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Determination of Water Quality Using Aquatic Insects as Indicators in Kware Lake of Sokoto State

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ABSTRACT:

Determination of water health status using aquatic insects as indicators was carried out between May and December. Insect species were sampled every month using scientifically approved techniques from Five (5) sampling stations, Insects identification was done in the Entomology Laboratory of Usmanu Danfodiyo University, Sokoto. The result obtained revealed that, composition and abundance of identified insects from the five stations was higher and more divers at station 1, with 304 individuals (32.61%), followed by station 5, with relative abundance of 226 individuals (24.25%), then station 3, with 200 individuals (21.46%). The 4th station has a number of 140 individuals (15.02%) and finally, station 2 with the least number of 65 individuals standing at (6.65%). The study further found that Dipteran family (Chironomidae) are the most abundant and diverse species widely distributed in sampling stations 1,3,4 and 5. However, the abundance and distribution of pollution tolerant species couple with Margalef's water quality index all suggested a safe water quality condition of Kware Lake

Keyword: *Determination, Water Quality, Insect indicators, Kware lake and Sokoto*

INTRODUCTION

Kware Lake is a very valuable source of livelihood to its inhabitants and neighboring community within Kware local government area and its environs. It serves as a source of drinking water, dry-season farming, fishing, transportation, recreational facility and for other domestic uses. Unfortunately, the impact of human activities on this lake such as outdoor bathing, washing and animal waste contaminations have continued to pollute and contaminate the lake's water. Although there was no literature specifically on the use of insects in determining the quality of water in Kware Lake, the only few researches available were mainly concern with productivity, yield and management of the fish in the Lake. However, in the only recent survey to determine the diversity and abundance of aquatic insects in Kware Lake, indication was that *Cordylegaster boltonii* (Dragonfly) had the highest abundance while *Haliplus solitarus* (water bettle)Recorded the lowest abundance among the Five species identified [1]. Biomonitoring according to Rosenberg and Resh [2], is an organized activity employing the use of living things (macro invertebrates) and their responses to ascertain the quality of an aquatic ecosystem, they also state that, "since Water pollution is essentially a biological problem, making a chemical measurement will be like taking snap-shot of the ecosystem, whereas biological measurement will be like taking a video tape". Iindicator species are those texa known to be particularly sensitive to environmental factors (such as Plecoptera, Ephemeroptera and Odonata) so that changes in their presence or absence may directly reflect an environmental change.

One of the biotic indices in biological monitoring to asses aquatic pollution and contamination is the Biological Monitoring Working Party - Average Score perTaxon (BMWP-ASPT) has classify organisms in to ten levels according to their capability to respond to pollution in their habitat. In this arrangement the least tolerant group of species to pollution are assign higher score and the highly tolerant groups are assign low score. According to shahabuddin [3], "Bioindicators or ecological indicators are taxa of macroinvertebrates that show signs that they are affected by environmental pressure because of human activities or as a result of abiotic system destruction". The aim of this work is to assess the water quality of Kware Lake using aquatic insects as indicators.

MATERIALS AND METHODS

Study Area

The study area represent a naturally occurring fresh water lake at Kware the Headquarter of Kware Local Government Area, some 20 – 25 km; north of Sokoto Township. It is located approximately on latitude 13°12′ North and longitude 5°17′ east [1]. The Lake has a surface area of 200 hectares and about Twelve (12) Km in length, covering a large area of land that stretches from Kware to Kainuwa near Gwadabawa. Kware Lake is fed by River Shela and its tributaries in the vicinity of Gwadabawa area [1].

According to Anonymous [4], River Shela and its tributaries are bounded by latitude 13°13′ N and 13°25′ N and longitude 5°9′ E and 5°16′ E respectively. The main villages situated along the cost are Gwadabawa, Ranganda, Gidan Jihadi, Gidan Bawa, Gidan Karma, Balkore Hubewa, Tungar Halilu, Tungar Ama, Bankanu and Kware (Source-: Sokoto Topo Sheet). The lake falls within tropical semi-arid climate with annual rain fall lasting from June to September and the dry season which lasts from October to May

Sampling Stations

Five sampling locations designated as 1, 2, 3, 4 and 5. Sampling stations were selected for the purpose of this research. The selected sampling stations comprises of the up, mid and downstream points of the Lake. Consideration was also given to areas of intensive human activities such as drinking and irrigation water uptake,

bathing, washing and animal watering points.

Sampling Methods

Samples of both water and that of insects were collected on monthly bases at the recommended time of between 8. 00-12.00 noon, morning time. This covers a period of eight months (May 2012 – December 2012).

Aquatic insects were collected using various methods at interval from the five different areas of the lake designated as sampling stations at several points within and around the lake. A pond/aquatic insect net (D-pond) with a dimension of 40 x 40 cm frame, 60 cm long net of 250 mesh size was the common aquatic net used in the collection of macro invertebrates including the adult insects. The sweep net was passed over the area for at least two minutes, the amount of time for sweeping/swinging assured repeatability protocols [5]. The collection of benthic macro fauna was done by gently dragging the D-shape net beneath the water surface at the bottom for one minute and between and within aquatic vegetation for another minute. Rooks and wood logs were also gently lifted and held over a white bucket to brush off any crawling or loosely attached organisms so that they drip in to the bucket.

Organisms obtained were removed from the D-shape net in to the white bucket provided while observing the net for any remain of the organisms, the net was also washed into the bucket all of which was sieved to eliminate the unwanted debris. All invertebrates were washed and put in a killing jar with 70% formalin at field, this was then retransferred in to the 70 % formulated ethanol preserving bottle and labelled according to the date, station, time and number of insects caught, for onward transport to Entomology Laboratory of the Usmanu Danfodiyo University, Sokoto for identification.

Subsequently, the collected benthic macro-fauna were identified with the aid of a dissecting microscope using Aquatic identification keys [6, 7, 8]. After identification benthic organisms were returned back in to their separate vials while adult insects were put into the museum insect storage box into which Blue Diamond Naphthalene balls was place to repelled carnivorous insects from destroying the stored samples.

Biological Indices

Biological Indices were used in this research to monitor the impact of disturbance and Pollution in Kware Lake, by indicating only and not specifying any of the disturbing agent but its negative impact on the water quality.

Margalef's Diversity Index (D) was used to determine species richness. This index classify water quality condition according to the calculated values obtain [9], that values less than 1.0 indicate bad water condition, while values between1.0–3.0 indicate low, moderate or poor water condition and value greater than 3.0 indicate a clean or safes water condition.

Statistical Analysis

Analysis of variance (ANOVA) using JMP SAS version 10, was used to test for statistical differences between the means of water conditions from the five sampling stations. Pearson's correlation coefficient (r) was also used to determine the relationship between water sampled from each of the station and to determine its relationship within macroinvertebrate species and water physico-chemical parameters on the other hand.

RESULTS

The overall insects composition, from the five sampling stations are summarized in Table 1. Seventeen taxa were identified from a total of 932 individuals collected during the sampling period. The number of encountered taxa and the percentage distribution from each station shows that, station 1 has about 304 individuals at 32.62%, while station 2,3,4, & 5 stations, had 62 individuals at 6.65%, 200 individuals at 21.46% , 140 individuals at 15.02% and 226 individuals at 24.25% respectively.

Table 1. Overall Composition And Distribution Of I1? nsects Sampled At The Five Stations, Kware Lake

Oder	Family	Species	1 (KNB)	2 (DJG)	3 (TAM)	4 (GKF)	5 (KSB)	TOTAL
Diptera	Simullidae	*Simuliium damnosum*	5	0	2	0	3	10
	Chironomidae	*Chironomus riparius.*	90	10	110	100	110	420
	Tipulidae	*Tipula* sp.	10	7	10	0	10	37
	Culecidae	*Culeciodes* sp.	15	0	20	0	19	54
	Anipheles	*Anipheles*	10	2	8	0	10	30
Hemiptera								
	Nepidae	*Laccotrephes* sp.	10	2	1	0	5	18
	Corixidae	*Centrocorisa nigripennis.*	10	5	4	1	2	22
	Belostomatidae	*Belostoma bossi*	10	12	0	2	1	25
	Notonec~~tiade~~	*Notonecta undulate*	8	11	8	4	5	36
Coleoptera								
	Dysticidae	*Thamonectus maginegutatus*	6	2	0	2	0	10
	Notoridae	*Hydraticus* sp.	0	5	11	10	0	26
	Gyrinidae	*Deneotus* sp.	7	0	0	4	5	16
Odonata								
	Aeshnadae	*Aeshna* sp.	10	6	4	0	7	27

	Lubellulidae	*Libulla quadrimaculata*	50	0	3	0	22	76
	Gomphidae	*Gomphus* sp.	30	0	1	3	25	59
Ephemeroptera	{Pontamanthidae	*Anthopotamus* sp.	3	0	7	11	0	21
	Caenidae	*Caenis* sp.	30	0	10	0	5	45
		TOTAL :	304	62	200	140	226	932
		% :	32.62%	6.65%	21.46%	15.02%	24.25%	100%

Key: KNB = KainUwa Bridge, DJG = Dan jirgi, TGA = Tungar Ama, GDK = Gidan Kifi, KSR = Kware/salame by - pass.

TABLE 2. Diversity Index of Aquatic Insects in The Study Stations of Kware

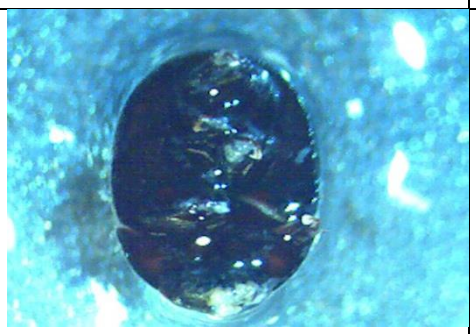
		Sampling Stations			
	1	2	3	4	5
	(KNB)	(DJG)	(TAM)	(GKF)	(KSB)
No of texa	16	10	14	10	14
No of individuals	304	62	200	140	226
Texa richness (d) Margalef's index	2.623	2.180	2.454	1.821	2.398
Key : KNB = kainuwa Bridge, DJG = Dan jirgi, TAM = Tungar Ama, GKF = Gidan Kifi, KSB = Kware / salame by					

Plate I: Order – Diptera= Speciess – *Chironomus riparius*

Plate II : Order – Hemiptera

Plate III : Order – Hemiptera

Plate IV: Order - Coleoptera -*Hydraticus* sp



PlateV: Order- Coleoptera

Plate VI: Order - Odonata= *Epitheca* sp

Plate VII: Order - Odonata = *Libulla quadrimaculata*

Plate VIII: Order - Ephemeroptera = *Anthopotamus* sp.

Plate IX: Order- Ephemeroptera= *Caenis* sp.

Figure 1: (i-ix) Showing features of the nine aquatic insect collected from Sampling Stations at Kware Lake.

Taxa richness and Dominance index of the different species of macroinvertebrates collected during the study period are shown in Table 2. The monthly total number of individual insect species within each of the five (5) main Families of Diptera, Hemiptera, Coleoptera, Odonata, and Ephemeroptera were presented in Figure 1. Dipteran Family recorded the highest number of individuals 551 distributed between the Five different species. Followed by Odonata and Hemiptera with 162 and 101 number sof individuals sampled within the four Families. While the lowest monthly insects species sampled comes from coleopteran family with a total number of 52 during the sampling period. These are distributed within the only three Families. Closely followed by was the last family Ephemeroptera with a slightly higher number of 66 sampled insects during the period of the study, although the total exceed that of Coleoptera the later has richer species diversity.

DISCUSSION

The overall insects composition and distribution from the Five (5) sampling station of Kware lake as shown in Table 4, indicate that Seventeen texa (17) comprising of 932 individuals were recorded , this when compared with the report of Victor and Ogbeibu [10] cited in [11] of over eighty seven texa (87) comprising of 12,088 individuals and over fifty five (55) for tropical waters. The relative low invertebrate population may be due to factors such as difference in the type of Fresh water system under study (moving / non moving), or as a result of the variation in the physical and chemical factors like fast water flow, high pH, low dissolved oxygen, and low conductivity. According to Odun [12]. Diversity tends to below in physically control water system. According to the overall composition and distribution of insects sampled from the five sampling stations during the study period, station 1 has more abundant and divers species with 304 individuals at a percentage of 32.62 %, this is closely followed by station 5 with a relative abundance of 226 individuals at 24.25 %, then station 3 with 200 individuals with 21.46 %, then the 4th station with 140 individuals at 15.02 %, and finally station 2 which has only 62 individual insect recorded throughout the sampling period with a percentage of 6.65 %.

In this study, Dipterans are found to be the most abundant and divers species widely distributed in almost all the sampling stations, (*Chironomous ripaius*, *Culicoid* sp., and *Anipheles*.sp). [13] has reported that Dipteran Family are represented by Chironomids, Swams of adult midges that are conspicuous and troublesome. Adult midges is said to live just long enough, usually less than a day, to mate and lay eggs. The life cycle is therefore, under the water at the larval stage, it was also reported to withstand poor Oxygen, as was the case in this study where members of Dipteran families were found in abundant at stations 1, 3, 4 and 5. [13]. This was followed by Odonata Family comprising of (*Aeshna* sp., *Libellula quadrimaculata.* and *Gomphus* sp.*)* with a total number of 162 members that are poorly distributed from among the five (5) station. Odonata manifested largely at station one an area with a large population of macrophytes. [14] Has reported that Dipterans and some other insects specie such as Midges, Water-boatman and Damsel flies are attracted and found mostly at in lakes with untreated water that have livestock excrement. This is rightly in agreement with the characteristics of our sampling station 1, as the most frequently visited site by herdsmen and Donkey owners of the neighbouring village for their Animal watering purposes. Coleopterans (Water Beetles) were found to follow somewhat similar trend with the Odonatans. This agrees with the report of Gaupin (1973) cited In [13], who found that most aquatic beetles are able to renew their oxygen supply directly from the atmosphare an ability that left them unaffected by waste induced oxygen depletion. However, *Anthopotamus* sp. and *Caeais* sp. belonging to Ephemeropteran Family were only found to occur sporadically within the sampling specie as reveled by this study, it is of cause a less pollution sensitive Family. However, the use of Diversity indices in this research has been very useful in the understanding of disturbances and the state of water quality, than the mere presence or absence of any one indicator organism [15]. Base on the Margalef's water quality index-classification values, [9], indicate that values greater than 3.0 shows a clean/good water condition, values less than 1.0 show a heavy pollution/bad condition, while values between 1.0 – 3.0 indicates between low to moderate or poor condition.

CONCLUSION

The researcher have concluded that in accordance with the indices used for this study, Kware Lake has only been moderately polluted and therefore, its water was of good quality and the anthropogenic activities within the Lake has apparently little effect on the general condition of the Lake water. As surface water monitoring is one of the first steps in the rational development and management of water resources, the government and it agency concerned with provision, maintenance and up-keep of Kware Lake should ensure a periodic water quality monitoring to keep abrase on the level and dangers of disturbance and pollution challenges of this valuable fresh water aquatic system.

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