ARTHROPOD FAUNA OF THE UNIVERSITY OF NIGERIA, NSUKKA, SEWAGE POND

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ABSTRACT

A survey of arthropod fauna of the University of Nigeria Nsukka sewage pond was carried out within May and June 2011. The aim was to determine the various arthropod species and its abundance in the sewage pond. The analysis was carried out by two methods, physico-chemical analysis and arthropod faunal studies. The physico-chemical parameters of the pond which included dissolved oxygen, temperature, water hardness, carbon dioxide, pH, depth and alkalinity were recorded. The arthropod faunal study was gotten through sample collections of shoreline zone with the use of insect net and scoop net, the mid benthic zone with the use of Eckman grab. The arthropods found were of the class insecta and class arachnida. The sewage pond had a high accumulation of organic waste with mean dissolved oxygen calculated to be 6.48. As a result of this high content of organic waste, most aerobic organisms cannot survive in the pond, and this resulted to low abundance of arthropods.

Keywords: Arthropod fauna, Sewage pond, Physico-chemical parameters, Biological characteristics

INTRODUCTION

Arthropoda is the most extensive phylum in the animal kingdom. They are everywhere and about 85% of all known animals in the world are part of this group. There are far more species of arthropods than there are species in all the other phyla combined. This can be seen in the work of Eyo and Ekwonye (1995) in a survey of the macro invertebrate fauna of the Fadama pools of Anambra, where they documented over 86% of macro invertebrate fauna belonging to the phylum arthropoda. Arthropods can be seen as an enormous assemblage of species that dwell in both marine, fresh water, air and terrestrial habitats and share common characteristics of having a hard exoskeleton (which acts as a template for body form which facilitates levers for locomotion, allows development of hard structures such as jaws and reduces water loss) and several pairs of jointed legs that may be used for a variety of purposes including swimming, walking, leaping and digging etc. (Barnes, 1968). These arthropods were originally thought to be related to annelids which have paired segmental appendages. The phylum arthropoda is divided into five classes: (i) arachnida e.g. scorpions, spiders, (ii) crustacea e.g. shrimps, crabs, (iii) diplopoda e.g. millipede, (iv) chilopoda e.g. centipede and (v) insecta e.g. grasshoppers, dragonfly (Smith, 1973). Karen and Flake (1995) reported that generally sewage ponds had higher nitrogen and phosphorus levels than industrial and radioactive ponds and higher number of insects (notonectidae, dytiscidae, chironomidae, daphnidae, eucopepoda, ostracoda and odonata) than industrial and radioactive ponds. Rouhollah *et al.* (2007) reported that out of 1032 collected samples from four sewage maturation ponds, the most prevalent insect groups were: Diptera (52%), Hemiptera (24%), Ciclopodidae (12%), Hydroacarina (9.5%), Coleopteran (0.77%), Aranida (0.67%), Hymenoptera (0.58%) and Odonata (0.48%). Also the families of Chironomidae and Culicidae from Dipteran order, Notonectidae from Hemiptera order were also dominate.

The specific objectives of this study were to determine the various arthropod species inhabiting the University of Nigeria, Nsukka, sewage pond, their percentage composition, abundance and the physico-chemical parameters influencing them.

MATERIALS AND METHODS

Description of the Study Area: The sewage pond of the University of Nigeria Nsukka is located beside the junior staff quarters and is about 181.5 meters yards long and 158.1 meters wide. It is immediately surrounded by farmland. There are two operational open ponds in the sewage unit, each about 125 meters long, 45.70 meters wide and 36 cm feet deep. The pond is connected to four soaked away pits that measures about 30 – 35 cm deep while the rest of the enclosure is planted with grasses.

Physico Chemical Analysis

Temperature: The temperature of the pond water was measured using clinical mercury in glass thermometer. This was done by dipping the thermometer in the pond water and allowing it to stay for about five minutes to stabilize before reading.

Alkalinity: This was determined by adding 2 drops of methyl orange indicator in 100ml of pond water in a conical flask. 0.02m standard H_2SO_4 was filled in a burette and used to titrate against the solution in the conical flask, the end-point was attained when the colour of the solution changed from orange to pink. Alkalinity calculated using the formula: Alkalinity = A x M x 50 x 1000 (mg/L) / V, where A = the titre value, M = molarity of the acid and V = volume of sample (100 ml).

Carbon iv oxide: Free carbon iv oxide was determined by adding 10 drops of phenolphthalein indicator to 100ml of pond water and then shaken thoroughly. The solution was titrated with standard sodium carbonate (Na_2CO_3) until the end point was reached (when the solution turns pink). The pink colour lasted for about 20 seconds before the colour disappeared again. Free carbon iv oxide was calculated thus; Free CO_2 = A x N x 22,000 (mg/l) / V, where: A = titre value, N = molarity of Na_2CO_3 and V = volume of sample (100 ml).

Water hardness: This was determined by adding 2ml of buffer solution to 100ml of water in a conical flask. 8 drops of Erichrome Black T indicator was added and the solution shaken thoroughly. The solution was titrated with standard Ethylenediaminetetracitic acid (EDTA) and the end point was reached when the solution turned blue. The water hardness was calculated thus: Hardness = TV x M x 1000 mg/L / V, where TV = Titre value, M = molarity of EDTA used and V = volume of sample (100 ml).

Dissolved oxygen: This was determined using the Winkler's method. The water sample was collected under water using a 500 ml volumetric flask. The water sample was fixed at the site using 2 ml of manganese sulphate and 2 ml of alkaline potassium iodide, a precipitate was formed which was dissolved by adding 2ml of concentrated tetraoxosulphate vi acid (H_2SO_4) solution turned to very light orange colour. In the laboratory 100ml of the fixed water was titrated using sodium thiosulphate ($Na_2S_2O_3$), the colour changed from orange to a milky solution. Dissolved oxygen = Titre value x M x 8 x 1000 (mg/L) / V, where M = molarity of $Na_2S_2O_3$, 8 = Atomic no of oxygen and V = volume of sample (100 ml).

Arthropod Faunal Study

Shore/littoral zone: This zone is exposed to air, solar radiation and at times covered by water. The scoop net or pond net was used for collecting organisms from the shallow area of the pond (Inyang *et al.,* 2006).

Mid channel benthic zone: The organisms found in the benthic zone of the pond were sampled using Eckman grab.

Identification: All the arthropods collected were sorted out, identified (Hyman, 1959; Barnes, 1968; Hynes, 1970; Russell-Hunter, 1979; Egborge, 1993) and preserved in 5% formalin to which some quantity of glycerol was added. Very large specimens were preserved in 95 parts of 70% alcohol plus 5 parts of glycerol (Russell-Hunter, 1979).

Data Analysis: Data collected were analyzed using descriptive statistics, analysis of variance (ANOVA) and Spearman's correlation at $P < 0.01$.

RESULTS AND DISCUSSION

The results of the physico-chemical parameters of the sewage pond (Table 1) indicated acidic pH, high free carbon dioxide and low alkalinity among others.

Table 1: Physico-chemical parameters of University of Nigeria, Nsukka, sewage pond

Physico-chemical parameters	Values
Free carbon dioxide	1.319 ± 0.264 mg/l
Alkalinity	0.023 ± 0.36 mg/l
Temperature	27.43 ± 3.04 °C
Dissolved Oxygen	6.47 ± 2.13 mg/l
Depth	5.0 ± 1.34 m
water hardness	0.22 ± 0.09 mg/l
pH	6.7 ± 2.23 pH

Spearman's correlation indicated that temperature had a perfect positive correlation with carbon dioxide, water hardness and alkalinity ($r = 1$, $P < 0.01$). Carbon dioxide, temperature, water hardness and alkalinity had perfect positive correlation ($r = 1$, $P < 0.01$), while depth and pH had perfect positive correlation ($r = 1$, $P < 0.01$).

The arthropods collected in the sewage pond were insects belonging to 4 orders namely Diptera, Hymenoptera, Coleoptera and Odonata and Chilopoda belonging to the order Scorpionida from the class (Tables 2, 3 and Figure 1). Both aquatic and non-aquatic insects were collected. The non-aquatic insects were collected around the pond and they include grasshoppers, houseflies and butterflies. The higher the diversity index, the more diverse were the arthropod. The scorpionids had perfect positive correlation with the dipterans ($r = 1.00$, $P < 0.01$). The scorpionids may have depended on the dipterans for food and survival. The coleopterans had negative correlation with the dipterans and the group scorpionida ($r = -1$, $P > 0.01$). The odonatans had perfect positive correlation with the dipterans and the group scorpionids ($r = 1.00$, $P < 0.01$). The hymenopterans have no correlation with the other four groups.

The relationship between physico-chemical parameters and arthropods indicted that temperature, carbon dioxide, dissolved oxygen and water hardness had negative correlation with abundance of dipterans, scorpionidans and odonatans ($r = -1$, $P > 0.01$) and a positive correlation with abundance of coleopterans ($r = 1$, $P < 0.01$). The depth of the pond, pH and alkalinity had negative correlation with abundance of dipterans and scorpionidans ($r = -1$, $P > 0.01$) but no correlation with the abundance of hymenopterans and coleopterans.

The sewage pond in University of Nigeria Nsukka was nutrient rich. Organic enrichment led to euthrophic conditions and may be the cause of high algal species diversity and low number of invertebrate taxa found. The reduced number of arthropod taxa in sewage may be due to lack of emergent vegetation in pond (Gordon, 1990). High organic waste content has been reported as another possible cause of low faunal species richness in waste water ponds (Pearson and Penridge, 1987).

Table 2: Arthropods species composition and abundance in University of Nigeria sewage pond

S/N	Species	WK 1	WK 2	WK 3	WK 4	WK 5	WK 6	WK 7	WK 8	Abundance	% Abundance
1.	Dragonfly	7	8	5	7	10	4	3	6	50	8.10
2.	Damselfly	5	7	3	4	5	4	5	5	38	6.16
3.	*Culex* spp	20	32	17	27	14	36	42	16	204	33.06
4.	Chironomids	3	4	5	8	6	4	7	2	39	6.32
5.	Ants	4	3	5	6	3	2	4	3	30	4.86
6.	*Laccotrephes* spp	10	14	9	12	10	9	15	12	91	14.75
7.	*Nepa* spp	8	5	7	8	6	2	4	3	43	6.97
8.	*Cybister* spp	2	3	1	2	3	2	1	2	16	2.59

WK = week

Table 3: Major arthropod orders associated with University of Nigeria sewage pond

S/N	Order	WK 1	WK 2	WK 3	WK 4	WK 5	WK 6	WK 7	WK 8	Total
1.	Coleoptera	2	3	1	2	3	2	1	2	16
2.	Diptera	23	36	20	35	20	40	49	18	243
3.	Hemiptera	2	1	3	2	1	1	2	3	15
4.	Hymenoptera	4	3	5	6	3	2	4	3	30
5.	Lepidoptera	2	4	5	2	3	3	2	2	23
6.	Odonata	12	15	8	11	15	8	8	11	88
7.	Orthoptera	12	15	8	11	15	8	8	11	88
8.	Scorpionida	18	19	16	20	16	11	19	15	134

WK = week

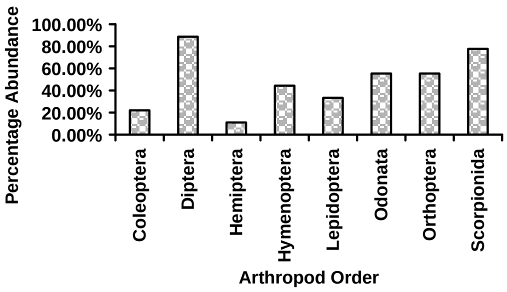

Figure 1: Persentage abundance of arthropods in University of Nigeria, Nsukka, sewage pond

Hilsenhoff (1988) assigned arthropod families from streams in the great lakes region to tolerance values ranging from 0 (lowest tolerance to organic pollution) to 10 (highest tolerance to organic pollution). Eleven of the families for which he presented tolerance values were found in INEC ponds and only two had tolerance values of less than 4. These 11 families and their tolerance values were as follows: Aerhnidae and Tipulidae (3), Baetidae, Elmidae and Leptoceridae (4), Ceratopogonidae (6), Caenidae (7), Chironomidae and Talitridae (8), Coengrionidae (9) and Psychodidae (10). The two families with 3 tolerance rating were represented by only single specimens in INEC wastewater ponds.

Furthermore high invertebrate growth and abundance have been associated with high algal productivity (Hyman, 1959). Taxa found in greater abundance in sewage ponds than in industrial ponds were those that could take advantage of the unique and difficult living conditions. Eutrophic waters typically exhibit lower dissolved oxygen concentrations and greater fluctuations in dissolved oxygen and pH. The population of the non-aquatic insects revealed that members of the dipterans were the most abundant and may be involved in the mechanical transmission of agents of intestinal disease associated with the sewage.

Temperature affected the physical, chemical and biological processes in the sewage pond by altering the concentration of dissolved oxygen, pH and thus rate of photosynthesis. The lives of most of the aquatic organisms were controlled by water temperature as shown in this study. The average temperature of the pond being 27.43 ± 3.04 ^{o}C was most suitable for the growth of arthropods because temperature influenced water quality and the distribution and abundance of arthropods (Wallace *et al.,* 1984). pH higher than 7 but lower than 8.5 was ideal for biological productivity, while pH lower than 4 was detrimental to aquatic life (Ezekiel *et al.,* 2011). As can be seen in this study 6.7 ± 2.23 pH was most ideal and therefore influenced the low species abundance in this sewage.

When water contains large amounts of organic wastes, the rate of micro-organism activity (effective decomposition) may be high and the water may rapidly become depleted of oxygen (Mancy and Jaffe, 1966). Therefore since the sewage pond had a high accumulation of organic waste with 6.48 mg/l dissolved oxygen aerobic organisms cannot survive thus resulting to low abundance of arthropods.

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