta.iliya@futminna.edu.ng

INTRODUCTION

The Chironomidae, Family of Diptera, commonly called the non-biting midges, are seen in several aquatic systems, and often are the dominant group of the benthic invertebrates' fauna of streams, both in numerical abundance and in species richness (Coffman and Ferrington, 1984). Recently, efforts to identify the effects of exposures of Chironomids to toxic sediment have been focused on deformities in benthic Chironomids living in contaminated sediments. In lentic and lotic environments, the analysis of benthic animals, particularly Chironomidae has played an assertive role (Saether, 1979). However, the use of communities of Chironomidae in terming and monitoring lotic ecosystems still lacks deducing power due to lack of knowledge on their ecological roles and their species distribution (De Bisthoven & Gerhardt, 2003).

Freshwater Chironomids are thought to be perfect bioassay organisms since they pass most of their larval stages in surface sediment, their relatively sedimentary falsifying behaviour ensures that their home ranges are localized areas and have an abundant distribution (Arimoro, 2011). Chironomids are a useful collection for describing abundance-distribution relationship due to their ecological importance to applied facets. Besides indicative of pollution in aquatic environment, Chironomids also present a sort of life history that differs evidently, for example, in life-span, locomotion, habits and physiological tolerance to oxygen deficit (Pinder, 1986) This Chironomid population structure is an index of environmental quality (Bird et al., 1995). The aim of this research is to monitor seasonal changes in environmental variables in relation to chironomid diversity and abundance at Shiroro Lake, Niger state, Nigeria to add to the gradual growing pool of data on their use as water quality indicators.

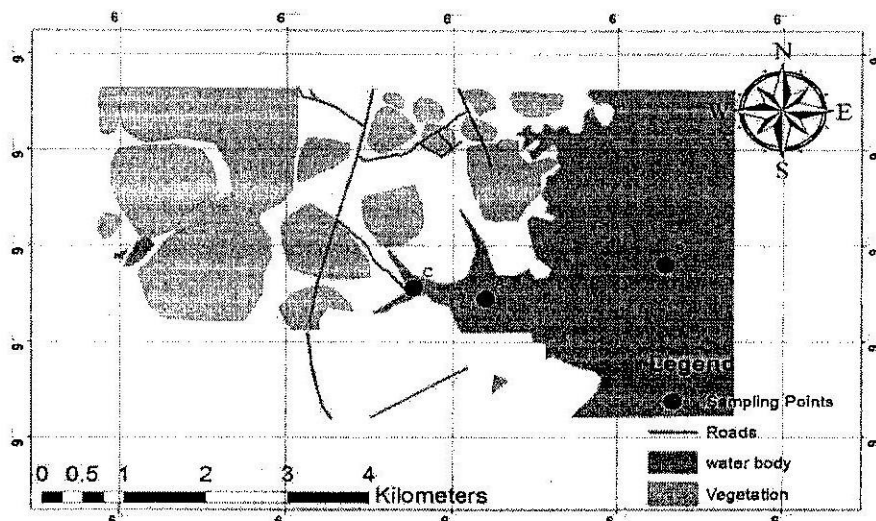


Fig 1: Shiroro Lake Showing Sampling Stations.
Source: Geography Department, Federal University of Technology, Minna.

MATERIALS AND METHODS

The Study Area

Shiroro Dam is located on latitude $9^{\circ} 58' 25''$ North and Longitude $6^{\circ} 50' 6''$ East and situated 550 meters downstream of the confluence of Kaduna River and its tributaries. There are about 15 tributaries within the Shiroro watershed, the major among them being Rivers Dinya, Sarkin Pawa, Guni, Erina, and Munyi. The tributaries flow in the North South direction and few in the North-west to Southeast direction. The storage areas do not sustain the River during extended dry season. This explains the seasonality characteristics of these rivers, since they depend on rainfall. It is obvious therefore, that the volume of the rivers swell in volume with ranging torrent while in the dry season they dwindle to dry up (Kolo and Oladimeji, 2004).

The inhabitants of Shiroro community, residing along the River floodplains depend on the Kaduna River as a source of irrigation and for their household use

and for drinking. Fishing activities is a daily affair in the lake. Another activity noticed at the lake is the weekly market that contribute to the pollution of the lake with a lot of waste materials and the grazing activity of Nomadic herdsman around the shoreline of the lake was a prominent feature throughout the period of this study.

Water Quality Parameters Analyses
Water quality analysis was carried out Monthly between August, 2013 and January, 2014. At each sampling site, the following physical and chemical parameters were measured: dissolved oxygen (DO), conductivity, turbidity, temperature, pH, BOD, Potassium and Sodium. Water samples used for the analysis of chemical variables, except for five days biochemical oxygen demand (BOD₅), were collected in 250 ml plastic bottles; water samples for BOD₅ were

collected in sterilized 500 ml glass bottles. Prior to each field trip, the sampling bottles were acid-washed according to the Institute for Water Research Glassware Acid Wash Protocol (Dickman and Rygiel, 1996). In addition, bottles used for the collection of water samples for BOD₅ were sterilized in an autoclave set to 120°C and heated for 15 minutes. Water samples were collected facing upstream of the river as recommended in APHA (1992) and the bottles for DO were filled to the neck allowing no head space and Winkler solutions A and B was added using pipette to avoid trapping air bubbles. This was transported to the laboratory in an ice-filled cooler box. Samples were preserved at 4°C in the laboratory for chemical analysis. All chemical analyses were performed within 24 hours of sample collection.

The estimation of sodium and potassium was based on the emission spectroscopy, which deals with the excitation of electrons from ground state to higher energy state and coming back to its original state with release of energy in the form of light (Kruis, 2005).

Chironomid Sampling

Chironomids samples were collected between August, 2013 and October, 2013 (Rainy season) and November, 2013 to January, 2014 (dry season) in accordance with Dickson and Graham (2002) protocol for the South African scoring system (SASS) version, 5. The protocol requires the collection of Chironomids from three biotopes, the stone biotope (stone in and out of current), the vegetation biotope (marginal and aquatic vegetation) and the gravel, sand and mud (GSM) biotopes. Chironomids collection was done using a D-frame net of mesh size $110 \mu\text{m}$ and a Surber sampler. The

Surber sampler was dragged inside the water for at least 20 meters at each station and the contents were discharge on a tray with a white background using clean water to reduce decay organic matter. Chironomid larvae were sorted out using forceps and sampling tubes containing 70% ethanol. A total of nine replicates (three per biotope) were collected and pooled. Collected Chironomid larvae were preserved in 70% ethanol and transported to the Biological Sciences Laboratory of Federal University of Technology, Minna for further analysis.

Screening, sorting and identification of Chironomid Larvae

In the laboratory, preserved chironomid samples were gently spread on a white tray and all Chironomid larvae sorted, under a hand-held magnifying glass, using fine forceps. Sorted chironomid larvae were preserved in specimen vials containing 70% ethanol. The chironomid larvae were mounted for taxonomic identification using mouth parts and other structures according to the keys described by Wiederhilm (1983) and Cranston (1996).

Data Analysis

Canonical correspondence Analysis, (CCA) was used to demonstrate relationship between chironomid larvae and physical variables in water using PAST statistical package (Dickman & Rygiel, 1996). Taxa richness (Margalef indices), diversity (Shannon and Simpson dominance indices) and evenness indices were calculated using the computer BASIC programme sp DIVERS (Ludwig and Reynolds, 1988).

RESULTS AND DISCUSSION

The summary of physicochemical parameters obtained for the three sampling stations of the lake is shown in Table 1. Dissolved oxygen (DO), Biochemical oxygen demand (BOD), air temperature, transparency, conductivity, and sodium showed higher significant differences ($p < 0.05$) among the months sampled. Also, pH and potassium were significantly higher ($p < 0.05$) with moderate variation among the stations.

Canonical correspondence Analysis (CCA) was used to demonstrate relationship between chironomid larvae and physical variables in the surface water and the result is presented in Figure 2. It is well established that multivariate analysis methods such as CCA have the potential to explain the interaction between Chironomids community and Environmental stressors (Mausavi *et al.*, 2004; Marziali *et al.*, 2010). In the present study, the CCA facilitated identification of the influence of various environmental variables on the distribution of Chironomid larvae in the Shiroro Lake. *Chironomus* sp., *Polypedilum* sp., *Clinotanypus* sp., *Ablabesmyia* sp. and *Dicrotendipes* sp., showed positive relationship with most of the environmental variables. These species were considered as tolerant species because they have the ability to survive in extreme environmental conditions with low amount of dissolved oxygen and high concentration of pollutants. The finding of Mausavi *et al.*, (2004) that *Chironomus* sp. and *Polypedilum* sp. were very tolerant to pollutants further supported this categorization. As displayed in the CCA output, the Tanypodinae, *Micropelopia* sp

and other species favoured habitats with higher level of DO content, Na, pH and water temperature during the wet seasons, but could not survive at low dissolved oxygen concentration. *Tanytarsus* species preferred environmental conditions with relatively moderate to high water temperature, DO and pH.

There were fourteen (14) Chironomid taxa at the three stations with richness at individual station ranging from 3 to 10 taxa. Two Chironomid taxa, *Chironomus* sp. and *Dicrotendipes* sp. were found in all the three stations (Table 2). Some sensitive Chironomid species, *Polypedilum*, *Clinotanypus* were found in stations 1 and 2, while tolerant species *Cladotanytarsus* sp was restricted to station 1 only. *Chironomus* sp (a) was the major taxa with a relative abundance of 54 (56%) followed by *Polypedilum* sp. 9 individuals (10%) and *Ablabesmyia* sp. 7 individuals (8%).