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An ecological study of a temporary pond in Ilorin, Kwara State, Nigeria.

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ABSTRACT: Physicochemical factors such as temperature, transparency, dissolved oxygen, carbon dioxide, nitrate, silica, calcium, magnesium, phosphate, pH and conductivity of water in a seasonal temporary pond located at the University of Ilorin, Mini Campus were studied for 6 months between the months of April and September, 1999 during the rainy season. Biotic communities of the pond were also quantitatively sampled.

Ecological Interactions occurring between the Physicochemical factors and the biotic communities on one hand and the Interrelationships between the biotic communities on the other hand were also investigated.

The rain has a tremendous influence on the physico-chemistry of the water as most chemical factors increase their concentration with the intensity of the rain. Temperature varied between 20°C and 27°C, pH fluctuated between 6.2 and 7.5. The biotic communities were classified into Planktons, Neustons, benthos and vascular flowering plants. The bloom of the planktons decreased the concentrations of most ions and reduced the transparency of the water.

Key Words: Temporary waters; Seasonal ponds; Planktons; Benthos; Flora and fauna; Ecological interactions.

Introduction

In Nigeria, Research and Information about temporary waters are scanty, despite the fact that such water bodies are found in every nook and crannies of the country. It might be due to the notion that temporary ponds are ephemeral and exist too short a time to support life or its resources are limited or the water body is small and cannot be developed to provide for fish production, water supply, irrigation and other viable uses.

Available information about temporary ponds are those of Amos (1969), Reid and Zim (1967), Barclays (1966) and Williams (1987). The fact that organisms such as Planktons, Amphibians, reptiles, worms and insects survive in temporary waters suggests that life exist in them and the water is productive.
The population of these organisms and their distribution is related to the availability of dissolved chemical factors in the water. The knowledge of existing species composition and state of balance between the population in a body of water is crucial to an efficient management programme (Swingle, 1950).

Ecological studies of water bodies most often predict the course of biological events in such habitat and generally give an insight into the productivity and interrelationships among the organisms in the water. The biotic communities in aquatic ecosystem have also been used in water quality analysis, biological indicators of pollution and to determine the average ecological conditions of aquatic habitats (Munawar, 1972).

This paper aims at examining the ecology of the temporary pond located at the University of Ilorin (Mini Campus) with a view of knowing the physical and chemical properties of the water and their effects on the abundance of floral and fauna communities of the pond. The result of this study will go a long way in providing efficient management programme for temporary water and towards any future transformation of such waters into good use for fish production, recreation and domestic (Micro) water supply.

Materials and Methods

The Study Site

The temporary pond is located on the South-eastern portion of the University of Ilorin, Mini Campus in Ilorin, Kwara State. It is a shallow pond with a maximum length and width of 11m and 5m respectively, 1.5m deep, surface area of 470.5m and a volume of 611.75cm^3 when filled up. The pond is always dry during the dry season i.e. between November and March. It becomes gradually filled with water with the onset of the rains in April. The pond is surrounded by Hornblende biotite gneiss rock.

Samplings

Water samples were taken monthly from April to September with aid of water sampling bottles. The samples were taken at 9.00a.m. Temperature was measured on the spot by the use of mercury thermometer. Transparency was measured with a Secchi disc as recommend by Welch (1948). Dissolved oxygen content was determined by Winkler's method (Willoughby, 1976), while carbon dioxide was determined using titrimetry method. Nitrate, silica, calcium and magnesium ions were measured by spectrophotometry and colorimetry methods. Persulfate digestion method was used to determine phosphate.

A Phillip Harris pH water was used to measure the pH of the water while conductivity was measured by the conductivity meter Mc-1 Mark V.

Qualitative Sampling of Planktons was carried out by sweeping 55 µm mesh size plankton net across the water surface and emptying the contents into a collecting bottle. Both phytoplankton and Zooplankton were fixed with 4% formalin and identified using the binocular microscope and relevant texts such as Edmondson (1959).

The benthic organisms were samples using the Van 'veen's bottom grab, the contents were poured on to a dissecting tray where they were separated and identified to Generic level by the use of MII binocular microscope. Aquatic macrophytes were collected by hand from different zones in the pond. They were taken to the University of Ilorin herbarium where they were identified to species level using Taxonomic keys.

Results

Surface water temperature varied from a minimum of 20°C to a maximum of 27°C (Fig. 1). The transparency of the water was generally low with the lowest Secchi disc value of 4cm recorded at the peak of the rains, while highest value of 32cm was obtained in April at the onset of the rains (Fig. 2).

The pH of the water flunctuated between 6.2 and 7.5. The concentration of dissolved oxygen was found to increase with time. The highest value of 6.4mg/L was recorded in August. Carbon dioxide concentration decreased with time. The highest value of 8.0 mg/L was recorded in April. Figure 3 shows the monthly variation in the concentrations of Dissolved Oxygen, Carbon dioxide and pH of water.

Of all the chemical factors of the water studied, Calcium and Magnesium were the most highly abundant ions recorded. The highest values of 110 mg/L and 96 mg/L were recorded for Calcium and Magnesium respectively in April, the two ions progressively decreased in concentrations with the time of study (Fig. 4). There was also progressive decrease recorded in the conductivity of the water. 90 µmhos/cm was the highest value obtained in April but reduced to 53 µmhos/cm in August.

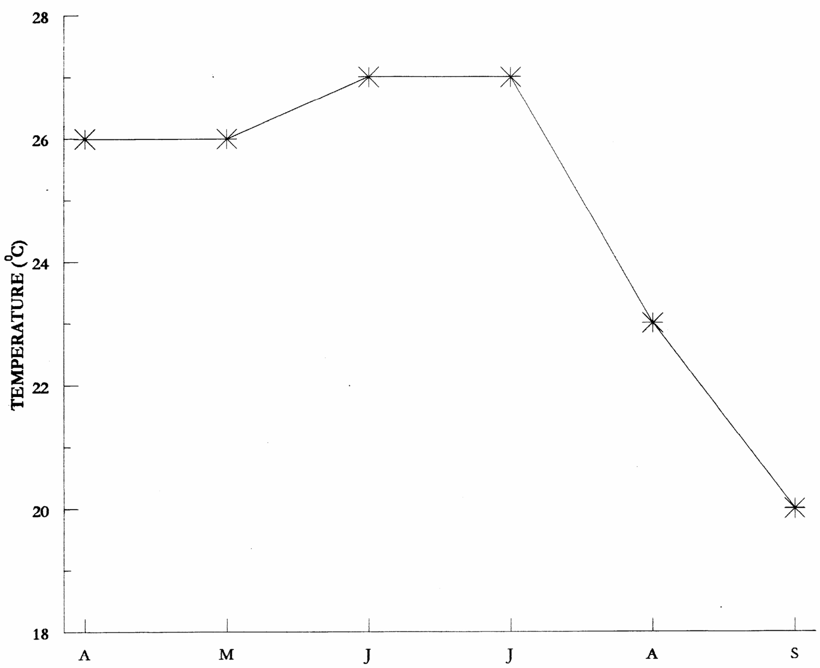

FIG. 1: THE MONTHLY VARIATION IN THE SURFACE WATER TEMPERATURE

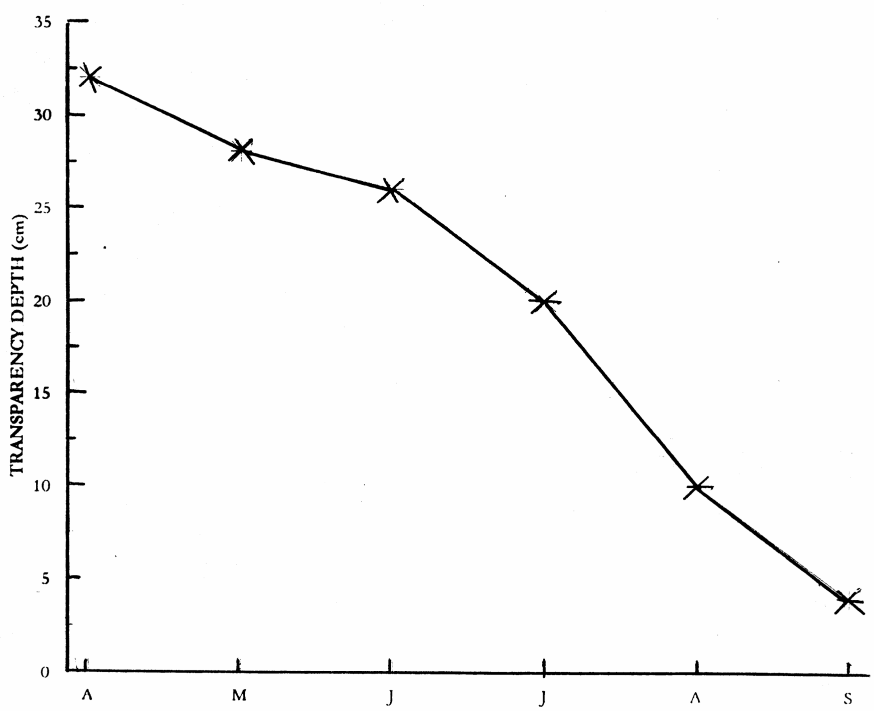

FIG. 2: THE MONTHLY SECCHI DISC TRANSPARENCY

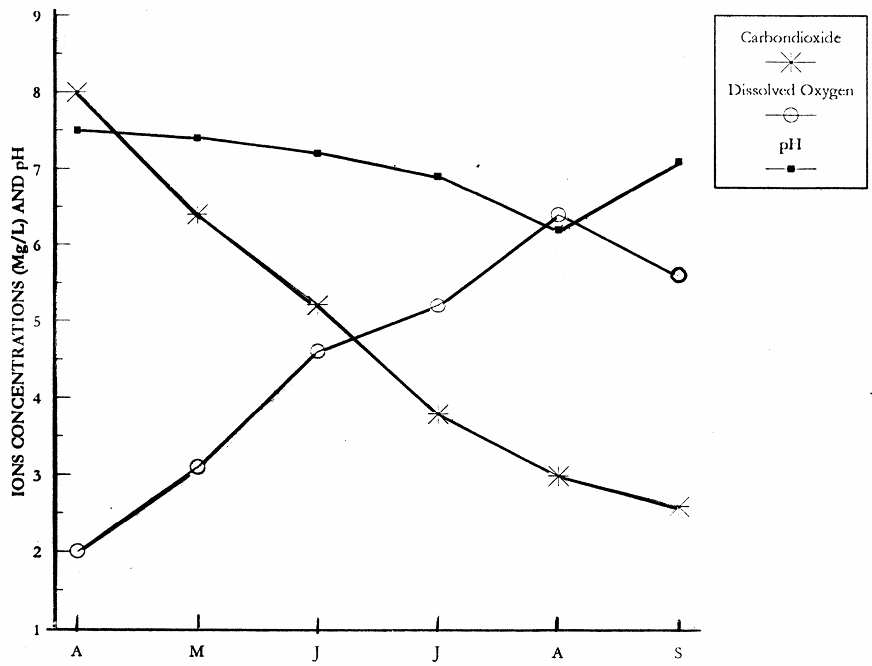

FIG. 3: MONTHLY DISSOLVED OXYGEN, CARBON DIOXIDE AND pH CONCENTRATIONS

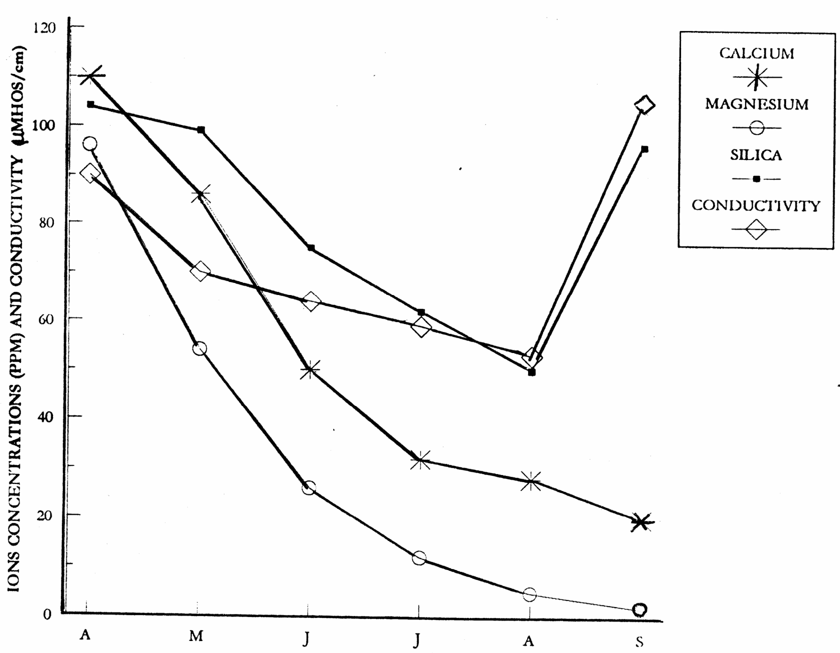

FIG. 4: THE MONTHLY CONCENTRATIONS OF CALCIUM, MAGNESIUM, SILICA AND CONDUCTIV

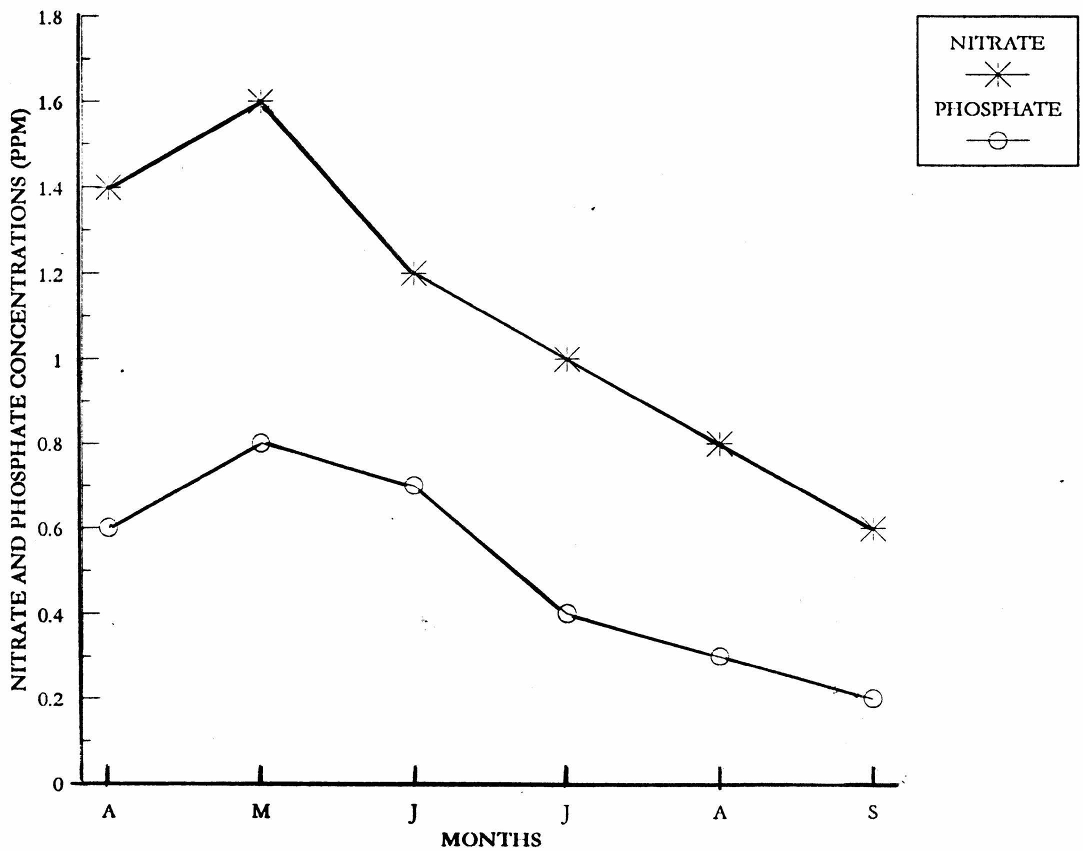

FIG. 5: THE MONTHLY CONCENTRATIONS OF NITRATE AND PHOSPHATE

The conductivity was later found to increase to 105 µmhos/cm in September (Fig. 4). Silica was the third most abundant ion recorded in the pond. A value of 104 mg/l was obtained in April, this became greatly deplated to 52 mg/l in August. Like conductivity, its value also increased to 96 mg/l in September (Fig. 4). The concentrations of Nitrate and Phosphates were found to be low compared to other ions. The highest values obtained for Nitrate and Phosphate were 1.6 mg/l and 0.8 mg/l and these were recorded in April. Like the other ions, their concentrations were also found to decrease with time till September (Fig. 5).

The occurrence and relative abundance of phytoplankton identified in the pond is presented in Table 1. Four classes were obtained with the Chlorophylceae (the Green algae) represented by six species of which *Spirogyra and Pediastrum* being the most abundant. The Cyanophylceae (Blue-green algae) has four species with *Oscillatoria* and *Anabaena* constituting about 60% of the class. Euglenophylceae is represented by just one species, *Euglena*. The class Baccillariophylceae *(Diatoms)* has three species, but were the most abundant in terms of number. The Zooplankton population in the pond fell into three phyla (Table 2). The Arthropod constituted the dominant phylum with *Daphnia* and *Cypris* being the most abundant in term of number. *Stentor* and *vorticella* were the most abundant Zooplankton in the phylum protozoa while Rotifera has only two species. *Notops* and *Harringia*. Table 3 shows the distribution, characteristics and relative abundance of the fauna communities in the pond. The fauna were classified into Nektons, Neustons and benthos. Majority of the fauna were Neustons and these are mainly insects that glideover the surface of the water. The Nektons observed were the frog *Rana* sp. and water turtle *Chresmy picta*. The Benthos were highly diversed and include worms, burrowing insects and insect larvae.

Table 1: Relative abundance of the phytoplankton of the Pond

Class	Genus	Relative abundance
Cyanophyceae	*Oscillatoria* sp	+ +
	Anabaena	+ +
	Coelophaerium	+
	Nostoc	+ + +
Euglenophyceae	Euglena *sp*	+ + +
Chlorophyceae	*Scenedesmus* sp	+ +
	Ulothrix	+ +
	Chlamydomonas	+ + +
	Hydrodicyton	+ + +
	Spirogyra	+ + + +
	Pediastrum	+ + + +
Bacillariophyceae	*Gyrosigma* sp	+ + + +
	Brebissonia	+ + + +
	Pinnularia	+ + + +

Table 2: Relative abundance of the Zooplankton

Class	Genus	Relative abundance
Protozoa	*Amoeba* sp	+
	Paramecium	+ +
	Stentor	+ + +
	Vorticella	+ + +
Rotifera	*Notops*	+ + +
	Harringia	+ + +
Anthropoda	*Nauplius larva*	+ +
	Simocephalus	+
	Daphnia	+ + + +
	Cypris	+ + + +
	Sida	+ + +

Table 3: The Fauna Communities in the pond

Phyllum	Genus	Relative abundance	Characteristics and distribution
Annelida	*Libyodrilus* sp.	+	Found as benthos,
	Tubifex	+ + +	Burrows occurs as
	Nais	+ + +	Benthos, found
	Aelosoma	+ + +	Among detritus.
Arthropoda	Water mite *Hygrobates*	+ +	Occurs as Neuston, glides
	Eristalsis	+ + +	Occurs as benthos
	Chrironomous larva	+ + + +	Occurs as benthos
	Mosquito larvae and Pupa	+ + + +	Occurs as Neuston
	Tipula	+	Found as benthos, burrows
	Ant	+ +	Lives in colony in the Soil
	Carabid beetle	+	Occurs as benthos, burrows
	Pond Skater	+ + +	Occurs as Neuston, lay
	Water boat Man	+ + +	Eggs on vegetation in water
	Dragon fly	+ + +	Glided over the water.
Amphibia	Frog: *Rana* sp.	+ +	Occurs as Nekton, feed on insect and breed in water
Reptilia	Water turtle: *Chresmy picta*	+ +	Occurs as Nekton, feed on insect and breed in water

Table 4: The Floral Communities of the Pond

Phyllum	Genus	Relative abundance	Characteristics and distribution
Emergent	*Luffa aegyptica* *(Cucurbitaceae)*	+ + +	Possess long Sinous leaves grow from the
	Leonotis repentifolia (Labiatae) *Typha australis* (Typhaceae)	+ + +	Bottom to produce leaves and flowers which arise above water surface
Submerged	*Sacciolepsis africana* (Poaceae)	+ +	Their foliage seldom reaches the surface.
	Fimbristylis ferruginea (Cyperaceae)	+ +	They poses long slender stem with thin leaves.
Floating	*Pistia Stratiotes* (Araceae)	+ + +	Found on water surface, root do not reach the bottom. Serve as sites for laying eggs by animals have broad leaves.
	Eicchornia crassipes (Pontederiaceae)		

Key:
+ = Few
+ + = Many
+ + + = Very Many
++++ = Highly abundant.

Discussion

The ecological factors investigated in this work have been known to have effect on the biotic community of freshwaters as reported by Hutchinson (1966). Temperature is one of the most striking phenomenon of ponds. It is one of the factors that determines distribution of organisms and other physical and chemical properties of water. A high temperature obtained in April could be due to the confined nature and shallowness of the pond. The high temperature follows that of the surrounding air because there is direct absorption of solar radiation by the water. The low temperature observed during subsequent months may be due to the water body losing heat rapidly as it gained from solar radiation. This reduced temperature and the nutrients contained in the water promoted the growth of algae and other phytoplankton.

The very low transparency recorded in September could be associated with heavy rainfalls which have washed silts and other debris into the pond, thereby causing the turbidity of the water. A similar effect was observed by Akande and Awotoye (1990)on Isinla lake. The bloom of phyto plankton and explosiveness of floating leaf plants *Eichhornia* and *pistia* also reduced the transparency of the water. Imevbore (1967) reportedthat dense algal growth was correlated with period of low transparency at Eleyele reservoir.

Changes in dissolved oxygen concentration occurs as a result of biological, chemical and physical processes going on in the water. The low value of dissolved oxygen obtained in April may be due to decomposition of decaying materials in the pond as reported by Rutner (1974). The subsequent increase in the concentration in May could be due to low temperature at that time which allows more oxygen to dissolve in the water as dissolved oxygen is inversely correlated with temperature. The increase may also be due to increased photosynthesis activities of phytoplankton and autochtonous oxygen production by aquatic macrophytes. Barclay (1966) made a similar observation in a temporary pond near Auckland, New Zealand while Biswass (1966) reported that dissolved oxygen is correlated with phytoplankton population. High rate of decomposition of organic materials coupled with low phytoplankton and plant populations may be attributed to the high carbon dioxide concentration recorded in April with the increasing population of plankton and plants in the pond, the carbon dioxide value becomes progressively reduced, suggesting that these organisms removed the CO_2 and utilizing it for the productivity. At this time also, active decomposition of organic materials have been reduced and this might lead to the low CO_2 observed.

The Hydrogen ion concentration of the pond water fell between 6.2 and 7.5. This agrees with Beadle (1981) observation that most natural water have a pH of between 6 and 9. The pH of the water supported a large community of organisms. The silica concentration was very high. This may be attributed to the washing of aluminium silicate minerals which are present in the honblende biotite gneiss rock which surrounds the pond. The high silica content promoted the growth and abundance of diatoms, consequently the bloom of the diatoms decreased the concentration of the silica.

The high Calcium and Magnesium concentrations might be due to the large amount of these elements in mineral deposit around the pond or from the water derived from rainfall as observed by Gibbs (1970). The Blue-green algae, the green algae and the aquatic macrophytes utilized these ions for their chlorophyll and their bloom considerably reduced their concentrations in water. Nitrates and phosphates ions were low, this was due to their uptake by Algae. Amos (1969) reported that Nitrates and Phosphate normally found in water is not more than 0.1ppm (Renn, 1970), but in this pond, the concentration phosphates exceeded 0.1ppm, this gave rise to Eutrophication which was observed in the pond. This created a favourable environment for increased growth of Algae and aquatic macrophytes.

The high dilution rate and the uptake of dissolved salts by organism in August might have resulted in the decrease of the ions (Salinity) observed at that time. According to Imevbore (1970), there is an inverse relationship between conductivity of water and discharge. This agrees with what was obtained in the pond, when the water was at its lowest, the conductivity was very high.

The availability of Nutrients and increase alkalinity of the water promoted the growth and diversity of phytoplankton. Round (1973) had observed that ponds with neutral to alkaline water, rich in nutrients often have a rich phytoplankton of Flagellates. The Rotifer and Cladocera dominated the Zooplankton. High concentration of calcium and the abundance of phytoplankton which serves as grazing food encouraged their population. Thus, predator – prey relationship exist among the Zooplankton and phytoplankton in the pond.

The fauna communities were highly diversed. The Benthic organisms such *Tubifex, Nais, Aeolosoma* and Chironomous larva which are species of benthic fauna of stagnant waters were readily found in the pond. The lentic nature of the water provided a good breeding surface for mosquitoes as evident from the numerous larva and pupa collected. Neustons such as dragon fly, water boatman and pond skater also had a good glinding surface on the pond, while frog and water turtle which constituted the Nektons were observed during the early rains in April. They invaded the pond to breed with insects and their larva serving as food for them.

The presence of *Eichhornia crassipes*, a floating leaf plant in the pond shows that the specie is not only a nuisance in rivers and lakes, but can also infest temporary waters and thus constitute a major problems towards effective utilization of such bodies. The submerged and emergent vegetation serve as breeding sites for the insects found in the pond which are sometimes vectors of diseases such as bilharzias and elephantiasis.

Temporary pond can be said to be a Microcosm or self contained world where physico-chemical conditions in it encourage and support a lot of biotic communities (Biocoenosis) with ecological interactions occurring between them. Such pond can be put into a good use for fish culture, microwater supply, irrigation and other viable uses to meet the increasing population demand for these products. Also, its resources, such as plankton and macrophytes can be harnessed and harvested for the formulation of artificial feeds, organic fertilizers and fodder for animals.

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