The Water Chemistry, Crustacean Zooplankton And Some Associated Faunal Species Of A Tropical Tidal Creek In Lagos, Nigeria

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Abstract: The water chemistry characteristics, crustacean zooplankton and associated species spectrum of the Abule-Agege creek was investigated. The water chemistry and zooplankton characteristics showed variations in response to tidal (brackish water) incursion from the adjoining Lagos lagoon and inflow of fresh water conditions from land. The transparency values of the area increased with reduction in the amount of rainfall while the water temperature as well as salinity values increased appreciably with the dry season. The pH of the area was alkaline throughout the study. The adult zooplankton spectrums were from four main phyla namely: the crustaceans (Arthropoda) being the most prominent. Other associated species were from the phyla Chaetognatha, Chordata and Cnidaria. The Arthropoda made up 59.31% (excluding juveniles), the Chaetognathas comprised 0.81%, the Chordates 0.20% and the Cnidarians recorded 2.83% of the total zooplankton crop. Similarly, the total recorded juvenile stages were dominated by crustacean forms. They were the zoea, megalopa, nauplii, fish larvae and fish eggs. Higher number of individuals was encountered in February and portends suitable hydro-climatic conditions at the period in terms of nutrients and water chemistry characteristics. [Journal of American Science 2010;6(1):81-90]. (ISSN: 1545-1003).

Key words: water chemistry, zooplankton spectrums, zoea larvae, megalopa, nauplii

1. Introduction

Crustaceans are an important and successful group in the ecology of marine ecosystems especially with regards to trophic relationships. Presently, there are over 45,000 species in this group (Pechenik, 2005). Crustaceans are consumed by man, important in eliciting data from fossils and are good indicators of water chemistry status. Furthermore, some adult crustaceans as well as the juveniles of a good number of this group are known to be planktonic. Holoplankton crustaceans accounts for at least 70% of the total zooplankton of the sea (Olaniyan, 1969, 1975; Nybakken, 1988) and marine meroplankton forms consists of a wide array of larvae with crustaceans having the greatest number of forms (Lawal-Are, 2006; Olaniyan, 1975 and Onyema *et al*., 2003). Hence, zooplanktonic crustaceans permanently exist as plankton while other are zooplankton spend only part of their life cycle in the plankton (Olaniyan, 1969; Odum, 1971; Waife and Frid, 2001). According to Lawal-Are (2006), the presence of three stages of larval development of *C. amnicola* (early zoea larval stage, late zoea larval stage and megalopa) observed in the plankton haul in the Lagos lagoon during the months of March and April was indicative of early life history beginning in the high brackish water. A few other studies on the zooplankton community in south-western Nigeria include Olaniyan (1969, 1975), Akpata *et. al.* (1993), Onyema *et. al.* (2003, 2007), Emmanuel and Onyema (2007) and Onyema and Ojo (2008).

Tidal creeks are known to be fertile coastal environment used as feeding and nursery grounds by a large number of fishes and aquatic crustaceans (Kusemiju, 1991). In south western Nigeria, a number of ecological studies have been carried out over the years with regards to the study of crustacean in the creeks and lagoons. Published works in this area include a study of the pink shrimp, *Penaeus duorarum* off Lagos coast (Kusemiju, 1975), while Bayagbona *et. al.***,** (1971) and Adetayo, and Kusemiju (1994) evaluated the shrimp resources of Nigeria particularly those of the Lagos coastal area. Shrimps, crabs, lobsters and molluscs that constitute the shellfish resources of Nigerian coastal environment were reported by Dublin-Green and Tobor (1992). More recently are literature on the biology of the lagoon crabs, *Callinectes amnicola* and smooth swim crabs, *Portunus validus* (Lawal-Are, 2003; Lawal-Are and Bilewu, 2009). Furthermore, Lawal-Are and Kusemiju (2009) reported on the effect of salinity on the survival and growth of the blue crab, *Callinectes amnicola* from the Lagos Lagoon.

The aim of this study was to investigate the zooplankton assemblage with special emphasis on the crustacean in relation to water chemistry characteristics in the Abule-Agege creek.

2. Materials and Methods

2.1. Description of Study Site

Abule – Agege creek (Fig 1) is a brackish water creek situated within the fringe of the University of Lagos and its linked to the Lagos lagoon. The site of this study is located at about longitude $06^{o}30^{o}$ 614 and latitude $003^{o}24^{o}142$ Lagos, Nigeria. The creek is shallow (≤1m), tidal and sheltered. It is fed by water from the adjoining Lagos lagoon at high tide, and at low tide the water ebbs through it into the lagoon. The region is located in south-western Nigeria and hence exposed to two distinct seasons, the wet (May - October) and the dry season (November - April) (Nwankwo, 1996). The creek meanders through a mangrove swamp which is inundated at high tide and partially exposed at low tide. Some notable species located in the swamps include *Paspalum orbiquilare, Acrotiscum aureum, Phoenix reclinata, Rhizopohora racemosa, Avicenia nitida, Drepoanocarpus lunatus* and *Cyperus articulatus*. Notable fauna include *Periopthalmus* sp, *Balanus pallidus, Chthamalus* sp, *Uca tangeri, Seserma huzardi, Gryphea gasar, Tympanotonus fuscatus* var. *radula* and shorebirds that browse the area especially at low tide.

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2.2. Collection of Water and Plankton Samples

Water samples were collected from the creek (Abule-Agege) at one station in the 1st and 3rd week of four consecutive months (January - April 2008) from the creek. The collection was carried out between 8 and 12hr on each sampling day. The water samples were collected with 50cl plastic containers with screw caps just below the surface of the water, labeled and taken to the laboratory for further water physico-chemistry analysis.

The plankton was collected using a standard plankton net of 55µm mesh size. The net was tied unto a motorized boat and towed horizontally at low speed (< 4 knots) for 5 minutes.

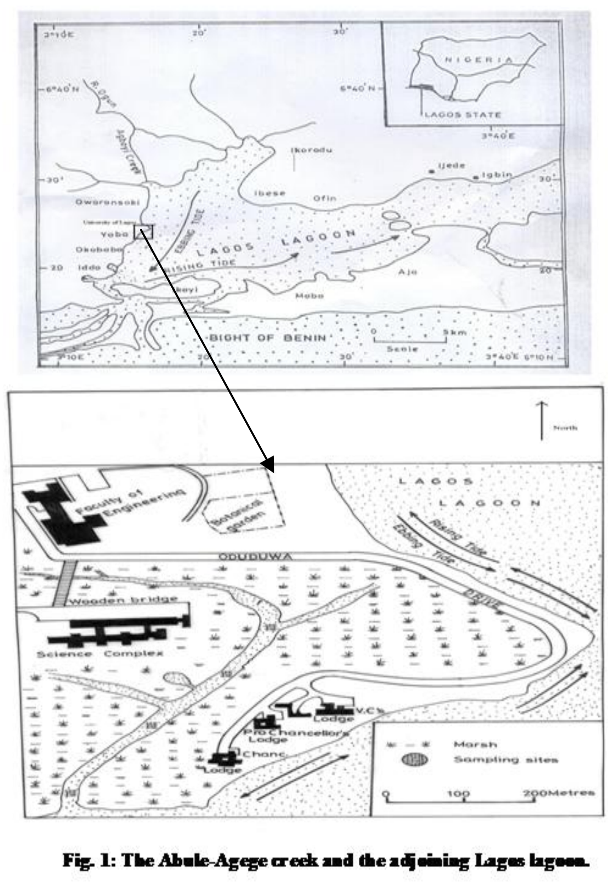

Fig. 1: The Abule-Agege creek and the adjoining Lagos lagoon.

After 5 minutes, the horizontal plankton haul was retrieved and the plankton samples were concentrated and stored in 50cl plastic containers with screw caps. Samples were labeled properly after which 4% unbuffered formalin was added to preserve the organisms.

2.3. Analysis of Physical and Chemical Parameters

Air and surface water temperatures were measured in-situ using a mercury thermometer while water depth was estimated with a calibrated pole. Salinity was determined using a refractometer (BIOMARINE Aqua Fauna Model). Transparency was measure using a 20cm black and white secchi disc. Total Dissolved Solids (TDS) were determined by evaporating 100ml aliquot at 105^{o}C and Total Suspended Solids (TSS) estimated by filtering 100ml of sample through a pre-weighed filter paper, dried to constant weight and reweighed. Conductivity was measured using a Philip PW9505 Conductivity meter. The surface water pH was determined with a Griffin pH meter (model 80) while dissolved oxygen was measured using a Griffin oxygen meter (Model 40). Biological and chemical oxygen demands were measured using methods described in APHA (1998) for water analysis. Calorimetric methods using a Lovibond Nessler were adopted for the direct determination of phosphate-phosphorus and nitrate-nitrogen values while sulphate levels were measured using the gravimetric method (APHA, 1998). Calcium and magnesium ions were determined using a 400 single channel, low flame photometer (APHA, 1998). Concentrations of copper, iron and zinc were determined with an atomic absorption spectrophotometer (AAS) Unicam 99model.

2.4. Zooplankton analysis

Plankton samples were allowed to settle in the lab for at least 24hr and concentrated by filtering via a filter paper to 20ml (filtrate). For each bottle five drops of well mixed samples were thoroughly investigated. On each occasion, one drop of sample was investigated using the Drop Count Method described by Onyema (2007). For each mount as many transects were thoroughly investigated with each transect at right angles with the first. Zooplankton species were examined, identified and counted using a Carl Zeiss Standard IV monocular microscope also consulting appropriate texts to aid identification (Newell and Newell, 1966; Wimpenny, 1966; Olaniyan, 1975; Gibbons, 2001; Waife and Frid, 2001). The number of each taxa occurring in each field and the total number of taxa per group were recorded as number of organisms per ml.

3. Results

3.1. Water Quality Indices

The bi-monthly variation in water quality indices at the Abule-Agege creek linked to the Lagos lagoon between January and April, 2008) is shown in Table 1and Figs. 2, 3 and 4.

Air temperatures during the study ranged from 18 to 29^{o}C, while rainfall values were between 17.6 and 74.4mm and Salinity ranged between 15.2 and 24.3‰. Transparency ranged from 95.5 to 149.5cm while conductivity was between 95.5 and 149.5cm. Total Dissolved Solids (TDS) and Total Suspended Solids (TSS) range between 13255 and 23162 mg/L and 3 and 122mg/L respectively while chloride was between 7910.0 and 13200mg/L. Acidity ranged from 4.0 to 11.8mg/L while Alkalinity was between 75 and 280 mg/L. Lowest value for Dissolved oxygen recorded was 3.9mg/L and the highest value was 5.0mg/L. Biological Oxygen Demand and Chemical Oxygen Demand were between 8 and 122mg/L and 39 and 388mg/L respectively. Values for nitrates was between 2.6 and 8.1mg/L, phosphate ranged between 0.06 and 2.6mg/L, sulphate ranged between 300.8 and 620mg/L and silica values were between 2.0 and 3.9mg/L. The cations which included calcium and magnesium ranged between 61.2 – 1005.0mg/L and 655.6 and 1290mg/L respectively. The monthly range in variation of the heavy metals were notable copper (0.002 – 0.008mg/L), Iron (0.08 – 0.16mg/L) and Zinc (0.003 – 0.03mg/L).

3.2. Biological Characteristics

The composition and abundance of zooplankton species at the Abule-Agege creek in the 1st and 3rd weeks between January and April, 2008 are presented in Table 2, Figs. 3, 4 and 5. The zooplankton throughout the sampling period were represented by four phyla namely: Arthropoda, Chordata, Chaetognatha and Cnidaria. A total of 2,470 individuals were recorded throughout the period of study. The arthropods which were the most abundant accounted for 1,465 individuals which gave 59.31% of the total individuals recorded. The chordates recorded 5 (0.20%), the cnidarians recorded 70 (2.83%), the chaetognatha recorded 20 (0.81%). The juvenile stages comprised the Barnacle nauplii, Copepod nauplii, Zoea larva, Megalopa, Fish egg and Fish larva which made up 36.84% of the total individual recorded. Zooplankton species with high occurrence throughout the sampling months include: *Nauplii* larvae, *Acartia clausii, Acartia discaudata* and *Cyclopina longiconis*. Other forms that occurred during the study were *Paracalanus* sp, *Calanoides, Oncaea, Penillia, Mysid* and *Sagitta* species.

3.3. Zooplankton Community Structure Analysis

The analysis of species diversity index, species richness, species equitability index and other bio-indices showed monthly variations (Table 3), while the relative abundance of zooplankton classes is shown in Fig. 4 and the percentage abundance of Juvenile stages in Fig. 5.

Table 1: Bi-monthly variation in water quality indices at the Abule-Agege creek of Lagos Lagoon (January – April, 2008).

PARAMETERS	January		February		March		April	
	1st week	3rd week	1st week	3rd week	1st week	3rd week	1st week	3rd week
Air Temperature (°C)	18	22	26	22	25	28	25	29
Water Temperature (°C)	27	24	28	26	28	27	28	30
pH at 26°C	7.49	7.57	7.17	7.43	7.44	7.11	7.38	7.51
Transparency (cm)	102.7	106.5	132.0	131.0	149.5	103.6	95.5	124.4
Conductivity (μS/cm)	29600	25500	30900	35200	41500	24900	38600	33700
Total Dissolved Solids (mg/L)	15390	13255	16351	18650	21980	14940	23162	21300
Total Suspended Solids (mg/L)	108	101	122	10	11	5	4	3
Rainfall (mm)	74.4		17.6		44.5		65.3	
Salinity (‰)	17.30	15.20	18.50	20.3	24.3	16.7	22.6	20.6
Chloride (mg/L)	8963.6	7910.0	8966.5	10100.0	13200.0	8864.0	12188.0	11080.1
Total Hardness (mg/L)	4680.1	6255.0	4865.5	5020.1	6335.0	4865.0	5556.0	6255.0
Acidity (mg/L)	11.3	11.8	5.2	4.1	4.0	4.2	4.0	4.0
Alkalinity (mg/L)	210.5	210.0	75.0	188.0	280.1	205.0	220.1	222.8
Dissolved Oxygen (mg/L)	4.0	4.2	3.9	4.8	4.9	4.3	4.8	5.0
Biochemical Oxygen Demand (mg/L)	105	122	26	20	24	16	12	8
Chemical Oxygen Demand (mg/L)	360	388	205	180	195	50	44	39
Nitrate (mg/L)	2.6	4.0	2.6	6.8	5.4	8.1	5.9	6.6
Phosphate (mg/L)	1.1	0.9	1.24	2.6	1.4	0.08	0.10	0.06
Sulphate (mg/L)	350.0	300.8	320.5	410.1	502.5	500.0	600.0	620.1
Calcium (mg/L)	895.9	905.3	695.0	722.8	1005.0	61.2	66.0	64.3
Silica (mg/L)	2.1	2.2	3.9	3.2	3.0	3.6	2.9	2.0
Magnesium (mg/L)	655.6	950.0	744.6	695.3	968.5	1127.3	1290.0	1108.9
Copper (mg/L)	0.002	0.002	0.004	0.008	0.005	0.006	0.005	0.003
Iron (mg/L)	0.16	0.15	0.102	0.16	0.14	0.10	0.08	0.12
Zinc (mg/L)	0.028	0.030	0.003	0.010	0.008	0.020	0.013	0.022

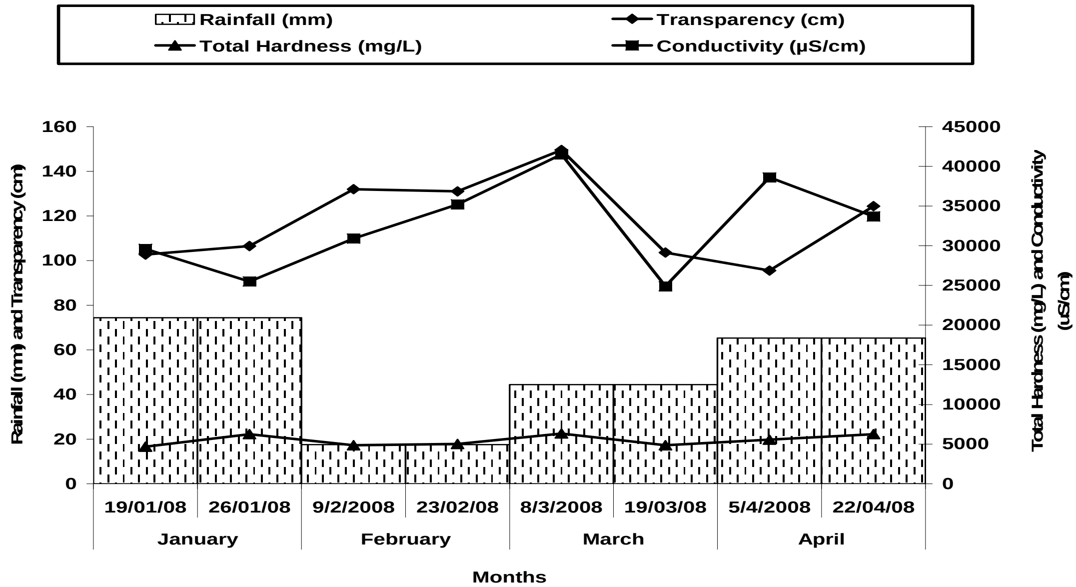

Fig. 2: Bi-monthly variation in Conductivity, Transparency, Total Hardness and Rainfall at the Abule-Agege Creek of the Lagos Lagoon. (January – April, 2008).

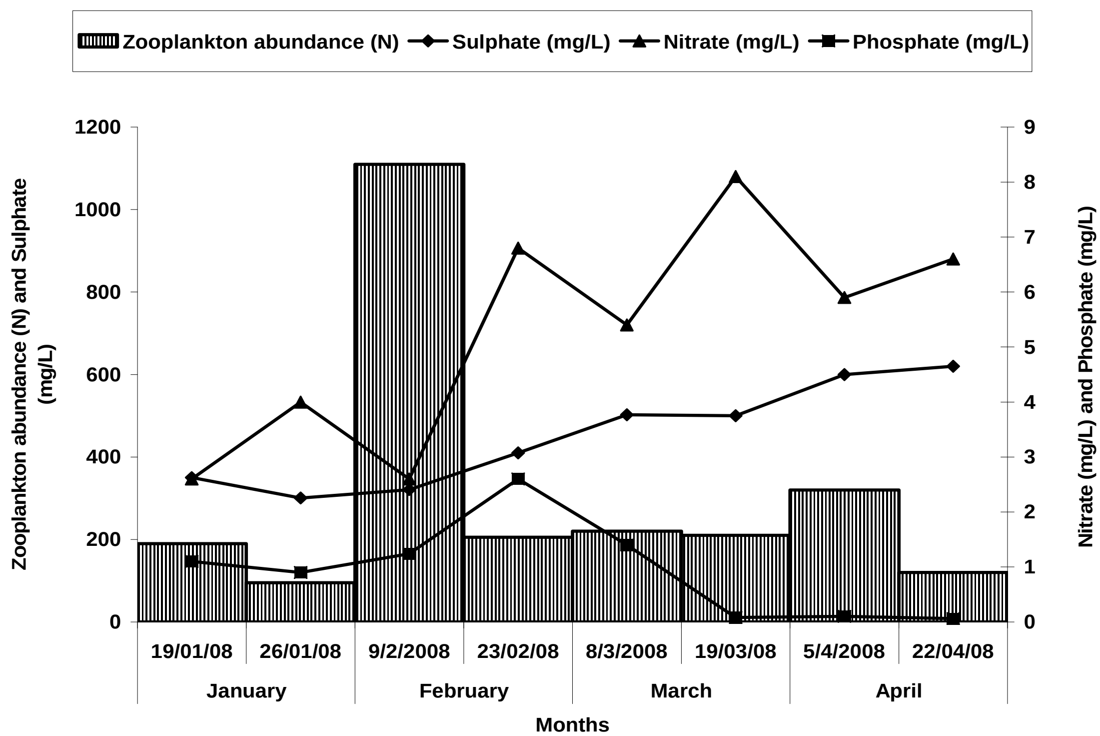

Fig 3: Bi -monthly variation of Zooplankton abundance and some nutrients at the Abule-Agege creek of the Lagos Lagoon (January – April, 2008).

Table 2: Bi-Monthly Variation In Zooplankton Taxa (Cell/ml) At The Abule - Agege Creek (January–April, 2008)

TAXA	**JANUARY**		**FEBRUARY**		**MARCH**		**APRIL**	
	1st week	**3rd week**	**1st week**	**3rd week**	**1st week**	**3rd week**	**1st week**	**3rd week**
PHYLUM :ARTHROPODA								
CLASS: CRUSTACEA								
SUBCLASS I: COPEPODA								
ORDER: CALANOIDA								
FAMILY: PARACALANIDAE								
Acartia clausii Giesbrecht	75	20	35	90	15	15	75	30
Arcatia discaudata Giesbrecht	20	55	55	55	5	25	115	45
Arcatia tonsa Giesbrecht	-	5	5	25	-	10	-	-
Calanoides carinatus	-	-	10	-	10	-	-	-
Paracalanus parvus Claus	5	5	15	-	-	-	-	5
ORDER 11: CYCLOPOIDA								
FAMILY: CYCLOPOIDAE								
Cyclopina longiconis Boeck	5	-	450	-	-	5	55	-
Oncaea sp.	-	-	40	-	-	-	15	-
ORDER 111: HEPATICOIDA								
FAMILY: HEPATICOIDAE								
Clytemnestra scutellata	-	-	10	-	-	-	-	-
SUB-CLASS 11: BRANCHIOPODA								
ORDER 1:CLADOCERA								
Penillia avirostris Dana	-	-	5	5	10	-	-	10
Evadne tergestina Claus	-	-	-	-	-	-	-	15
SUB-CLASS 111: MALACOSTRACA								
ORDER : MYSIDACEA								
Mysid sp.	-	-	5	5	5	-	-	-
PHYLUM :CHAETOGNATHA								
ORDER: APHARAGIMORPHA								
Sagita enflata Vogt	-	-	-	-	20	-	-	-
PHYLUM : CHORDATA								
CLASS : LARVACEA								
Oikopleura dioica Vogt	-	-	-	-	5	-	-	-
PHYLUM :CNIDARIA								
SUB-PHYLUM: MEDUSOZOA								
CLASS: HYDROZOA:								
Unidentified jelly fish	10	-	30	5	-	20	-	5
JUVENILE STAGES								
Fish egg	-	-	5	-	5	-		-
Fish larvae	-	-	5	-	-	-	-	-
Megalopa larva	-	-	-	-	5	-	-	-
Zoea larva	5	5	15	5	25	20	30	-
Nauplii larva of copepod	55	-	175	-	10	10	25	-
Nauplii larva of barnacle	15	5	250	15	105	105	5	10

Table 3: Zooplankton Community Structure Indices at The Abule-Agege creek (January – April, 2008).

	JANUARY		FEBRUARY		MARCH		APRIL	
	1st week	3rd week	1st week	3rd week	1st week	3rd week	1st week	3rd week
Total species diversity (S)	8	6	16	8	12	8	7	7
Total zooplankton abundance (N)	190	95	1110	205	220	210	320	120
Log of Species diversity	0.90	0.78	1.20	0.90	1.08	0.90	0.85	0.85
Log of zooplankton abundance	2.28	1.98	3.05	2.31	2.34	2.32	2.51	2.08
Shannon-Wiener Index (Hs)	0.70	0.55	0.78	0.66	0.80	0.70	0.71	0.72
Menhinick Index (D)	0.58	0.62	0.48	0.56	0.81	0.55	0.39	0.64
Margalef Index (d)	1.33	1.10	2.14	1.32	2.04	1.31	1.04	1.25
Equitability Index (j)	0.77	0.70	0.65	0.73	0.75	0.78	0.84	0.85
Simpson's Dominance Index (C)	0.26	0.39	0.25	0.29	0.26	0.29	0.23	0.22

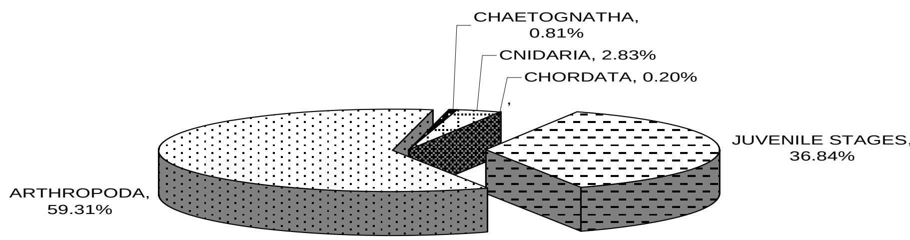

Fig 4: Relative abundance of zooplankton classes at the Abule-Agege creek of the Lagos Lagoon (January–April, 2008).

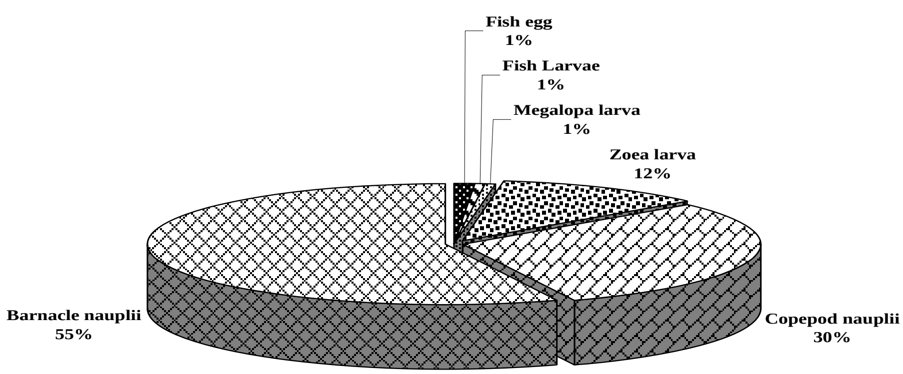

Fig 5: Percentage abundance of Juvenile stages at the Abule-Agege creek

4. Discussion

The present water chemistry data confirms an earlier report by Emmanuel and Onyema (2007), though fewer parameters were investigated in that study for the creek. According to them, the diluting and enriching effects of floodwaters, inflow of lagoon brackish water hence the existence of environmental gradients, governs the distribution of creek and lagoon biota in south-western Nigeria. Air and water temperatures were typical for the tropics and similar regimes have been reported by Lawal-Are (2006). The surface water pH values in the Abule-Agege creek were alkaline in all the months this alkaline pH may be due to the buffering effects of the seawater (Onyema *et al*., 2007). Nwankwo (1990) highlighted that seasonal variation in transparency in the coastal waters of South-western Nigeria is linked to the rainfall pattern and associated floods. Furthermore, high transparency values confirm the known phenomenon that transparency and rainfall are inversely related in the region. Conductivity values of the study site increased with rise in the total dissolved solids and a decrease in the total suspended solids. These variations to a large extent could be attributed to the effect of tidal sea water incursion and also freshwater input from adjoining creeks and land as expected during the dry season (Onyema, 2009).

Salinity regimes in the Lagos lagoon have been related to rainfall distribution. According to Fagade and Olaniyan (1975), Nwankwo (1996) and Onyema *et. al*. (2006), salinity is an environmental barrier in the distribution of biota. The cations values (Calcium and Magnesium) recorded were relatively high and increased with the dry season while the heavy metal concentrations were low. Nutrients concentrations recorded were high especially sulphates. The high levels of nitrate-nitrogen and sulphide may be due to the effect of direct discharges of pollutants and other biodegradable wastes into the coastal waters coupled with the enrichment of adjoining wetlands, creek and subsequent run-offs for the coastal water of south-western Nigeria. The level of the phosphate-phosphorus and nitrate-nitrogen during the period suggested nutrient enrichment required by plankton for growth and reproduction (Nybbaken, 1988). Increases in phytoplankton production in the dry season may have led to a corresponding increase in zooplankton diversity and density in February and March.

According to Nwankwo (1998), dissolved Oxygen decreases with increased Biological Oxygen Demand, probably due to increased metabolic activities of bacteria and fungi which are common in polluted sites. Similarly, Akpata *et al.* (1993) reported that the continuous activities of bacteria led to the release of nutrients into the water. These nutrients directly enhance the multiplication of phytoplankton leading to an increase in zooplankton biomass. It is important to note however that Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) can be employed to determine the level of pollution in an aquatic environment (Onyema and Nwankwo, 2009).

Olaniyan (1969) observed that zooplankton spectrum in the Lagos harbour varied with season and that recruitment was mainly from the sea. Crustacean zooplankton were the key components of the plankton of the creek. The calanoid copepod were the more frequent and notable species occurring in the survey. Other crustacean categories such as cladoceran and mysids were also recorded. The array of juvenile stages comprising of fish egg and larvae of crabs - megalopae and zoea larvae were also noted in the creek. According to Lawal- Are (2009) and Lawal-Are and Bilewu (2009), crabs are known to begin the early stages of their lives in estuarine systems which are regarded as “nursery grounds”. They also point to the suitability of the water quality characteristics of the creek to sustain diverse aquatic life. The chordate (*Oikopleura dioica*), arrow worm (*Sagitta enflata*) and the jelly fish are likely pointers of an array of planktonic faunal components that inhabit the creek at varying time of the year especially from the sea via the Lagos lagoon. According to Onyema *et al*. (2006) in a study of diatoms and dinoflagellates recorded from the Lagos Lagoon reported that the source of recruitment of the lagoonal dinoflagellates was the adjacent sea since most reported species were warm water oceanic forms.

The relatively high species richness and Diversity indices showed a fortnightly variation in conformity with the zooplankton distribution. High values of the diversity index indicated that the species were more evenly dispersed. The occurrence of higher values of copepod populations confirmed the observations of Olaniyan (1975) that crustacean copepods are the taxonomically more important zooplankton group in the Lagos lagoon and adjoining water systems. Similarly, Onyema *et al*. (2003, 2007) are of the view that although diatoms dominated the phytoplankton spectrum, copepods were prominent members of the zooplankton assemblage of the Lagos lagoon. Higher values of zooplankton diversity, abundance and bio-indices were recorded especially in February and March. These months were associated with higher salinity values and reduced biological and chemical oxygen demand for the creek. Transparency and conductivity were also higher during this period. In conformity with Onyema *et al*. (2003) increasing tidal influence occasioned by dry conditions usually elevates salinity and creates conditions suitable for the colonization and development of marine species in the Lagos lagoon. This situation must have affected the adjoining Abule-Agege creek and determined largely its water chemistry and zooplankton crop.

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