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# Assessment of physico-chemical parameters and cyclopoid copepod abundance in Awba Reservoir, Ibadan

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## Abstract

A study was carried out on the effects of physico-chemical parameters on the microscopic cyclopoid copepod abundance in Awba reservoir, University of Ibadan between January and February 2005.McMaster Microscope was used to observe and identify the copepods while a water quality test kit was used to assess the physico-chemical parameters. The results showed a variation in the physico-chemical parameters of the sites with ranges for dissolved oxygen: 21.2mg/l ± 0.85 to 24 mg/l ± 1.71, biochemical oxygen demand (BOD): 10.3 mg/l ±0.57 to 11.2 mg/l ±1.4. Temperature 28.1$^0$C±0.23 to 30$^0$C ±2.07, pH 7.2±0.13 to 7.5±0.27 and conductivity 304 µS/cm ± 42.7 to 330.5 µS/cm ± 70.3. Diverse taxonomic groups of cyclops were encountered at the four study sites in Awba Reservoir during the sampling period. The dominant groups varied across the sites. For site 1, *Tropocyclops mellonbyi* was dominant with a Berger-Parker Diversity Index (BPDI) of 92%, for site 2, *Tropocyclops mellonbyi*, *Halicyclops korodiensis; Thermocyclops iwogiensis* were present with a BPDI of 72%, 16% and 12%, respectively. For site 3, *Tropocyclops mellonbyi* and *Halicyclops korodiensis* were encountered with a BPDI of 88% and 12% for site 4, *Ectocyclops ilariensis* had a BPDI of 100% as the only cyclop species. The number of taxonomic groups also varied along the sites. The correlation between the physico-chemical parameters and Cyclops abundance at the four study sites was indicative of the effects of ecological factors on the Cyclops and the potential of cyclops to be used as bioindicators of environmental perturbation in the reservoir.

## 1. Introduction

Cyclopoid copepods are aquatic crustaceans that are very diverse and often regarded as the most numerous metazoans in the aquatic community. Copepod habitats range from freshwater to hyper saline conditions, from subterraneous caves to water hill eased in bromeliad leaves or leaf litter on the ground and from streams, rivers and lakes to the sediment layer in the open ocean. Their habitats also range from the highest mountains to the deepest ocean trenches and from the cold polar ice water interface to the hot active hydrothermal vents (Brusca, 1980). Copepods may be free living, symbiotic or internal and external parasites on almost every type of animal in water (McConnaughey, 1983). The usual length of adults is 1-2mm, but adults of some species may be as short as 0.2mm and others may be as long as 100mm.

Ecologically, they are important links in the food chain linking microscopic algal cells to juvenile fish to higher consumers. The subclass Copepod is composed of 10 orders namely Calanoida, Mormonilloida, Gelyelloida, Pecilostomatoida, Misaphrioida, Cyclopodia, Harpacticoida, Platylcopioida, Monstrillooda, and Siphonostomatoida (Dales 1981).There are approximately 210 described families, 2280 genera and over 14000 species. The free – living Copepods fall into three orders namely; the cyclopedia, calamoidea and harpacticoidea.

The cyclopoida includes the well known cyclops of which there are over a hundred species. Moderately long secondary antennae and the females carry twin eggs sacs. Calanoidea are characterized by long secondary antennae and in the females, a single egg sac, includes diaptomus.

The Harpacticoidea are much smaller than Cyclops and diaptomus, and usually found foraging on submerged plants. Their small antennae do not enable them to swim. (Dales 1981). The ecological success of the Cyclops copepods however depends on an optimal water quality that is determined by the physiochemical parameters (Pearse *et al*, 1987). These parameters greatly impinge on the abundance, diversity and distribution of Cyclops copepod in fresh water ecosystems.

The Awba reservoir in the University of Ibadan receives effluents from two streams with a heavy load of organic pollutants from the halls of residence (Obi – Egbedi, 1998). These anthropogenic inputs into the Awba hydrology have the potential of altering the water quality and could affect the abundance of cyclop copepods in the reservoir. Several studies have been carried out in the Awba stream and reservoir which includes (Hassan, 1974, Ugwumba, 1990, Agboola, 1998, Obi – Egbedi 1998). Scanty literature exists on the cyclops of Nigeria despite the wide spread occurrence in several parts of Nigeria of the guinea worm (*Dracunculus medinensis*) to which some cyclops serve as intermediate host. The first description of some species of cyclops taken in Nigeria was made by Brady (1990)

However, no detailed work has been done on studies on physico-chemical parameters and cyclopoid abundance in Awba Reservoir. Human contact with the reservoir water includes washing, bathing, fishing, building construction and for laboratory research. This project is aimed at sampling cyclops and relating their abundance to the physico chemical parameters of the four study sites. The objectives of this research work are to assess the distribution of cyclops at the different sites in the reservoir, to assess the physico-chemical parameters at the study sites and to study the abundance and diversity of cyclops at the different sites.

### 1.1. Anthropogenic Inputs into Freshwater Bodies

In recent years all over the world and particularly in many African countries there has been remarkable population growth accompanied by an intense urbanization, increase in industrial activities and a higher exploitation of cultivable lands. These transformations have brought about a huge increase in the quantity of discharged effluents and a wide diversification in the type of pollutants that reach the aquatic environment (Biney *et al*, 1994) .Pollutants get into the aquatic environment either directly or indirectly. Almost all organic materials are decomposed by normal biological process, but others such as chlorinated hydrocarbon pesticides are resistant to decay and persist for a long time in the environment. The effects of untreated effluents whether liquid matter or in sewage form have been of great concern to environmentalist (Hawkins, 1982).

There has been reports that apart from the aesthetic nuisance of sludge accumulation, the foul smell and human health hazards (Ward and Young, 1963), much ecological pressure is exerted by such effluents, especially sewage deposition (Ajao, 1990). Environmental hazards of such discharges include increase in organic load (Jenkens 1982) with a reduction of dissolved oxygen available to organisms (Ajayi and Adeleye, 1977). It also includes increase in the standing crop of phytoplankton (Thompson and Ho, 1981; Mason, 1992); surface metal enrichment (Fadeke, 1977); decrease in species diversity and increase in abundance of a few opportunistic species like cyclop copepods that take advantage of the changed conditions (Wass, 1967; Ajayi and Adeleye 1977); increase in fish diseases (Jenkins, 1982); and a long time record of decreased fisheries production. (Hawkes, 1982) stated also, that the overall ecological consequences of toxic discharges on the aquatic environment are the reduction in both the number of species and in the total number of individuals, resulting in reduced variety of abundance and that species are eliminated according to their specific tolerance to the pollutants.

According to Mason (1990), aqua-pollution is any alteration of chemical, physical or biological quality of water which results in unacceptable depreciation which adversely affects its subsequent beneficial uses.

Apart from oxygen, temperature is a factor that affects the welfare of aquatic organisms. The rates of chemical and biological reactions double for every $10^0$C increase in temperature. (Boyd *et al*, 1979). This means that aquatic lives will use two times as much oxygen at $30^0$C as they would utilize at $20^0$C. Oxygen requirement of aquatic forms are more critical when temperature is high, than when temperature is low. Temperature greatly influences metabolic and physiological activities and life processes such as feeding reproduction, growth, movement and distribution of aquatic organisms. However, (Boyd 1979) and (Odiete 1999) reported that oxygen content of water decreases with rise in temperature and vice versa.

Dejoux *et al* (1981) reported that organic wastes mineralize in the receiving water bodies and the resulting nutritive elements stimulate plant production leading to eutrophication. The water surface is covered with the unwanted algae, thus preventing the penetration of light which is the major factor needed for photosynthesis to take place. Odiete (1999) stated that “the decomposition process of organic matter utilize oxygen, therefore reducing the minimum dissolved oxygen required by the aquatic animals.

According to Mason (1990), sewage decreases the number of benthic invertebrates and also promotes the growth of benthic algae. Cyclop copepods are important as food for economically important fish and shell fish species in most aquatic environment where they are the major secondary producers. Alternations in the ecological conditions of the fresh water ecosystem as a result of organic inputs will therefore affect the abundance, diversity and distribution of cyclops.

## 2. Materials and Methods

### 2.1. Review of Study Area

The study area is the Awba reservoir in the University of Ibadan main campus. The University of Ibadan is sited at the north of Ibadan along the Ibadan – Ilorin road. It lies roughly on latitude $07^0$ $26^I$ N- $07^0$ $27^I$ N and longitude $03^0$ $53^I$ E-$03^0$ $54^I$ E at an altitude of 185 meters above sea level (Hassan, 1974; Adeogun, 1991).The reservoir receives water from the Awba stream that flows into the University at the southeastern end and runs its course in a southwestern direction. Effluents from the student’s halls on campus, food cafeterias and laboratories all empties into the reservoir. The stream covers a distance of about 975 meters long (Ugwumba, 1990, Hassan (1974) .The reservoir popularly known as the Awba dam was constructed in April 1964 as a fish pond by damming the Awba stream. It was reimpounded again in 1971 to increases its water supply to the University particularly the laboratories. Its length is about 700m, with an average width of 130m and a maximum depth of 5.5m. It has an area of 6 hectares and holds water capacity of about 230 million liters (Ugwumba, 1990). The area occupied by water varies with the seasons.

### 2.2. Field Study

Sampling of Cyclopoid copepod and the measurement of physico-chemical parameters were done at four different sites in the Awba stream weekly for a period of 5 weeks during the dry season from January to February 2005.

Site 1: Site 1 is at the distal end of the stream from the point of entry into the reservoir.

Site 2: Site 2 is just a few meters away from site 1 and it is characterized by small quantity of water hyacinth.

Site 3:The substratum of site 3 is embedded with stones and burnt ashes and it is also characterized by a very large quantity of water hyacinth and is located a few meters from the spill-way of the reservoir.

Site 4: Site 4 is at the site where the spill-way of the reservoir empties excess water into a receiving stream downstream of the reservoir.

The map of the study area is shown in figure 1.

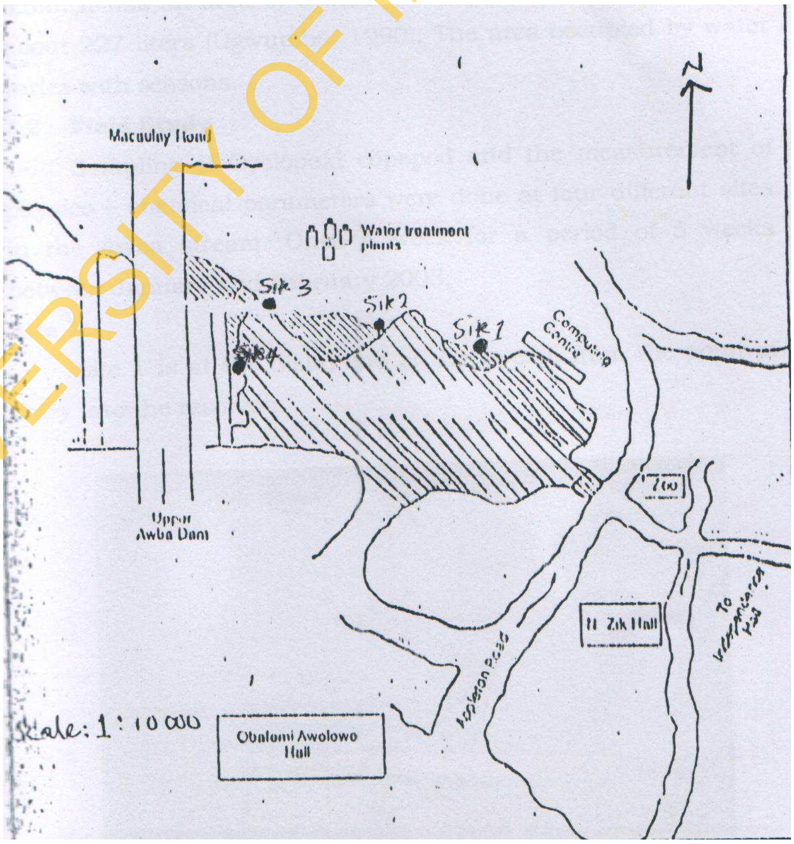


***Figure 1.*** *Extract map of University of Ibadan showing the study area (sites) (Modified from Oben, 2000)*

### 2.3. Determination of Physico-Chemical Parameters

The physico-chemical parameters of the water determined were temperature ($t^0C$), dissolved oxygen (DO), biochemical oxygen demand (BOD), pH, conductivity.

The temperature was measured at each site using mercury in glass thermometer. The thermometer was inserted in water and allowed to stabilize for about two minutes before readings were taken.

Dissolved oxygen in mg/1 at the sites were also determined using the Hach test kit on the site.pH was determined using the Kent pH meter. The probe of the pH meter was dipped into the water bodies at the different sites and the pH read directly. For the biochemical oxygen demand (BOD), water samples were also taken by dipping 250ml stoppered bottles into the water bodies and allowed to overflow to prevent air bubbles from getting into the glass bottles. The bottles were corked tight immediately and were taken to the laboratory for incubation for a period of 5 days at $20^0C$ after which it was titrated following the Winkler's titrimetric methods (APHA/AWWA/WEA, 2005) and the BOD value obtained by subtracting the titre values from the initial oxygen concentration in the water. Conductivity was also determined using a YSI model 63 meter.

### 2.4. Collection of Cyclops

Cyclops were collected using Muslin net. At the site, water from the littoral and pelagic zones was continuously emptied from a 10 litres bucket through the Muslin net after which it was filtered into the sampling bowl.

Copepod Analysis: In the laboratory, samples collected were concentrated to approximately 50ml using a sieve. 0.1ml of the sample was then collected and introduced into a slide with the aid of dropping pipette and viewed under the McMaster Microscope (Dahlin 1985; Ugwumba 1990). The species of Cyclops Copepod present were identified and enumerated using illustrative guides and keys provided by Onabamiro, (1951); Dales ,(1981) and Brusca and Brusca, (1980). Samples introduced on the slide were viewed under a binocular microscope and counted. The number of cyclops encountered was expressed as number/ml of water.

## 3. Results

Physico-chemical parameter

The results of the mean and standard deviations of the physico-chemical parameters during each sampling trip at the study sites are presented in Table 1. Temperature values were highest in sites 3 and 4 ($30^0C$,SD=0.23) and the lowest in site 1($28.2^0C$,SD=2.074).Dissolved oxygen ($DO_2$) content in mg/1 was highest in site 4 with the mean values of 24mg/1 with the least 21.1mg/l at site 1. Biochemical Oxygen Demand (BOD) value was highest in site 4 (11.2mg/1) and lowest in site 2 (10.3mg/1).pH values at site 1 had the lowest mean value of 7.2 (SD=0.13) with the highest mean value of 7.6 in site 4.Conductivity value was highest in site 4 with a value of (330.5 µS/cm, SD=41.866) and lowest in site 2 (301.1µS/cm, SD=64.805).

***Table 1.*** *Mean values of the physico-chemical parameters at the study site*

| *Parameters* | *Site 1* | *Site 2* | *Site 3* | *Site 4* |
|---|---|---|---|---|
| Temperature ($^0C$) | 28.21 | 28.6 | 30 | 30 |
| SD | 2.074 | 1.919 | 0.230 | 0.230 |
| $DO_2$ (mg/L) | 21.1 | 21.2 | 22.1 | 24.0 |
| SD | 1.348 | 1.636 | 1.563 | 0.854 |
| BOD(mg/L) | 10.4 | 10.3 | 10.4 | 11.2 |
| SD | 1.408 | 0.938 | 0.683 | 0.573 |
| Ph | 7.2 | 7.5 | 7.5 | 7.6 |
| SD | 0.130 | 0.208 | 0.241 | 0.172 |
| Conductivity (µS/cm) | 309.2 | 301.1 | 308.980 | 330.5 |
| SD | 42.701 | 64.805 | 70.394 | 41.866 |

SD=Standard deviation

The total number of each genera of Cyclops copepod at the different sites during the sampling period is shown in table 2.

***Table 2.*** *The abundance of Cyclops in the study*

| | *Site 1* | *Site 2* | *Site 3* | *Site 4* |
|---|---|---|---|---|
| *Thermocyclops iwogiensis* | 1 | 4 | - | - |
| *Tropocyclops mellonbyi* | 11 | 23 | 14 | - |
| *Ectocyclops ilariensis* | - | - | - | 13 |
| *Halicyclops korodiensis* | - | 5 | 2 | - |
| Total | 12 | 32 | 16 | 13 |

*Thermocyclops iwogiensis* was no encountered at sites 3 and 4 ,however,1 was found in site 1 and 4 in site 2.11,23 and 14 *Tropocyclops mellonbyi* were found respectively found in sites 1,2 and 3 while none was found in site 4. *Ectocyclops ilariensis* was only found in site 4 (13),while *Halicyclops korodiensis* was only found in sites 2 (5) and 3(2),while none were found in sites 1 and 4.The number of cyclops shown in the table are indicative of the total number encountered throughout the study.

The Berger-Parker Diversity Index (BPDI) is the percentage contribution of each taxonomic group to the total number of cyclops in each site. Taxa provided at least 10% of the total density of cyclops in the site where they were encountered as shown in table 3.

***Table 3.*** *Berger-Parker Dominance Index (specie/number ratio expressed in percentage) of Cyclops at the study site*

| Cyclopoid copepod | Site 1 | Site 2 | Site 3 | Site 4 |
|---|---|---|---|---|
| Thermocyclops iwogiensis | 87 | 12 | 0 | 0 |
| Tropocyclops mellonbyi | 92 | 72 | 88 | 0 |
| Ectocyclops ilariensis | 0 | 0 | 0 | 100 |
| Halicyclops korodiensis | 0 | 16 | 12 | 0 |
| Number of taxonomic group | 2 | 3 | 2 | 1 |
| Number of dominant group | 1 | 3 | 2 | 1 |

***Table 4.*** *Shows results of correlation coefficient between the physico-chemical parameters and cyclops abundance*

| | *T.iwogiensis* | *T.mellonbyi* | *E.ilariensis* | *H.korodiensis* |
|---|---|---|---|---|
| Temperature ($^0$C) | -0.827 | 0.894* | 0.793 | -0.099 |
| pH | -0.247 | 0.517 | 0.173 | 0.522 |
| Conductivity | 0.124 | -0.253 | 0.633 | -0.757 |
| DO | -0.239 | 0.322 | -0.371 | -0.916* |
| BOD | 0.836 | -0.681 | -0.211 | -0.055 |

*Significance at 95% confidence interval. DO=Dissolved oxygen (mg/l) BOD=Biochemical oxygen demand (mg/l), Conductivity (µS/cm)

Pearson's correlation coefficient between the means of physico-chemical parameters and cyclops abundance at the four sites was only significant between the occurrence of *T.mellonbyi* and temperature, and *H.korodiensis* and dissolved oxygen. Statistical correlation between the physico-chemical parameters and cyclops abundance of the study sites showed that abundance of *Tropocyclops mellonbyi* and *Ectocyclops ilariensis* increases with increasing temperature. Abundance of *Halicyclops korodiensis* and *Thermocyclops iwogiensis* decreases with increase in temperature; the abundance of *Tropocyclops mellonbyi* and *Halicyclops korodiensis* increases with increasing, dissolved oxygen while abundance of *Thermocyclops iwogiensis and Ectocyclops ilariensis* decreases with increasing dissolved oxygen; the abundance of *Tropocyclops mellonbyi*, *Halicyclops korodiensis and Ectocyclops ilariensis* increases with increasing pH while *Thermocyclops iwogiensis* abundance decreases with increase in pH the abundance *Tropocyclops mellonbyi*, *Halicyclops korodiensis*, *Ectocyclops ilariensis* decreases with increasing biochemical oxygen demand while *Thermocyclops iwogiensis* abundance increases with increasing biochemical oxygen demand while the others decreased. The abundance of *Tropocyclops mellonbyi* and *Halicyclops korodiensis* decreases with increasing conductivity (µs) while *Thermocyclops iwoginesis* abundance and *Ectocyclops ilariensis* increases with increasing conductivity.

## 4. Discussion

The observed differences in the physico-chemical qualities of the water at different sites indicate variation in environmental conditions. These variations could be attributed to the effect of effluents discharge (Adebayo and Wade, 1984). The effluent discharged affects the dissolved oxygen and biochemical oxygen demand in these sites through eutrophication.This also affects the salinity and alkalinity of the water which in turn affects the types of organisms in the water body.

The highest mean temperature (30$^0$C) recorded in site 4 and site 3 (30$^0$C) could be attributed to influx of effluents at the sites that triggered decomposition resulting to an increase in temperature.

The low dissolved oxygen levels with mean values of (21.1±1.35) obtained at site 1 and site 2 (21.2 ± 1.64) is due to decomposition by bacteria which make use of the oxygen in the water. Dissolved oxygen values in water bodies receiving organic pollution are known to deplete at a greater rate than it can be replenished, bringing about oxygen depletion (Mason, 1992). With increase in organic pollution there will be a corresponding increase in the biochemical oxygen demand as a result of proliferation of bacteria that acts on the organic pollutants. The mean dissolved oxygen level observed in site 4 (24mg/l ±0.854) was higher due to two reasons namely self purification of the water by the bacteria and the floating hydrophytes dominated by water hyacinth through photosynthesis. It has long been known that biodegradation is the first and most important step in self-purification of organically impacted surface water bodies (Oladimeji and Wade, 1984; Mason, 1992). Secondly super saturation of dissolved oxygen during the day in the presence of sunlight due to phytoplankton photosynthesis (primary production). Oluwande *et al* (1983) in the study of pollution levels in some Nigerian Rivers also observed a super saturation of dissolved oxygen during the daytime. According to Pratti and Pavanello (1971) report on the criteria for gross organic pollution, the level of dissolved oxygen observed in site 3 (22.1) mg/l makes the water body at this site qualify as slightly polluted. In the same vein, the level of dissolved oxygen in sites 1 (21.1) mg/l makes it qualify as highly polluted by organic pollutants. Cyclops abundance measured with Berger Parker Dominance Index (BPDI) differed from site to site. This is because of differences in the abundance of cyclops that describes the structure of the community and may be used to monitor changes in communities in response to environmental changes (Hellawell; 1977).

## 5. Conclusion

The study shows that Awba reservoir is polluted by the effluents discharged into it as reflected in the abundance and diversity of the microscopic copepods. In all, this results show that species of cyclopoid copepods can be used to biomonitor ecosystem health and perturbation.

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