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Gut Contents and feeding pattern of *Macrobrachium vollenhovenii* (HERKLOTS, 1857) and *Caridina africana* (Kingsley, 1882) at Asejire Lake and Erin-Ijesa waterfalls Southwest Nigeria

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Abstract

The gut contents and feeding pattern of (*Macrobrachium vollenhovenii* and *Caridina africana)* at Asejire Lake and Erin-Ijesa waterfalls respectively were studied for two seasons (October 2007 and September 2009) with intent towards acculturation. Sampling of each site for prawn composition and abundance was done twice every month. Catches obtained from the two areas were isolated and transported in ice chest boxes to the laboratory for numerical and biomass analysis of the gut contents. Data collected were subjected to one-way analysis of variance (ANOVA) and means were separated using Duncan New Multiple Range Test. There was a strong correlation ($p<0.05$) between prawn abundance and food availability. The gut content analysis of *M. vollenhovenii* showed that juveniles were predominantly zooplanktivorous feeding on copepods and rotifers while adult prawns were omnivorous feeding more on animal food than plant dietary items. This observation showed that prawns change diet as they advance in age. This has positive implication on its culture potential. Stomach fullness index was high during the wet season which coincided with high number of prawns. *C. africana* fed predominantly on diatoms and other micro-phytoplankton. The availability of both species in freshwater bodies and its food and feeding habit revealed that the species can be cultured in earthen ponds like its temperate counterpart *Macrobrachium rosenbergii and can* utilize artificial feeds for optimal productivity.

Keywords: Gut contents; Biomass analysis; *Macrobrachium vollenhovenii*; Diet composition.

Introduction

Prawns which are valued food organisms are currently under-produced in Nigeria. The production and supply for local consumption is declining. There still exists wide gap between supply and demand, at least to meet FAO requirement for protein consumption [10]. Prawns are Omnivorous, and under natural condition feed on aquatic products. The natural foods of the freshwater prawns are vegetable waste, plankton, dead fishes, insect larvae, small worms and microorganisms [1]. But when farmed commercially, formulated feedstuffs are also provided. Natural food plays an important part in feeding especially young prawns. Food is held by the maxillipeds and torn into small pieces before being pushed into the mouth by the mouth parts [2].

Bello – Olusoji *et. al.* (2006) reported that prawns are zooplankton feeders with rotifers and copepods constituting the highest percentage occurrence in their stomach

content and that there is a change in feeding habit from planktonivorous in the larvae to carnivorous in adult stages [3]. They further stated that prawns can function as primary consumer, secondary consumer and detrivore in aquatic system and hence be classified as omnivorous.

It has been reported that development of viable prawns farming requires effective feeding strategy which can be obtained through the knowledge of their food and feeding patterns in their natural habitat [2]. Therefore, this study was carried out on the food and feeding pattern in juvenile and adult *Macrobrachium vollenhovenii* and *Caridina africana* obtained from Asejire Lake and Erin-Ijesa waterfalls respectively.

Materials and Methods

Asejire Lake and Erin-Ijesa Waterfalls are located in Osun State Nigeria. Asejire Lake is man-made, constructed on river Osun. It lies on latitude 7° 23′ North and longitude 4° 05′ West. The Lake is Y-shaped with two unequal arms of the Y as shown in Figure 1. The catchment area of the dam is 7,800km2 and the impounded area is 2,342 hectares. The dam has a pool elevation (water level) of 150m and maximum flood elevation of 152.4m. The Lake has gross storage of 7,403 million litres.

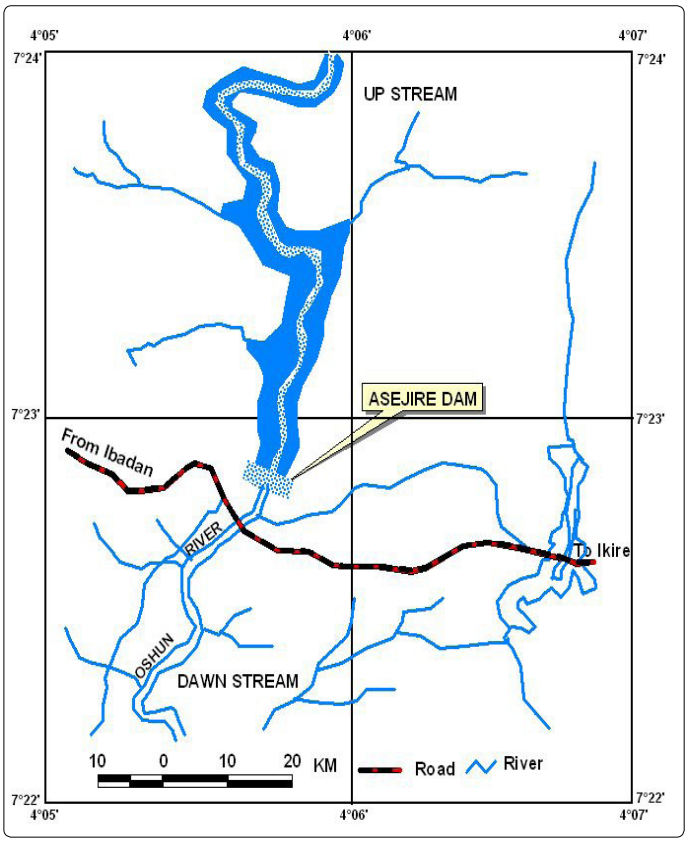

Figure 1: Map Showing Asejire Lake

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 0′ East. The inhabitants named the falls "Olumirin" the waterfalls have seven layers and only few visitors can climb beyond the second layer. Prawns are found more abundantly in the first, third and fifth layers the breeze at the waterfalls is cool and refreshing with average temperature variation of less than 25˚c. The water flows among the rock and splashes down with great forces to the evergreen vegetation around. The whole scenery is fascinating and ideal for mountain hiking, tourism and recreation. The location is shown in figure 2.

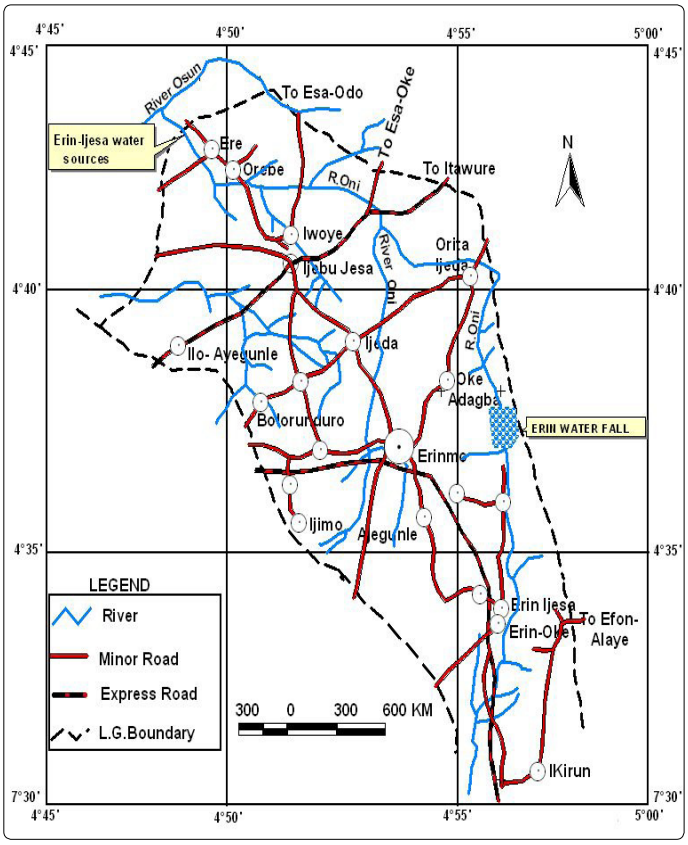

Figure 2: Map showing Erin-Ijesa Waterfalls

The prawns were collected twice a month for each of the study sites for two hydrological cycles; from October 2008 – September 2009 using baited traps at Asejire Lake while Plankton and hand nets were used to collect *C. africana* at Erin-Ijesa waterfalls. The samples were randomly selected and iced in order to reduce post-mortem digestion to minimum before analysis in the laboratory.

In the laboratory, the prawns were counted, sorted and identified based on taxonomic keys prepared by Reed *et al* (1967) and Lowe-McConnell (1972) [19,23]. The stomach of each prawn specimen was dissected and the entire gut was emptied into the petri dish. Stomachs containing food were size classified according to a table from Olatunde (1978) [21]. The content of each stomach was weighed after being placed on a pile of filter papers that soaked away most of the moisture content. The content of all stomach were examined immediately or preserved in 4% neutral formalin for a later analysis. Fraction of food content placed on glass slides were observed under varying magnification of the microscope (MI-1100LED). The food items were identified and in some cases up to generic levels.

Frequency of occurrence method were used by counting the number of stomachs in which each food item occurred, this was recorded and expressed as percentage of all non-empty stomach. Numerical abundance method was done by

counting the number of individuals of each food type/ category in each stomach. These were added to give total for each kind of food item in the total samples examined and expressed in percentage as described by Bagenal and Tesch, (1978) [5]. The stomach contents were also identified based on methods described by Hyslop (1980), Imevbore (1965), Egborge (1972, 1973), Jeje and Fernando (1986) [8,9,13,15,16]. Occasionally, some food items were observed crushed and others were at varying stages of digestion. Consequently, it was not possible to identify these at the species level. These were measured as unidentifiable food items. The periodicity of feeding for juvenile and adult prawns was investigated as well.

Results

Specimens of *Macrobrachium vollenhovenii and Caridina*. *africana*, examined during the period of investigation showed that the condition of all stomachs varied from 1/4 to 4/4 full. Only 10% of the specimens had empty stomach suggesting that food was readily available for the species, it was observed that number of empty stomachs varied seasonality. Higher percentage of empty stomachs was observed in January and February, March, April and also in October, November and December. The month of intensive feeding was May, June, July, August, and September. This is shown in Table 1 & Fig 1.

Tables 2 and 3 shows the frequency of occurrence and abundance in diet composition in the stomach of *M. vollenhovenii* and *C. africana* respectively. The blue green algae consisted of *nostoc*, *Coelosphacnium* and *Aphanizomenon*. The Green Algae included *Memgeotia, Spirogyra, Protococcus, Coscinodiscs* and *Chaetocerus*. The Protozoa was made up of *Volvox, Ceratium, Fontonia* and Diatoms (*Diatoma*). Rotifers consisted of *Filinia, Rotaria* and *Keratella*. The Clatoocerans on the other hand include *Daphnia*, Amphipods and the Copepods were made up of *Cyclops*. Fish remains and unidentified benthic matters (Detritus) were included in their food.

The preference of adult and juvenile for dietary items was almost the same, although the dietary spectrum of the adult was broader than that of juvenile, which fed mainly on zooplankton sources.

The adult *M. vollenhovenii* fed more on other dietary items such as protozoa, green algae, amphipods and fish remains that were not prevalent in the diet of juveniles. However, the food preference of adult and juvenile in *C, africana* did not show a marked pattern but their feeding range is relatively distributed among the dietary items.

Table 1: Monthly changes in the number of empty stomach of *Macrobrachium vollenhovenii* and *Caridina africana*

	M. vollenhovenii			*C. Africana*		
Month	Number of Specimens Examined	Number of Specimens with Empty Stomach	% Empty Stomach	Number of Specimens Examined	Number of Specimens with Empty Stomach	% Empty Stomach
Oct. 2007	52	8	15.4	25	3	12
Nov. 2007	54	11	20.4	20	6	30
Dec. 2007	60	9	15	22	4	18.18
Jan. 2008	52	12	23.1	24	5	20
Feb. 2008	56	10	17.86	23	6	26.1
Mar. 2008	50	6	12	26	2	7.7
Apr. 2008	65	8	12	36	2	5.6
May 2008	80	5	6.25	42	3	7
Jun. 2008	92	3	3.3	46	2	4.3
Jul. 2008	88	2	2.3	48	1	2.08
Aug. 2008	94	1	1.06	47	3	6.38
Sep. 2008	75	6	8	46	2	4.35
Oct. 2008	62	12	19.4	38	1	2.6
Nov. 2008	58	10	17	28	2	7
Dec. 2008	47	9	19	30	5	16.67
Jan. 2009	49	8	16	23	4	17.4
Feb. 2009	36	6	16.7	22	3	13.6
Mar. 2009	48	9	18.8	24	6	25
Apr. 2009	52	6	11.54	26	3	11.5
May 2009	75	2	2.7	32	2	6.25
Jun. 2009	83	1	1.2	46	1	2.2
Jul. 2009	78	2	2.56	52	2	3.8
Aug. 2009	66	3	4.55	50	4	7
Sep. 2009	58	4	6.9	56	3	5.36

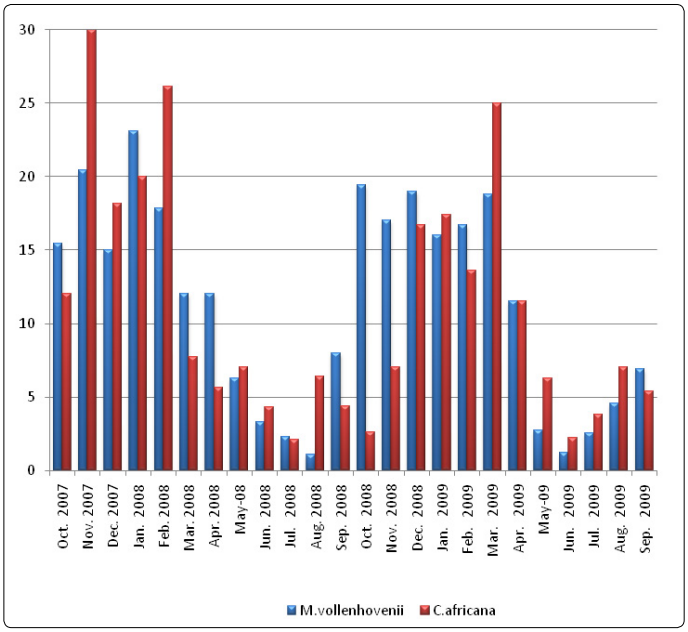

Figure 1: Monthly changes in the percentage of empty stomach of *Macrobrachium vollenhovenii* and *Caridina africana*

Discusion

Abundance of gut content composition increases during the rainy seasons as a result of nutrient upwelling caused by the rain. The gut content of the juveniles showed that they are zooplankton feeders with rotifers (19.3%) and copepods (18.5%) constituting the highest percentage of occurrence in the diet.

The food items in the stomach of adult M. *vollenhovenii* suggest that they are euryphagous (i.e. feeding on a wide range of organisms). It was also observed that *M. vollenhovenii* could be classified as an omnivorous feeder as the diet covers a wide spectrum of food ranging from various types of plankton to invertebrates and plants. Bello-Olusoji *et al.* (2006) described palaemonid prawns as non-selective feeders [3]. Fagade (1983) and Omoniyi & Bakare (1998) observed same with feeding habit of tilapia species [11,22].

The prawn also exhibits an overlapping in food and feeding habits in order to avoid inter- and intra-specific competition for available food. *C.africana* fed on macrophages, diatoms and other unidentifiable benthic micro organisms. They exhibited nearly similar feeding pattern with *M vollenhovenii*

Table 2: Frequency of occurrence and abundance in diet composition in the stomach of *Macrobrachium vollenhovennii* in Asejire Lake.

GROUP OF DIETARY ITEM	ABUNDANCE						FREQUENCY OF OCCURRENCE			
	ADULT		JUVENILE		TOTAL		ADULT		JUVENILE	
	Number	%	Number	%	Number	%	Stomach Number	%	Stomach Number	%
Blue-Green Algae	1280	12.8	376	7.4	1656	11.3	335	28.4	124	25.5
Green Algae	1388	13.9	800	15.9	2188	14.8	621	52.6	208	42.1
Diatom	513	5.1	328	6.5	841	5.7	59	5.0	51	10.2
Protozoa	1007	10.0	707	14.1	1714	11.6	637	54.0	190	38.4
Rotifers	1496	14.9	903	18.0	2399	16.3	720	61.2	288	58.1
Copepods	1672	16.7	864	17.2	2536	17.2	673	57.3	364	73.5
Amphipods	784	7.8	344	6.9	1128	7.7	544	46.1	140	28.2
Cladocera	928	9.3	593	11.8	1521	8.8	448	37.9	209	42.2
Fish Remains	198	1.9	-	-	198	1.4	473	40.1	-	-
Unidentifiable materials	760	7.6	106	2.2	866	5.2	336	28.5	63	12.7
Total	10026	100	5021	100	15047	100	1180		495	

Table 3: Frequency of occurrence and abundance in diet composition in the stomach of *Caridina africana* in Erin-Ijesa Waterfalls.

	ABUNDANCE						FREQUENCY OF OCCURRENCE			
	ADULT		JUVENILE		TOTAL		ADULT		JUVENILE	
	Number	%	Number	%	Number	%	Stomach Number	%	Stomach Number	%
Blue-Green Algae	85	16.2	25	6.3	110	11.3	90	9.5	60	7.6
Green Algae	92	17.6	32	8.1	124	14.8	64	6.8	48	6.1
Diatom	24	4.6	18	4.6	42	5.7	28	2.7	34	4.3
Protozoa	52	9.96	33	8.4	85	11.6	150	15.9	120	15.2
Rotifers	61	11.69	49	12.5	110	16.3	72	7.6	80	10.1
Copepods	71	13.60	52	13.2	123	17.2	30	3.2	-	-
Amphipods	38	7.28	35	8.9	73	7.7	80	8.5	185	23.4
Cladocera	36	6.9	60	15.3	96	8.8	50	5.3	62	7.9
Fish Remains	-	-	-	-	-	-	-	-	-	-
Unidentifiable materials	63	12.1	88	22.4	151	5.2	185	19.6	188	23.8
Total	522	100	392	100	914	100	943	100	789	100

Monthly variations in feeding habits of the prawns showed an increase in the stomach fullness during the rainy season and decreases in the dry season. The proportion of empty stomachs in the juveniles was higher during the dry season. This may reflect a steady dwindling of food resources in a habitat that is continually decreasing in volume with the onset of the dry season. However, the proportion of empty stomachs were low, the percentage may reflect that the periods feeding was short followed by longer periods of rapid digestion. This may suggest that the two prawns feed intermittently and or have a high rate of digestion. Other reasons for this may be; during handling and transportation some food items may be quickly or partly digested thus making identification difficult. Moreover with high rates of digestion, some food practices may be difficult to observe or identify if the prawn has been caught in the traps for several hours, while digestion during this time can also reduce stomach fullness. These may account for the reduced stomach fullness found among the evening collections, because the prawns might have been trapped for longer period of time. Another possibility is that the fraction of empty stomachs observed may be biased upward owing to sampling with passive gear (baited non-returned traps) as opposed to active gear (towing plankton net) because hungry prawns are more likely to take bait from a baited trap than satiated animals. According to Bello-Olusoji *et al* (2006) most aquatic animal's species appear to be opportunistic feeders consuming a large diversity of prey [3].

Periodicity variation shows that more prawns were caught in the night than the morning collection. Prawns collected during the wet season especially at the peak of the wet season (August-October) had fuller gut contents than collections made during the dry season (February-April).more food availability occur during the rainy season than dry season. This perhaps suggests increase the prawn population during raining season. Moreover morning collections during the dry season had fuller gut content than collections made in the evening collection. This is an indication that, the animals are nocturnal and night feeders when they are more active searching for foods unlike in the day when they hide. In order words, the stomachs fill up earlier and remain full over a longer period. Thus increase in food abundance during the raining season, justified fuller stomach contents than dry season catches. Another possible reason why there was higher amount of food in their guts was due to the heavy and incessant rains, there is a lot of nutrients upwelling and a lot of washing of the substratum to the water bodies by run off; all resulting in increased availability of food for the prawns. The visibility remains poor and turbidity high for most of the day and this could induce feeding in prawns if there was food. This over-night periodicity tests show that prawns stomach is cleared each day when they buried themselves in the bottom sediments, or hide during the day when they are less catchable and came out to feed at night when most of them were caught.

Some of the variability in the dietary composition of *M. vollenhovenii* could be explained on the basis of the change in water level since the planktons have their preferred water condition. Seasonal variation occurs in the composition of the diet of the *M.vollenhovenii* because availability of food organisms is often cyclic due to factors of their life histories, climate, or other environmental conditions. Seasonal variation in the feeding habits of fish resulting from environmental changes has been reported by Moriarty and Moriarty (1973), [Ikusemiju (1975), Tudorancea *et al.* (1988) [14,24,18,19]. The diet and feeding intensity can vary even during the diurnal cycle [7,17]. During the rainy season, there is a wide variety and abundance of food available due to high nutrient brought by the run-off from land promoting plant growth and increasing invertebrate productivity [20]. This is reflected in the range of food items found in *M. vollenhovenii* captured during the rainy season (i.e June to September) supplying the Lake. As the dry season sets in the Lake becomes shallow and the abundance and variety of food decrease. This agrees with the findings of Hyslop (1986) [12]. However there is no marked pattern of seasonal variation in adult prawn, this may reflect that they do not have a preferred food items but feed on available diet irrespective of the season. It implies that the juvenile are stricter in their preference for food than the adult.

From the report of Wassenberg and Hill, (1987), it was also seen clearly that juvenile do not feed on fish and other bigger animals, though amphipods and polychaetes parts were found in the gut content of advance post-larvae, an indication that they are changing diets [25]. The shift from diets of animal origin as they grow older is also well known among penaeids. In the early adult, the proportion of animal organism in the diet showed an increase, though the early adult prawns were still zooplanktivorus, but the animal contents increases, until it became more pronounced in the mature adults. This shows a change in feeding habits, with all kinds of detritus, benthic organisms, phytoplankton, zooplankton and animal matter found in the gut. This view was supported by Costa and Wanninayake (1986) who had a similar observation in *M. rosenbergii* [6]. This observation can be inferred that prawn can function as a primary consumer, secondary consumer and detritus feeder in the aquatic system, and hence could be classified as ominivorous. However, Bello-Olusoji *et al.* (1995) reported that stomach contents of the juvenile prawns (5.00 – 7.80cm in length) comprised remains of benthic animals and fish as well as detritus which is an indication that they are benthic or detritus feeders/scavengers [4]. They also remarked that polychaete, small crustacean and fish remains constituted a proportion of not less than 40.85% of its food.

Costa and Wanninayake (1986) observed also that adult prawns have preference for more animal food items than plant matters [6]. Tripathi (1990) further established that *M. rosenbergii* is an omnivorous animal.

In addition to confirming the main dietary components, this study has shown four important features:

a) The periodicity of feeding of the apparent effect of season on feeding pattern,

b) The changes in the diet as the prawn get larger.

c) The apparent lack of habitat difference in diet from the two water bodies considered in this research

d) The similarities of the diet and feeding patterns of the prawns irrespective of species, age and the environment.

Conclusion and Recommendations

The results of the stomach content analyses showed that the *M. vollenhovenii* were omnivorous because they consume both plant and animal material as food. *C.africana* fed on macrophages, diatoms and other unidentifiable benthic microorganisms which are sometimes referred to as detritus. They exhibit almost similar feeding pattern with *M vollenhovenii*. Adult prawns of both species were non-selective and opportunistic feeders.

Conflict of Interest

The authors confirm that there is no conflict of interest regarding this manuscript**.**

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