DYNAMICS OF LIMNOLOGICAL FEATURES OF A MAN MADE LAKE AND A WATERFALL IN RELATION TO PRAWN ABUNDANCE

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Abstract: Limnological features in relation to prawn catch at Asejire Lake and Erin-Ijesa waterfalls were studied from 2007 to 2009. The preponderance of *M.vollenhovenii* and *C. africana* in their natural habitats with intent towards acculturation was investigated. Sampling of each site for prawn abundance was bi- weekly. Prawns were collected with properly baited traps and scoop nets. Catches obtained from the two sites were isolated and conveyed in ice chest boxes to the laboratory for examination. Water samples were collected for physical and chemical water quality parameters assessment. Data collected were subjected to one way analysis of variance (ANOVA) and where differences in mean existed Duncan Multiple Range test was carried out using Statistical Package for Social Science (SPSS). Abundance in terms of number, sex and age were more during the wet season with a peak in August. Both adults and juveniles showed a progressive increase from late dry season to mid-rainy season (August). The results of physical and chemical parameters revealed that the mean water Temperature, Transparency, Depth, Dissolved Oxygen, pH, Alkalinity, Total Dissolved Solid, Conductivity, Nitrate and phosphate were 27.52±2.05^{0}C, 1.5 ± 0.44m, 3.16±1.3m, 6.70±0.82mg/l, 7.28 ± 0.55, 144.17 ± 30.05mg/l, 388.46± 211.48mg/l, 82.90±1.60µohms/cm, 4.62±0.79mg/l and 0.27± 0.04mg/l respectively at Asejire lake which were not significantly different (P>0.05) from the values of Erin-Ijesa waterfalls which were 27.77 ± 2.27^{0}C, 1.71 ± 0.39m, 1.43±0.22m,6.21±0.77mg/l,7.25±0.68, 136.62±41.6mg/l,402.13±253.25mg/l,83.40±1.86µohms/cm,4.76±0.76mg/l and 0.28±0.05mg/l respectively. Both water bodies exhibited features that are typical of tropical environment, as almost similar limnological factors were recorded which fell within the range that can support aquatic life. High value in Condition factor for both species under investigation shows the total well being of the prawns and suitability of their environment for sustainability.

Keywords: Limnology, Asejire Lake, Erin-Ijesa waterfalls, *Caridina africana*, *Macrobrachium vollenhovenii.*

INTRODUCTION

Shrimps, prawns along with crabs, lobsters are invertebrates belonging to Order Decapoda that are included in the Class Crustacea. There are about 8,500 species of decapods, including 2,000 species of shrimps, in the marine and brackish waters of the world (Wallace, 1997). Prawns are often confused with shrimps because physically they look very similar. One way to tell them apart is by the way in which the plate of the second abdominal segment of shrimps overlaps the segment in front and behind. Prawns have an abdominal side plates overlapping tile –like from the front.

Crustaceans are popular source of animal protein, minerals and vitamins (Balogun and Akegbejo–Samsons, 1992). Shell-fish aquaculture has been operated successfully in many countries, such as in Asia/Pacific and Latin American regions, making them one of the leading suppliers of shell fish in the world (Amadi, 1991). Shell-fish production in Nigeria is mainly export oriented with potential revenue of about U.S. $1.6million per annum. (Balogun and Akegbejo-Samsons, 1992).

More than 90% of crustaceans consumed in Nigeria are obtained from capture fisheries, mostly from artisanal, coastal and fresh water fisheries (Marioghae, 1982, FAO, 1996). There are large

varieties of prawns and shrimps which inhabit water bodies of Nigeria. The most common freshwater prawn species found in Nigeria Rivers are *Macrobrachium*, they are widely distributed abundant macro invertebrates in most aquatic system (Cook, *et al* 2002).

There are many fresh water prawns (*Palaemonidae*) of economic importance which have been identified as suitable species for aquaculture (Powell, 1982). *Macrobrachium vollenhovenii* has been discovered to have the highest aquaculture potential (Marioghae, 1987) as it completes its life cycle in fresh and brackish waters.

The literature available on limnology of lakes, rivers, streams, and reservoirs in Nigeria is vast (Ita, 1982), but there has been no previous attempt on comparative studies to monitor the bio-ecological features of a man-made lake and Waterfalls simultaneously in relation to prawn production.

The need to consider fresh water prawn culture, which is of economic value, is becoming imperative as little or no attention is paid to them in Nigeria. This study investigates the effect of limnological features of the natural habitats on growth of *Macrobrachium vollenhovenii* (African River Prawn) in Asejire Lake and *Caridina africana* (Rocky waterfall prawn) in Erin –Ijesa waterfalls as initial step before their suitability for culture is established.

MATERIALS AND METHODS

Description of Study Areas

Lake Asejire is man-made, constructed on River Osun in 1972. River Osun is one of the series of West African rivers which do not drain into Niger systems but discharge into coastal Lagoons and Creeks bordering the Atlantic Ocean.

The lake is Y-shaped with two unequal arms as shown in Fig. 1. It lies on latitude 7^o 23' North and longitude 4^o 05' East. The catchment area above the dam is 7,800km2 and the impounded area is 2,342 hectares. The dam has a normal pool elevation (water level) of 150m and maximum flood elevation of 152.4m. The lake has appropriate gross storage of 7,403 million litres. (Pers. Comm., Osun State Water Cooperation).

Erin-Ijesa waterfalls is situated in Oriade Local Government Area of Osun State within latitude 7^0 30' and 8^0 45' North and longitude 4^0 31'and 5^0 East. (Fig.2). The waterfalls is located two kilometers off Erin-Ijesa Town. Historically, the inhabitants named the fall "Olumirin"

Erin-Ijesa waterfalls have about seven layers and only few visitors can climb beyond the second layer. The area can also serve for mountain hiking. The water flows among the rock and splashes down with great forces to the evergreen vegetation around. The area is ideal for tourism and recreation.

Analysis of Limnological Parameters

Physical and chemical water quality parameters were monitored twice a month (October 2007 to September 2009) at both sites. **Temperature** was measured to the nearest 0.1^oC with mercury in - glass thermometer at about 10cm below water surface. **Transparency** was measured with a 15cm diameter white and black secchi disc to the nearest 0.1m. **Depth** was determined by using a lead sinker attached to a calibrated rope. The sinker was lowered until it reached the floor of the water. **pH** of water samples was determined in the laboratory using Kent pH meter 7020. **Dissolved Oxygen** was determined using Winkler titrimetric method (APHA, 1985). **Alkalinity** was also determined according to APHA (1985). **Conductivity** of the water samples was measured in μohms/cm by using the *HACH* Conductivity meter probe.

Total Dissolved Solid was calculated from the conductivity reading obtained. The conversion factor given in HACH conductivity meter was used to multiply the conductivity values, the values were multiplied by 0.7 (APHA 1985). **Nitrate** concentration was determined by using phenyl di-sulphuric acid as described by APHA (1985). **Phosphate** was determined by the ascorbic acid method according to APHA (1985).

Collection of Prawns

M. vollenhovenii were harvested at Asejire lake by the artisanal fishermen using single inlet double chamber traps. Scoop nets were used to collect *C. africana* at Erin-Ijesa waterfalls. The prawns were then isolated and placed in ice-chest boxes and transported to the laboratory for examination.

Laboratory Analysis

In the laboratory, prawns were counted, sorted into species, age, sexes and identified based on the taxonomic keys prepared by Reed *et.al*. (1967) and Lowe-McConnell (1972). **Sexes** of prawns were determined by visual examination of the second pleopods or chelipeds at the sides of the carapace as described by Powell (1982). The confirmation of male sex was by the presence of the appendix masculina in the second chelipeds also the genital pores are underneath the body at the base of the third pair of leg in the female (thelycum) and a gonopore at the base of the fifth pair of leg in the male (Patasma). (Edokpayi, 1990).

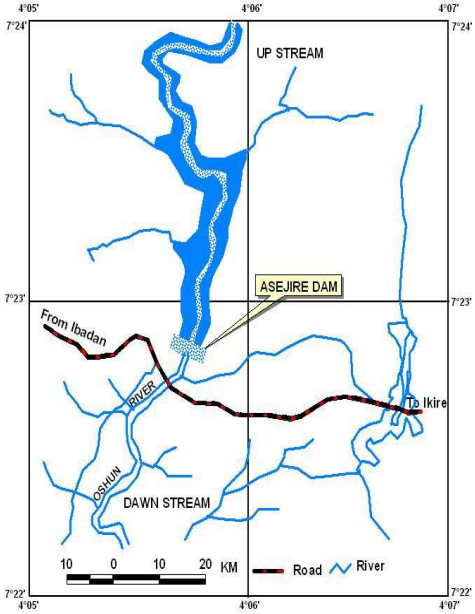

Figure 1: Map Showing Asejire Lake

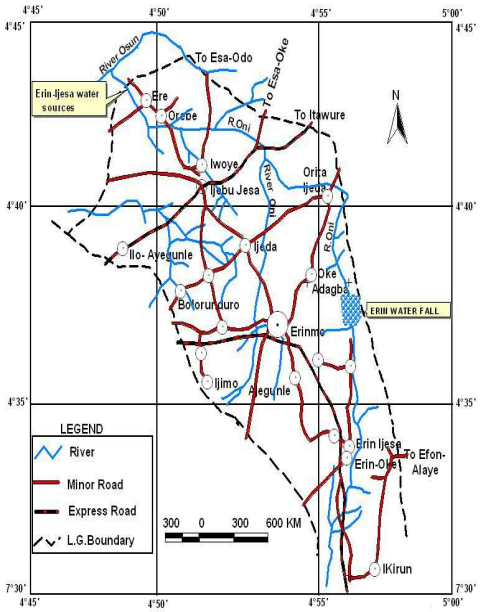

Figure 2: Map showing Erin-Ijesa Waterfalls

Table 1: Range and Mean Values of Physical and Chemical Parameters of Asejire Lake and Erin-Ijesa Waterfalls

Parameters	ASEJIRE		ERIN-IJESA	
	Range	**Mean ±SD**	**Range**	**Mean ±SD**
Depth (m)	1.87 – 6.70	3.16 ± 1.3 [a]	1.20 – 2.92	1.71 ± 0.39 [b]
Transparency (m)	0.70 – 2.20	1.50 ± 0.44 [a]	1.00 – 1.92	1.43 ± 0.22 [a]
Temperature (^{0}C)	24.20 – 31.00	27.52 ± 2.05 [a]	22.00 – 31.50	27.77 ± 2.27 [a]
pH	6.20 – 8.50	7.28 ± 0.55 [a]	6.08 – 8.22	7.25 ± 0.68 [a]
Alkalinity (mg/l)	94.00 – 188.00	144.17 ± 30.05 [a]	100.00 – 278.00	136.62 ± 41.6 [a]
Dissolved Oxygen (mg/l)	5.30 – 8.90	6.70 ± 0.82 [a]	5.10 – 8.30	6.21 ± 0.77 [a]
Nitrate (mg/l)	3.23 – 6.52	4.62 ± 0.79 [a]	3.45 – 6.66	4.76 ± 0.76 [a]
Phosphate (mg/l)	0.14 – 0.35	0.27 ± 0.04 [a]	0.13 – 0.36	0.28 ± 0.05 [a]
Conductivity (µohms/l)	81.00 – 86.70	82.90 ± 1.60 [a]	80.00 – 86.80	83.40 ± 1.86 [a]
Total dissolved solids ((mg/l)	142.00 – 782.00	388.46 ± 211.48 [a]	131.00 – 882.00	402.13 ±253.25

**Same superscripts along the row indicated that there are no significant difference at p>0.05.*

Table 2: Seasonal Mean Values and Range of Abundance of *M. vollenhovenii* and *C. africana*

Variables	*M. vollenhovenii*		*C. africana*	
	Mean ± SD	**Range**	**Mean ± SD**	**Range**
Male				
Dry season	15.83 ± 5.3[a]	10.00 – 28.00	16.71 ± 4.71[a]	10.00 – 24.00
Wet season	17.83 ± 2.4	15.00 – 23.00	19.5 ± 4.20	11.00 – 26.00
Female				
Dry season	30.75±7.73[a]	16.00 – 44.00	31.58 ± 8.11[a]	16.00 – 44.00
Wet season	38.67±6.08[a]	29.00 – 48.00	33.17 ± 4.55[b]	23.00 – 41.00
Juvenile				
Dry season	19.00±8.17[a]	10.00 – 35.00	19.75 ± 7.10[a]	10.00 – 35.00
Wet season	21.33± 5.55[a]	13.00 – 30.00	27.25 ± 5.03[b]	17.00 – 32.00

* Same superscripts along the row indicated that they are not significantly different at p>0.05.

Statistical Analysis

The relationships between the physical and chemical parameters were computed using linear regression routine of the SPSS 1.5 and Microsoft Excel One-Way Analysis of Variance (ANOVA) followed by Duncan New Multiple Range Test (DMRT) and Student T –test were used to compute results of the findings.

RESULTS AND DISCUSSION

The results of the physical and chemical parameters of Asejire Lake and Erin- Ijesa waterfalls during period of study are presented in Table 1. In both study sites, there are two distinct seasons, wet and dry seasons. Ayoade *et al*, (2006) stated that in the tropics, where the different seasons are not clearly demarcated, the amount and type of rainfall may play a significant part in regulating the various seasonal biological rhythms. The variations in chemical conditions of freshwater ponds have generally been found to be due to effects of rainfall (Bello-Olusoji *et al*, 2006)**.** Rainfall influences the amount of discharge into river and consequently into the lake. It has been pointed out that rainfall affects water quality at Asejire Lake and Warri River (Anetekhai, 1986; Egborge, 1994). Thus, due to the effect of rainfall on water level, physical and chemical parameter of lakes, the differences observed in amount and duration of rainfall between both sites may likely cause differences in physical and chemical parameters which will affect prawn growth and production. Lower atmospheric temperatures were recorded in the rainy season in both sites. This may be associated with rainfall and relative humidity which were higher during rainy season, thus lowering the atmospheric temperature. However, lower water temperatures were observed in November (24.2^{o}C) and December (25.0 ^{o}C) in Asejire lake and this is likely to be due to harmattan. In Erin-Ijesa waterfalls low temperatures were observed in January (22.0^{o}C) and November (24.0^{o}C). This could be due to harmattan and the rocky and shady environment.

Depth of these water bodies differ statistically, Erin-Ijesa waterfalls is shallower than the Asejire Lake. The shallowness of Erin-Ijesa waterfalls allows the insolation of light to the water bottom. This feature accounts for the higher plankton density observed in Erin-Ijesa. In aquatic ecosystem dynamics, light penetration and water depth influence the rate of photosynthetic activities which in turn can change the amount of dissolved oxygen in the water. This observation agrees with the view of Adeniji (1990) who stated that photosynthesis is limited to only the top 1m depth of water. Smith and Swingle (1983) also showed a positive relationship between plankton abundance and fish production in pond. However, low temperature in Asejire could be due to the regular influx of water from the dam gate to the downstream which could possibly reduce the water temperature.

The lowest water level recorded coincided with period when little or no rainfall occurred in all the sites. Highest water level recorded showed that intensity of rainfall varies from one site to another. Also,the consistently higher water level in Asejire implied that rainfall was highest and of longer duration in this period.

The inverse relationship between transparency and rainfall in this study agrees with those of Egborge (1977) in some Nigerian freshwaters. Means transparency values of 1.50m ± 0.44 at Asejire lake and 1.43m ± 0.22 at Erin-Ijesa waterfalls recorded were almost similar to values documented by Ugwumba and Ugwumba (1993). This shows that Asejire lake during the dry season contain adequate nutrients hence its being fairly turbid (Ugwumba and Ugwumba, 1993). The higher dry season secchi-disc transparency mean values than those of the wet season values in all sites could be due to the absence of flood water, surface run-off and settling effect of suspended matter which followed the cessatation of rainfall.

pH in Asejire Lake and Erin-Ijesa waterfalls were 7.28 ± 0.55 and 7.25 ± 0.68 respectively, making these waters very good for fish/prawn production, since Boyd and Lichtkoppler (1979) reported that waters with pH range of 5.5 to 9.0 are most suitable for fish production. High mean values in pH could be due to combined effects of greater water volume and rocky landscape at Asejire lake and Erin-Ijesa waterfalls that could produce high calcium carbonate effluent contents which increased the pH. On the other hand, the lower pH value could be as a result of high acid content of organic effluents.

Dissolved oxygen concentration was high because the water bodies are lotic water. The water has high velocity which generates the ripple that could eventually increase the Dissolved oxygen content. This might be responsible for the observed high oxygen content. In addition, dissolved oxygen content in the water could be high as a result of phytoplankton density especially in Erin-Ijesa waterfalls which is shallow and has high plankton density. In general, a maximum of 8.90 mg/l dissolved oxygen concentration was recorded, although less than this value, as low as 5 mg/l dissolved oxygen would be satisfactory limit for most of the processes required for a successful prawn life cycle. Since the oxygen of the natural habitat is high,

it could mean that the prawn would require relatively high dissolved oxygen content when cultured. However, this is contrary to the observation of Marioghae (1987) who reported that *M. vollenhovenii* could survive in water with low dissolved oxygen of 2.0mg/l.

Seasonal variation in values of Total Dissolved Solids (TDS) could be as a result of dilution from rainfall since lower values were recorded during the wet season at Asejire Lake and Erin – Ijesa waterfalls mainly between June and October when the rainfall was at its peak. The observation that higher TDS values were recorded during the dry season months (March to May) were supported by Egborge (1977) and Adeniji, (1991), that water temperature affect TDS. According to them a rise in temperature also results in a corresponding increase in the concentration of TDS.

Nitrate value of Asejire Lake ranged from 3.23-6.52mg/l while that of Erin-Ijesa waterfalls was from 3.42-6.66mg/l. At Asejire lake phosphate ranged from 0.14-0.35mg/l while it was from 0.13-0.36mg/l in Erin-Ijesa Waterfalls. Adeosun (2007) in his study observed that the concentration of nitrate in Ikere Gorge ranged between 3.25-7.1mg/l and phosphate ranged between 0.14-3.7mg/l. The nitrate values were low and phosphate high when compared to the recommended concentrations of 10mg/l and 0.005mg/l respectively for nitrate and phosphate in drinking water for human by world health organization. According to Ikenweiwe (2005), the values recoded for nitrogen and phosphorus in Oyan lake were higher ranging between 41.10 – 62.64mg/l and 0.64 – 0.88mg/l respectively as compared with those of other Nigerian water such as Asejire Lake. Phosphorus and nitrogen are known to play major role in biological metabolism of aquatic plant notably phytoplankton and macrophyte (Wetzel, 1983).

The conductivity value of Asejire lake ranged from 81.00-86.70 mg/l (Mean =82.90 ± 1.60 mg/l). It ranged at Erin-Ijesa waterfall between 80.00-86.80 mg/l (Mean=83.40 ± 1.86 mg/l). However, there was no significant difference between the values in the two sites. The larger the conductance, the more mineralized the water (McNeely *et al* 1979). The conductivity of water was observed to be higher during the period of higher temperature when the dissolved oxygen was lower. This is also in accordance with the observation of (Ayoade *et al* 2006) in their work on the limnology of two man-made lakes. It was reported that the distribution patterns of conductivity were in several respect mirror images with those of the temperatures.

The relationship between fish yield and water parameters in this study showed that no single parameter can be singled out in relation to prawn species composition and abundance. However, temperature, transparency, dissolved oxygen, pH and depth when kept at optimal level can guarantee high prawn yield.

Prawn Abundance

The seasonal abundance of *M vollenhovenii and C.africana* revealed that the highest prawn catch was recorded in wet season irrespective of the stage of development and sex but the lowest seasonal abundance occurs during the dry season. One – way ANOVA revealed that seasons have a strong effect on the abundance of the male *M. vollehonvenii* because, it shows significant difference at ($p<0.05$). Male of *M. vollehonvenii* shows a significant difference ($p<0.05$) when the effect of monthly abundance is considered but it has no effect on the female and juveniles. The implication of this statistics is that the number of females and juveniles caught were varied but that of the male was relatively constant over the months of the study. In *C.africana* the abundance of juveniles was more during the wet season than the dry season. However the abundance of adult *C.africana* was not affected by season. This is further illustrated in Table 2

CONCLUSION AND RECOMMENDATIONS

Asejire Lake and Erin-Ijesa water fall exhibited features that are typical of tropical environment. The physical and chemical parameters that were observed for both water bodies fall within the range that can support aquatic life, thus making them productive. (Boyd and Lichtkoppler, 1979, Aquacop 1977). This could be responsible for the success of these species in these water bodies. The rise in condition factor values for both species under investigation shows the total well being of the prawns and suitability of the environment for prawn sustainability. The water chemistry of both water bodies was influenced principally by physical and chemical nature of inflows into it and also of the submerged vegetation and soils (Egborge, 1979). Spatial and seasonal variations in the limnological and biological parameters bring about changes in the quality and quantity of prawns produced. These marked variations were observed between samples, sites, months and seasons as they affect prawn resources within both sites.

Based on the findings, the following recommendations were made: (a) The results of this research can be used as baseline in commencing their production in artificial environment (b) Efforts should be made to keep data on their exploitation to prevent them from extinction. (c) Production of the two species under this study should be maximized like its finfish counterpart in order to get their full potential for sustainable development and poverty

alleviation. (d) Research on the hatchery production of freshwater prawns should he intensified. (e) There is need to cage-culture *C. africana* in its natural environment at the initial stage, providing artificial feeds so as to improve the size. (f) The economic viability of freshwater prawn farming in Nigeria should be investigated. (g) The two study sites where these prawns are found should be protected from destruction as a result of human activities so as to prevent them from extinction because they are habitat specific.

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