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A SURVEY OF PHYSICO-CHEMICAL CHARACTERISTICS AND MACROINVERTEBRATE COMMUNITIES OF THREE CONTRASTING STREAMS IN DADIN KOWA, GOMBE STATE, NIGERIA

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Abstract

A survey of physico-chemical characteristics and macroinvertebrate communities in three contrasting streams in Dadin Kowa was carried out between March and June 2016. Physico-chemical parameters (i.e. temperature, pH, conductivity, turbidity, depth and width) and macorinvertebrates were sampled forthnightly. It was observed that physico-chemical characteristics of the three streams did not differ much except for conductivity which was highest in stream B and lowest in stream A. Record showed five major taxa (Odonata, Coleoptera, Hemiptera, Mollusca and the amorphous species) in the 3 streams. The macroinvertebrate community composition observed were; Gomphidae 52.38% , Dyticidae 28.57%, Notonectidae 9.52%, *Melanoides tuberculatus* 7.14% and Amorphous species 2.38%**.** Results obtained reveals that macroinvertebrate community composition differed between agricutural and urban streams. Land use activities taking place in the area might have influenced these changes. There is the need to regulate the use of agrochemicals and methods of effluents discharge into aquatic system.

Keywords: Physico-chemical, macroinvertebrates, streams, land-use, Dadinkowa

Introduction

Water is one of the most important and abundant solvent of the ecosystem. All living organisms on earth need water for their survival and growth. Humans are at the head of the demand chains with regards to level of dependence on a daily basis. In spheres of life humans have come to depend on water, be it portable, underground, surface etc; this is evident in for example industrial water supply, irrigation, drinking, propagation of fish and other aquatic organisms and generation of hydro-electiric power (Shrivastava and Kanungo, 2013).

Population is one of the challenges of water management. Increase in human population, industrialization, use of fertilizers in agriculture and human activities has led to high level of pollution in aquatic environments (Basavaraja *et al.,* 2011).

The availability of good quality water is an indispensable feature for preventing diseases and improving quality of life. Natural water contains different types of impurities which are introduced in to aquatic system in different ways, such as weathering of rocks, leaching of soils, dissolution of aerosol particles from the atmosphere and from several human activities, including mining and the use of metal based materials (Adeyeye, 1994).

The increased use of metal-based fertilizer in agricultural revolution of the government could result in continued rise in concentration of metal pollutants in fresh water reservoir due to the water run-off. Also faecal pollution of drinking water causes water born disease which has led to the death of millions of people (Adefemi and Awokunmi, 2010).

Chemicals are a major source of water contamination that are introduced during water movement through geological materials (Kataria *et al.,* 2011). Fertilizers and pesticides are major contributors to water pollution Harding *et al*., (1997). Weathering of rocks, leaching of soils and mining contaminate natural water (Manjare *et al.,* 2010). In the ecosystem water is considered to be the most important component for life but day by day the quality of water become degraded. Therefore, it is necessary that the quality of water be checked at regular interval to reduce the financial losses due to water born diseases and other related hazards.

In most urban-rural communities in the developing countries especially the Sub-Saharan Africa, surface waters (rivers, streams, and lakes among others) have been the most available sources of water used for domestic purposes. The water from these sources are contaminated with domestic, agricultural, and industrial wastes and likely to cause water related diseases (Ojekunle, 2000; Ayeni *et al.,* 2009).

The water quality of rivers, streams and lakes changes with the seasons and this has profound influence on the population density of aquatic plants and animals (Lawson, 2011; Adeyemo *et al.,* 2008 and Newton *et al.*, 2017). Anthropogenic activities (e.g. bush burning and deforestation) natural processes (e.g. erosion, weathering, geochemical and geological characteristics of the environment) as well as the increase in human population have kept changes in natural water bodies persistant (Arain *et al.,* 2008; Adefemi and Awokunmi, 2010; Nduka, 2008; Bellingham, 2012).

Important physical and chemical parameters that affect the natural water quality are temperature, pH, Turbidity, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), alkalinity, nutrients (Nitrate-N, Phosphate-P), etc. (Lawson, 2011; Nduka *et al.,* 2008). These parameters are limiting factors for the survival of aquatic organisms (flora and fauna) (Lawson, 2011 and Umar *et al.*, 2017).

The aim of this study is to evaluate the cumulative impact of land use intensification on physico-chemical characteristics and benthic invertebrate community composition of some streams in Dadin kowa.

Methods

Study sites

The research was carried out in Dadinkowa Yemaltu/Deba local Government area of Gombe State, Nigeria. The area lies along Latitude 10° 18'N and Longitude11° 32'E and study sites are located near the Dadinkowa Dam. The study site is about 38 km from Gombe metropolis. Dadinkowa Dam was constructed in 1981 and was commissioned in 1988 (Fig. 1).

Figure 1: Map of Gombe State showing the study area (Dadin Kowa = ↑)

Sampling methods and regimes

Each stream was sampled for a range of physical and chemical parameters, fine particulate organic matter (FPOM), coarse particulate organic matter (CPOM), algae and benthic invertebrates. At each site a representative reach at least 10 m long and containing a riffle/run/pool sequence was selected. Physico-chemical factors measured on site were temperature, pH, specific conductivity at 25ºC (using a portable 4-star Orion pH/conductivity meter), and dissolved oxygen (using a WTW oxygen meter). The algae and benthic invertebrates collected on one site (representative reach), 10-50m length per stream or catchments studied were used following Hardings *et al.,* (1997) and Hynes (1974). During every sampling ocassion, physico-chemical and biological characteristics were measured in the field. Samples collected were carefully preserved in 70% ethanol and 4% formalin and transported to the Gombe State University laboratory for sorting and identification to the lowest possible taxonomic level, using binocular microscope and taxa keys e.g. Winterbourn *et al.,* (1997).

Results

Physico-chemical parameters

The results of physico-chemical parameters of water in streams A, B and C were analyzed. Water temperature ranged between 33.5 ºC - 38.5ºC with the mean values of 37.5º C in the three streams. Stream A (Yelwa) had the highest mean temperature of 38.4ºC while stream B had the lowest temperature of 33.5ºC (Table 1). The highest transparency was encontered in stream B with 1.0 m and the least transparency level was in stream A with 0.3 m respectively. In terms of width and depth, stream B had 8.5m depth and 9.4m width while stream A had the least with 2.0m depth and 3.0m width respectively (Table 1).

The hydrogen ion concentration (pH) variation indicates that all the streams (A, B and C) had varied pH values of 9.3, 8.4 and 8.8 respectively. Dissolved oxygen ranged from 6.0-7.0 (mg/L) in all the

streams. Stream A had the highest dissolved oxygen and stream C was lowest (Table 1, Fig. 2). The conductivity of the three streams ranged from 221.17 – 421. Stream B (Garin Bukar) recorded the highest with 421 while stream C (Tunga) had the lowest with 221.17µS/cm.

Table 1: Mean (±SE) Physico-chemicl characteristics of 3 streams sampled during the study

Parameter	Site A	Site B	Site C
Temperature (^{0}C)	38.4	34.0	39.0
pH	8.8	9.3	8.4
Dissolved Oxygen (mg/l)	7.7	7.0	6.6
Turbidity (NTU)	0.3	0.1	0.9
Conductivity (µS/cm)	351	421	221
Depth (m)	2.0	8.5	6.0
Width (m)	3.0	9.4	7.5

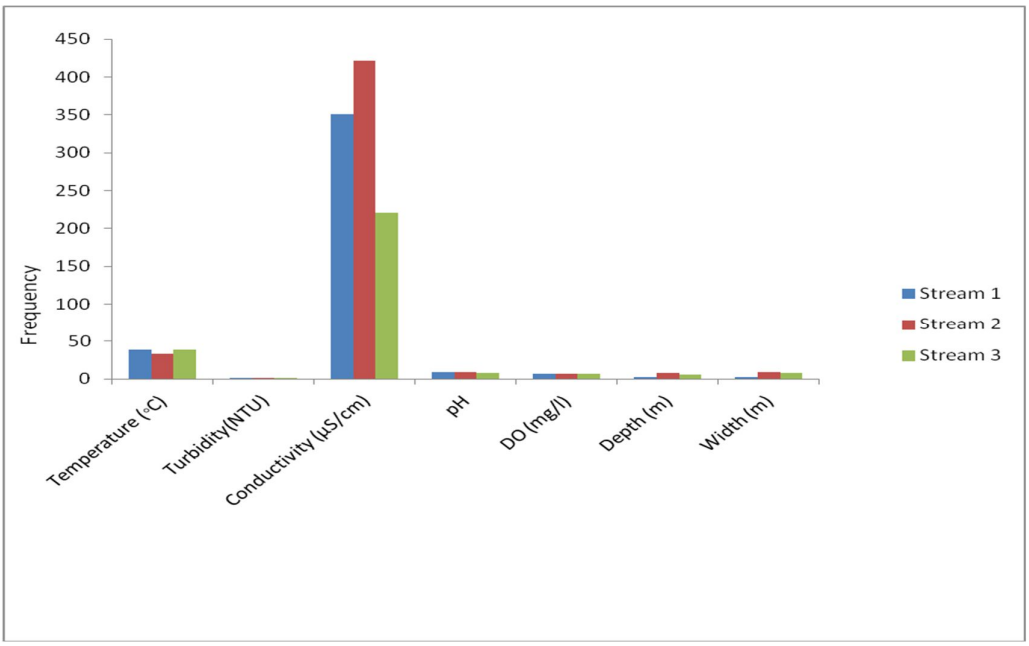

Figure 2: Physico chemical parameters sampled of 3 streams in Dadin Kowa

Macroinvertebrates

The macroinvertebrates composition, abundance and distribution at the study sites (A, B and C) are summarised (Table 2). Five taxa were identified from a total of 84 individuals collected. Stream A (Yelwa) had 54 (64.28%), stream B had 5 (5.95%) and stream C 23 (27.38%) respectively. Stream A contributed the highest (64.28%) of the total number of individual and the least number of individuals were recorded in stream B with (5.95%). The taxa Odonata had the highest occurence of species of 52.38%, followed by Coleoptera (28.57%), Hemiptera (9.52%), Mollusca (7.14%) and the amorphous species Sp. A (2.38%) respectively (Table 2). Odonata was more abundant while amorphous species (Sp.A) was least (Fig. 3).

Table 2: % Macroinvertebrates distribution in 3 study streams (A = Yelwa, B = Garin Bukar & C = Tunga).

Taxa	Stream A	Stream B	Stream C	Total (%)
Odonata				
Gomphidae	17	5	17	44 (52.38%)
Coleoptera				
Dytisdae	24	0	0	24 (28.57%)
Hemiptera				
Notonectidae	8	0	0	8 (9.52%)
Mollusca				
Melanoides	5	0	1	6 (7.15%)
Sp.A	0	0	2	2 (2.38%)
Total	**54 (64.2%)**	**5 (5.8%)**	**25 (30%)**	**84 (100%)**

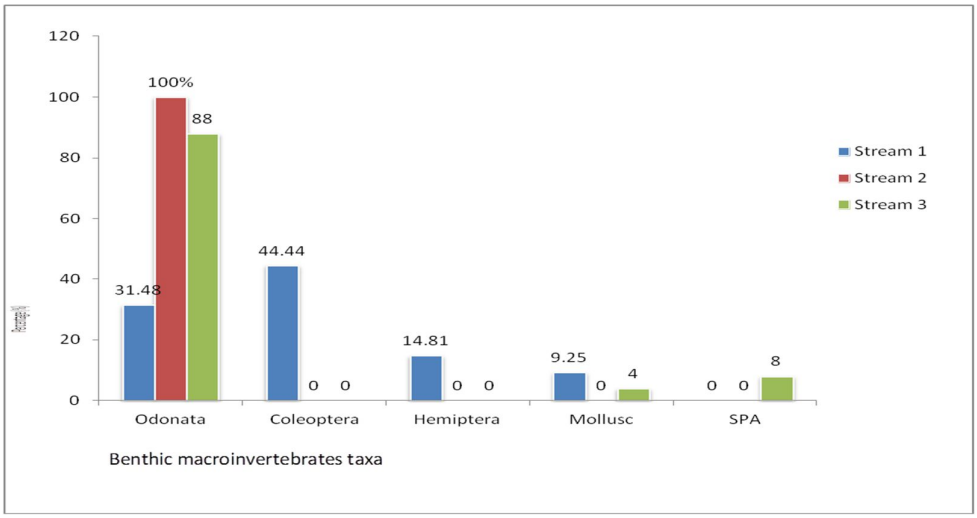

Figure 3: Disribution of macroinvertebrates of 3 streams in Dadin Kowa

Discussion

The physico-chemical parameters of the three study streams in Dadin Kowa conforms with some tropical water coditions, for example the high temperatures observed in most of the streams had similar pattern with what was reported by Adakole and Anunne (2003).

Life cycles and population densities of many streams are very much dependant on temperature and any alteration of the average stream temperature by a few degrees could alter the flora and fauna of the river (Omoigberale and Ogbeibu 2010). The near alkaline pH values recorded throughout the study period falls within the recommended range (6.5-9) as suitable for aquatic life by APHA-AWWA (1998). Similar to our findings an alkaline pH has been reported in some riverine ecosystem (Okarfor *et al.,* 2013). The alkalinity of pH during the study period may be due to the influx and decay of debris in the area as well as imbalance level of hydrogen ions input from surface run-offs during the rains. Change in pH may hold direct consequences for the health of the aquatic organisms since most of their metabolic activities are pH dependant (Okafor *et al.,* 2013). Turbidity in the water may be due to organic and inorganic constituents. During this study, the mean turbidity of 0.7m was obtained. This result is below the recommended standard value for turbidity of 5.0m (WHO, 2011). However, this result agrees with the findings of an ealier study which reported a mean turbidity value of 0.06m in some streams in Benue (Eneji *et al.,* 2012). Turbidity results may be due to anthropogenic activities such as washing, bathing, irrigation and animals such as cattle. Dissolved oxygen concentration in natural waters depends on the physical, chemical and biochemical activities in the water body. Dissolve oxygen values recorded during this study were slightly higher than the permissible limit of 5.0mg/l. This agrees with the findings of Ofombuk *et al.,* (2014) who reported highier DO of 7.0mg more than the WHO standard value in a study conducted in Uyo, Nigeria. Conductivity indicates the presence of ions in the water which is usually due to the salt intrusion and leaching. The conductivity is an indispensable water quality parameter for indicating risks associated with salinity Usman *et al.,* (2014) reported even higher values of conductivity that ranged from 327.67-492.87µS/cm in the upper Awash River, Ethopia. The community structure reveals the qualitative nature of the macro benthic fauna associated with the bottom sediment of Dadin Kowa stream. A total taxa of 5 macro benthic invertebrates comprising 84 individuals were recorded. They include Odonata (44 species), Coleoptera (24 species), Hemiptera (8 species), Mollucs (6 species) and SPA (2 species). Macrobenthic distribution is often affected by the availability of food and shelter rather than the physical and chemical parameters (Oscar *et al.,* 2015). The number of taxa recorded from this study is quite high and this is supported by the fact that tropical streams generally harbour a large number of taxa compared to temperate streams (Sharma and Samita, 2011). Futhermore, tropical rivers tend to recover rapidly; the rate of reproduction and relatively high primary production has

been suggested as factors responsible (Oscar *et al.,* 2015). Macro invertebrates are useful in indicating environmental changes in aquatic environment in relation to human and industrial activities. There was biodiversity in stream 1 and 3 because the two streams harboured varieties of invertebrates. The absence of macro invertebrates in stream 2 could be due to the presence of macrophytes in the stream and more effluents land use activities around the stream i.e watering of livestock and washing of clothes might have caused some anthropogenic disturbances causing invertebrate drift downstream.

Conclusion

Physical, chemical and biological parameters that influence water quality keep changing. Therefore, regular quality monitoring of water bodies to ascertain these changes from time to time is necessary this will ensure protection of public health.

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