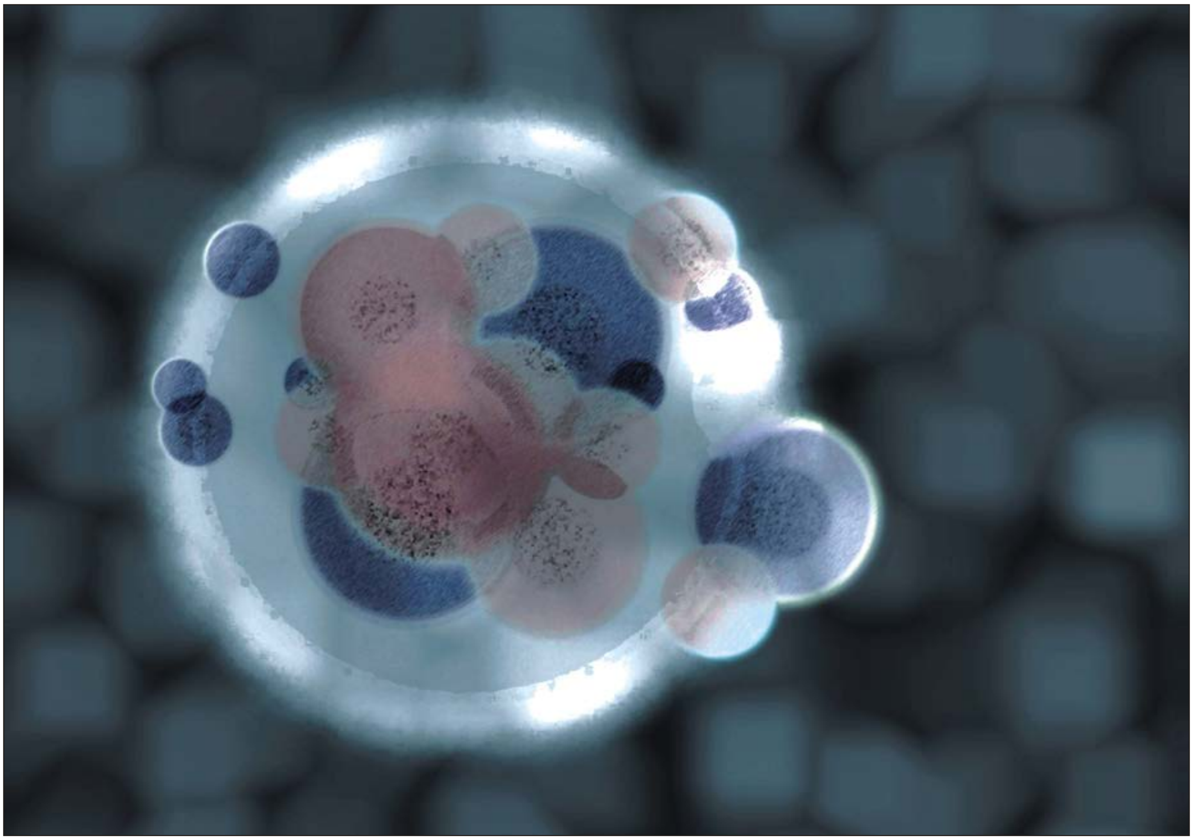

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Availability, Diet Composition and Feeding Behaviors of Some Commercially Important Palaemonidae Prawns in Fresh and Brackish Water of Nigeria

[1]O.A. Bello-Olusoji, [2]M. Bankole, [3]A. Sheu and [4]F.B. Oyekanmi
[1]Department of Fisheries and Wildlife, Federal University of Technology, PMB 704, Akure, Nigeria
[2]Federal College of Agriculture, Moorplantation, Apata, Ibadan, Nigeria
[3]Department of Fisheries and Aquaculture, Lagos State University, Ojoo, Lagos State, Nigeria
[4]Osun State College of Education, Ilesa, Osun State, Nigeria

Abstracts: Food and feeding pattern of *Macrobrachium vollenhovenii* and *M. macrobrachion* collected from fresh and brackish water habitats were studied for a year (March 2003 to February 2004). Stomachs contents of 1400 prawns (3.5-19.2 cm) were examined. Twelve major diet groups, made up of 31 species were identified by taxa. Diet did not differ significantly between the two species and their environment. The mostly consumed diets with the highest Relative Abundance (RA) in the freshwater habitat, *M. vollenhovenii* were Cyanophyceae (17.68%), followed by Cladocerans (14.62%) and Bacillariophyta (5.54%), in *M. macrobrachion* the highest RA was Cladocerans (31.07%), followed by Dinoflagellates (18.54%) and Bacillariophyta (15.56%). In the brackish environment the two prawn species had similar diets composition with Bacillariophyta (*M. vollenhovenii*-25.66% and *M. macrobrachion*-28.69%) as the major diet with the highest RA, followed by Dinoflagellates and Cladocerans. Index of Relative Importance (IRI) was used to assess the food preference. Diet species with the highest IRI were *Biddulphia* sp. (1066.80) for brackish water *M. macrobrachion*; *Rhizosolenia* sp. (IRI-1587.60) for freshwater *M. macrobrachion.* In *M. vollenhovenii*, *Rotifera nepturis* (IRI-915.60) and *Moina* sp. (912.822) were the highest recorded for brackish water. *C. radiatus* (IRI -1131.69), *Ceratium* sp. (IRI-1128.33) and *Moina* sp. (1105.65) were recorded for freshwater *M. vollenhovenii* and seasonal variation was observed in their feeding habits.

Key words: Diet, stomach, crustaceans, content, prawns, zooplankton, feeder, relative abundance, frequency, *Macrobrachium*

INTRODUCTION

Crustaceans are dominant and successful group, represented by a high number of species, exhibiting a great array of life styles and occupying quite dissimilar habitats. This diversity is a result of their life patterns and reproductive strategies[1].

Many freshwater prawns (Palaemondae) of economic importance have been identified as suitable species for aquaculture in Nigeria[2,3]. The African river prawn *Macrobrachium vollenhovenii* which are found in inland freshwater streams, lakes, rivers and brackish water systems[4]. *M. macrobrachion* are found in brackish water environment[3]. The two species had been described to posses the highest commercial potential[5,2]. Ecological and aquacultural requirements of the two commercially important freshwater prawn species; *M. vollenhovenii* and *M. macrobrachion*[2] has been studied.

Prawns are however known to feed on a wide variety of small epibenthic animals, especially polychaetes, mollusks and other crustaceans. It was reported that the existence of a clear positive correlation between gut contents and the abundance of natural foods irrespective of time of day in *Penaeus merguiensis* is an indicative of an opportunistic mode of feeding implying that the time of day or night is secondary to the availability of food in determining the feeding patterns of this penaeid.

Toward the development of viable prawn farming the food and feeding patterns in its natural habitats setup have to be well known for the setup of an effective feeding strategy. In this study the food and feeding patterns of the Post Larval (PL) and adults *M. vollenhovenii* and *M. macrobrachion* collected from fresh and brackish water in the South western Nigeria were carried out; thus analyzing their stomachs' contents and the various food components itemized to evaluate the natural food composition and their feeding patterns.

Corresponding Author: Dr. O.A. Bello-Olusoji, Department of Fisheries and Wildlife, Federal University of Technology, PMB 704, Akure, Nigeria

MATERIALS AND METHODS

Study sites: The study was conducted within two different water habitats (brackish and fresh water) located in South western Nigeria. The brackish water was the coastal lagoon, very close to the Atlantic ocean, two major sites were picked for sample collection these were; Ologe (Badagry) and Epe on the lagoon. While the fresh water was river Ogun with two sites selected for prawn collection.

Collection of specimens: Field sampling was carried out twice a month (bi-weekly) for each of the stations for twelve months; from March 2003 to February 2004. Traps with baits, plankton and hand nets were used to collect Post larvae (*M. macrobrachion* PL < 3.5 cm, *M. vollenhovenii* <5.5 cm) and adults prawns (*M. macrobrachion* >3.5 cm and *M. vollenhovenii* >5.5 cm). Collections were made twice on sapling day; (i) morning collection between 04:00 am and 06:00 am and (ii) evening collection, between 17:00 pm and 19:00 pm with the assistance of the Fishermen fishing on the water. The specimens were randomly selected, iced and transported to the Limnology Laboratory in the Department of Fisheries and Wildlife, Federal University of Technology, Akure for sorting and analyses.

Laboratory analyses: In the laboratory, the stomachs of collected PL and adult prawns were dissected out with the content washed into a petri dish and examined under a binocular microscope (X100 magnification). Each dissected stomach was blotted dry and weighed on a top balance (Mettler Toledo, PB8001) to the nearest 0.1 mg. The volume (mL^3) of each stomach (stomach capacity) was determined, after contents were emptied, the pyloric sphincter was tied off, the stomach was filled with water using calibrated syringe and needle until it became distended and water flowed over. The water was then poured into a graduated cylinder and measured to the nearest 0.01 mL. The various food items were identified and classified to the lowest possible taxonomical level. Whole segments, bundles of setae, jaws and segmented gut walls, can distinguish Polychaetes. Intact or near intact Crustaceans, especially Copepods, Amphipods and Rotifers were easily identifiable. All other severely fragmented food items were measured as unidentified food items. The following indices[6,7] were used; Relative Abundance (RA): the ratio of the number of stomachs with one type of prey present to the total number of stomachs with food, each stomach being counted as many times as the number of different types of prey it contained. Frequency of occurrence (%F): number of stomachs with a specific type of prey expressed as a percentage of the total number of stomachs containing food. Numerical analysis was used that is the occurrence of a particular food item was measured as the percentage of specimens in which that food item was identified. An Index of Relative Importance (IRI) for all prey items combined was calculated with the formula (% RA+ % Volume) × (% Frequency)[8].

The periodicity of feeding for post larval and adult prawns were investigated from the brackish water system for six months; August-September (rainy season) and February-April (dry season). The degree of stomach fullness was calculated by dividing the total stomach content weight (mg) by stomach capacity (mL^3). Emptiness Index (EMI); the percentage of specimens with no food in their stomach. In order to compare diets between *M. vollenhovenii* and *M. macrobrachion* the major groups of food items found in the stomach (Bacillariophyta, Cladocerans, Dinoflagellates etc.) were tested by χ^2 test[9]. The EMI was analyzed by species and maturity stage and tested by the fisher exact test[10] between species, maturity (size) level and habitat levels. The mean Whiteney U-test was used to test the significance between samples from the various sites.

RESULTS

A total of 1400 prawn stomachs were analyzed these consisted of 800 *M. vollenhovenii* (400 PL and 400 Adults) and 600 *M. macrobrachion* (300 PL and 300 Adults) (Table 1). The prawns compositions were similar in the two sites; In the catches *M. vollenhovenii* dominated in the river (freshwater) while *M. macrobrachion* dominated in the brackish water environment during the study period. Equal number of *M. vollenhovenii* and *M. macrobrachion* were collected from the lagoon while lesser numbers of *M. macrobrachion* (33.3%) were collected from the freshwater system. A variety of food items was found in the stomachs of the various stages. These along with the frequency of their occurrence and relative abundance are presented in Table 2. The food items varied according to the environment of the animals neither on the species nor with the size of the prawn. Of all prawns examined, 6% of the stomachs were empty and 94% contained food items. A total of 12 different families and 31 species could be positively identified (Table 2a and b).

In the PL *M. vollenhovenii* from the two water habitat diet item with the highest IRI recorded was *Moina* sp. with IRI of 1794.70 and 1308.76 (Table 2b) for brackish and freshwater respectively. *Coscinodiscus radiatus* (IRI-1131.69) and *Rotifera nepturis* (IRI-915.60)

Table 1: Total stomach analysis and EMI

	Brackish water habitat				Fresh water				
	M. vollenhovenii		*M. macrbrchion*		*M. vollenhovenii*		*M. macrbrchion*		
	PL	Adults	PL	Adults	PL	Adults	PL	Adults	Total
No. of stomach examined	200	200	200	200	200	200	100	100	1400
No. of empty stomachs	6	12	10	8	8	12	16	12	84%
EMI									6%

Table 2a: Frequency of occurrence and Relative Abundance (RA) of food items and Index of Relative Importance (IRI) in the PL and adults stages of *M. macrobrachion* from two different water habitats

		PL *M. macrobrachion*								Adult *M. macrobrachion*							
Food item organisms		Brackish water				Fresh water				Brackish water				Fresh water			
Class	Species	(%) F	RA	(%) V	IRI	(%) F	RA	(%) V	IRI	(%) F	RA	(%) V	IRI	(%) F	RA	(%) V	IRI
Cyanophyceae	*Nostoc*					40	2.11	2.81	196.80					50	3.99	5.32	465.50
	Coelosphaerium sp.	20	1.90	2.5	88.67	20	1.91	2.54	4.46	40	0.83	1.11	77.60	30	1.16	1.55	81.30
	Phormidium																
	Aphanizomeron																
Chrysophyta	*Coscinodiscus radiatus*	70	5.56	7.40	907.20					90	4.61	6.15	968.40				
	C. excentricus	60	4.21	5.60	588.6					90	5.36	4.12					
Cyanophycota	*Chetoceros* sp.	50	8.28	11.04	966.00					70	9.14	5.22					
Bacillariophyta	*Rhizosolenia* sp.	40	1.36	1.80	126.40	60	11.65	15.53	1631.00	60	0.76	1.01	106.40	70	9.72	12.95	1587.60
	Guinardina flaccida	70	5.56	7.41	907.90					30	6.64	8.85	464.80				
	Melosira granulata	30	8.28	11.04	579.60	20	13.98	18.64	652.40	30	6.87	9.16	480.90	50	5.84	7.79	681.30
	Biddulphia sp.	50	5.43	7.12	633.50					60	7.62	10.16	1066.80				
	Coscinodiscus gram	60	5.97	7.96	835.80					60	6.80	9.07	952.00				
Dinoflagellate	*Ceratium* sp.					50	2.75	3.67	320.80					60	6.00	8.00	840.00
	C. hirnudinella	50	1.63	2.17	190.00	60	2.97	3.96	415.80	40	3.10	4.13	289.30	70	7.00	9.33	1143.10
	Dinophysia sp.	40	2.84	3.79	265.20	20	2.96	3.95	138.20	30	3.02	4.03	21.14	40	5.54	7.39	517.00
	Gymmodium sp.	40	8.28	11.04	772.80					40	5.28	7.04	492.80				
	Rhodomonas sp.	30	5.56	7.41	389.10					70	2.34	3.17	382.20				
Amphipod	*Gammarus zaddachi*	40	1.22	1.630	114.00	40	3.18	4.28	296.80	30	0.91	1.21	36.40	60	7.80	10.40	1092.00
	G. tigrinus	30	0.95	1.270	66.60	60	2.54	3.39	355.80	30	1.13	1.51	79.10	50	4.96	6.61	330.67
Cladocerans	*Daphnia pullex*	40	12.21	16.16	1134.80	90	19.28	25.71	4049.10	50	6.80	9.07	793.33	80	7.78	10.37	1452.27
	Bosmia sp.									60	5.89	7.85	825.20	80	7.00	9.33	1306.40
	Sida sp.	40	2.03	2.71	189.60	60	8.68	11.57	1215.00	40	3.02	4.30	292.80	60	3.99	5.32	372.40
	Moina sp.	30	5.56	7.41	389.10	70	6.65	8.75	1071.70	20	2.34	3.12	109.20	70	1.60	2.13	261.00
	Ceriola sp.	40	1.36	1.81	126.80	50	3.18	4.24	371.00	40	2.41	3.21	224.80	40	5.84	7.79	311.46
	Nauplius larvae	20	0.67	0.89	31.20	40	1.48	1.97	138.00	20	3.10	4.13	144.67	50	4.86	6.48	324.00
Copepods	*Cyclops*	40	0.95	1.27	88.80	60	2.33	3.11	326.40	50	2.11	2.81	14.07	70	4.08	5.44	380.80
	Diaptomus sp.	50	2.33	3.24	283.50	70	2.33	3.11	380.80	40	3.10	4.13	289.20	70	3.50	4.67	571.00
Rotifers	*Rotaris* sp.	40	1.08	1.44	100.80	30	5.29	7.05	370.20	30	1.06	1.41	74.20	40	1.36	1.81	126.93
	Rotifera nepturis	50	0.94	1.25	109.50					40	1.20	1.60	112.00				
Protozoa	Frontonia	30	0.94	1.25	65.70	20	1.06	1.41	49.40	30	0.45	0.53	29.50	20	1.60	2.13	74.67
Polychaetes		20	0.81	1.08	37.80	10	1.48	1.97	34.50	20	0.91	1.21	42.4	30	2.04	2.72	142.80
Fish eggs		20	1.36	1.89	63.40	50	2.96	3.95	345.50	30	1.58	2.11	110.60	60	3.01	4.01	421.40
UBO		80	1.63	2.17	304.00	80	1.27	1.69	236.80	80	1.58	2.01	294.00	80	1.46	1.95	272.53

L: Larval; PL: Post Larval; A: Adult stage; P: Present. UBO: Unidentified Benthic Objects

were recorded for adults *M. vollenhovenii* from fresh and brackish water, respectively. In Table 2a *D. pullex* has the highest IRI 4049.10 and 1134.80 for PL *M. macrobrachion* from fresh and brackish water, respectively. In the adult *M. macrobrachion,* Rhizosolenia with IRI-1587.60 for freshwater *M. macrobrachion* and *Biddulphia* sp. with the highest IRI of 1066.80 for the brackish *M. macrobrachion.* Among the PL, the diet item with the highest RA in brackish water was *D. pullex (*RA-12.21) followed by *Moina* sp. (RA -11.48). In the freshwater collections *D. pullex* had the highest RA (19.28) followed by *Phormidium* (Cyanophacae) with RA of 15.57. In the adult *M. macrobrachion*, *Rhizosolenia* sp. had the highest RA (9.72) while in the stomach content of *M. vollenhovenii* it was *C. radiatus* with RA of 1131.69.

Prawns that were collected in the morning, at 04:00-06:00 am had fuller stomach than prawns collected in the evening between 17:00 and 19:00 am. There was an increase in the numbers of prawns collected in August and September (Table 3).

It was seen that in all the data collected, there was a close agreement between the % occurrence of *M. vollenhovenii, M. macrobrachion* and % of stomach volume of the prawns. In stomach contents of PL *M. vollenhovenii* collected from brackish water, the three major diet groups with the highest RA were Bacillariophyta (27.08), followed by Cladocerans (26.36) and Dinoflagellates (8.68), while in the adult prawn the highest three groups were Bacillariophyta (25.56), followed by Dinoflagellates (16.54) and Cladocerans (14.75). In the PL of *M. macrobrachion* the highest three groups were Bacillariophyta (26.60), followed by Dinoflagellates (18.31) and Cladocerans (10.83), for the adults, Bacillariophyta (25.66), was the highest followed by Dinoflagellates (16.87) and Cladocerans (14.75). Stomach contents from fresh water habitat showed the

Table 2b: Frequency of occurrence and relative abundance of food items and Index of Relative Importance (IRI) in the PL and Adults stages of *M. macrobrachion* from two different water habitats

Food item organism		PL *M. vollenhovenii*								Adult *M. vollenhovenii*							
		Brackish water				Fresh water				Brackish water				Fresh water			
Class species		(%) F	RA	(%) V	IRI	(%) F	RA	(%) V	IRI	(%) F	RA	(%) V	IRI	(%) F	RA	(%) V	IRI
Cyanophyceae	*Nostoc*					40	11.70	15.60	1092.00					50	3.99	5.32	465.50
	Coelosphaerium sp.	15	0.79	1.05	27.67	28	10.22	13.63	667.80	16	0.24	0.32	8.96	16	1.06	1.41	39.57
	Phormidium					30	15.57	20.76	1090.50					45	8.92	11.89	936.60
	Aphanizomenon sp.	10	1.14	1.52	26.60	40	0.08	0.11	7.47					40	4.61	6.15	430.27
Chrysophyta	*Coscinodiscus radiatus*	10	5.80	7.33	135.33	30	9.30	12.40	657.00	42	4.84	6.45	474.32	51	9.51	12.68	1131.69
	C. excentricus	25	7.27	9.69	424.08					39	7.32	9.76	666.12				
Cyanophycota	*Chetoceros* sp.	43	6.93	9.24	695.31					72	4.30	5.73	722.40				
Bacillariophyta	*Rhizosolenia* sp.	51	3.41	4.55	405.96	42	3.95	5.27	387.10	48	4.24	5.65	474.88	58	3.43	4.57	464.00
	Guinardina flaccida	16	1.59	2.12	59.36					27	6.11	8.15	384.93				
	Melosira granulata	23	7.95	10.60	426.65	42	4.18	5.57	409.64	41	3.69	4.92	353.01	56	7.15	9.53	934.27
	Biddulphia sp.	51	6.18	8.24	735.42	56	3.18	4.24	415.52	31	5.51	7.35	398.56	61	3.96	5.28	563.64
	Coscinodiscus gram	41	7.95	10.60	760.55					39	6.11	8.15	556.01				
Dinoflagellate	*Ceratium* species					48	2.40	3.20	261.12					81	5.57	7.96	1128.33
	C. hirudinella	30	9.10	12.13	637.00	62	5.50	7.33	795.67	64	3.09	4.12	461.44	68	4.19	5.58	664.36
	Dinophysia sp.	48	1.14			51	1.34	1.78		66	6.09	4.12	475.86	78	2.42	3.23	440.44
	Gymnodinium sp.	31	1.59	2.12	115.01			159.46		36	3.63	4.84	304.92				
	Rhodomonas sp.	38	1.25	1.67	110.83					48	4.06	5.41	454.72				
Amphipod	*Gammarus zaddachi*	62	1.48	1.97	214.00	51	0.85	1.13	101.15	66	0.24	0.32	36.95	66	0.47	0.63	72.38
	G. tigrinus	40	1.70	2.27	134.67	42	0.85	1.13	83.16	72	0.97	1.29	162.96	53	1.12	1.49	138.33
Cladocerans	*Daphnia pullex*	52	4.89	6.52	593.32	72	3.41	4.55	573.12	66	3.09	4.12	475.86	77	2.83	3.71	508.45
	Bosmia sp.									29	1.27	1.69	85.94	72	1.71	2.28	287.28
	Sida sp.	36	1.70	2.26	142.80	49	3.18	4.24	363.58	52	1.27	1.69	154.69	91	1.34	1.78	221.99
	Moina sp.	67	11.48	15.31	1794.70	71	7.90	10.53	1308.76	71	5.51	7.35	912.82	81	5.85	7.80	1105.65
	Ceriola sp.	40	7.95	10.06	720.40	61	5.50	7.33	782.83	63	3.09	4.12	454.33	70	2.36	3.15	385.47
	Nauplius larvae	10	0.34	0.45	7.93	21	0.31	0.41	15.19	15	0.61	0.81	21.35	22	0.53	0.71	27.21
Copepods	*Cyclops*	43	1.47	1.96	147.49	56	1.70	2.27	222.13	71	4.84	6.45	801.82	60	2.07	2.76	289.80
	Diaptomus sp.	47	1.81	2.41	198.49	51	1.86	2.48	221.34	52	3.63	4.84	440.44	71	2.13	2.64	352.87
Rotifers	*Rotaris* sp.	51	0.57	0.76	67.83	63	1.24	1.65	182.07	63	4.84	6.45	711.48	81	3.01	4.01	568.89
	Rotifera nepturis	50	0.79	1.05	92.17	64	1.16	1.55	193.23	72	5.45	7.27	915.60	74	3.37	4.49	581.88
Protozoa	Frontonia	30	1.25	1.67	87.60	32	0.62	0.83	46.29	30	0.42	0.56	29.4	38	1.30	1.75	65.86
Polychaetes		10	0.45	0.06	5.10	18	1.32	1.76	55.44	15	0.97	1.29	33.95	10	1.24	1.65	28.93
Fish eggs		11	0.23	0.30	5.90	20	0.31	0.41	14.47	7	0.61	0.81	9.94	10	0.59	0.78	13.76
UBO		30	1.13	1.51	79.10	15	0.85	1.13	29.75	6	0.91	1.21	12.66	6	0.95	1.27	13.30

L: Larval; PL: Postlarval; A: Adult stage; P: Present; UBO: Unidentified Benthic Objects

Table 3: Day and night collection and mean stomach fullness analysis

	Brackish water habitat															
	M. vollenhovenii								*M. macrbrchion*							
	PL				Adults				PL				Adults			
	D	ST	N	ST	D	ST	N	ST	D	ST	N	ST	D	ST	N	ST
Feb'02	11	0.50	18	0.25	12	0.50	22	0.25	18	0.50	22	0.25	20	0.50	24	0.25
March '02	10	0.75	21	0.50	8	0.50	20	0.25	16	0.75	23	0.50	19	0.25	29	0.50
April '02	15	0.50	24	0.25	18	0.25	20	0.50	16	0.50	23	0.75	19	0.50	29	0.75
Total	36		63		38		62		50		68		58		82	
Empty stomach	8				14				16				12			
August '02	18	0.75	33	1.00	20	1.00	41	1.00	24	1.00	39	1.00	26	0.75	42	0.75
September'02	24	1.00	38	0.75	26	1.00	44	0.75	28	1.00	38	0.75	32	0.75	50	1.00
October '02	19	1.00	32	1.00	20	0.75	40	1.00	20	1.00	35	1.00	28	0.75	48	1.00
Total			103		66		125		72		112		86		140	
Empty stomach																

ST: Stomach condition, PL: Postlarval; A: Adult stage; D: Day collections, N: Night collections

highest RA for Cyanophyceae (37.57 for PL, adults 17.68), followed by Cladocerans (PL-20.30, adults-14.62) and Bacillariophyta (PL-11.31, adults-14.54). In the freshwater *M. macrobrachion* PL-Bacillariophyta (25.63), Cladocerans (21.27) and Dinoflagellates (8.68), the adults prawn showed Cladocerans (31.01), Dinoflagellates (18.54) and Bacillariophyta (15.56).

Frequencies of occurrence of the major food categories did not differ appreciably between PL and adults prawns throughout (Table 2), although more food and fuller stomachs were observed in the night catches. Table 4 shows the Relative Abundance (RA) of the various food classes and the different stages of prawn species. Bacillariophyta (27.08) formed the majority of the PL's diet of the two species, this was also observed in the Adult stomachs, more Cladocerans were observed and less polychates. In the evening collections the stomach contents were noticeably reduced, than the morning collections. In contrast, *M. vollenhovenii* from brackish water had apparently fuller stomachs than its counterpart

Table 4: Relative abundance of the various food classes

	Post Larvae (PL)				Adults			
	Fresh water		Brackish water		Fresh water		Brackish water	
Class	*M. vollenhovenii*	*M. macrobrachion*	*M. vollenhovenii*	*M. macrobrachion*	*M. vollenhovenii*	*M. macrobrachion*	*M. vollenhovenii*	*M. macrobrachion*
Cyanophyceae	37.57	4.02	1.93	1.90	17.68	5.15	0.24	0.83
Chrysophyta	9.30	-	13.07	9.77	9.51	-	12.16	9.97
Cyanophycota		-	6.93	8.28	-	-	4.30	9.14
Bacillariophyta	11.31	25.63	27.08	26.60	14.54	15.56	25.66	28.69
Dinoflagellate	9.24	8.68	13.08	18.31	12.18	18.54	16.87	13.74
Amphipods	1.70	5.72	3.18	2.27	1.59	12.76	1.21	2.04
Cladocera	20.30	21.27	26.36	10.83	14.62	31.07	14.75	23.56
Copepods	3.56	4.66	3.26	3.24	4.20	7.58	8.47	5.21
Rotifers	2.40	5.29	1.36	2.02	6.38	1.36	10.29	2.26
Protozoa	0.62	1.06	1.25	0.94	1.30	1.60	0.42	0.45
Polychaetes	1.32	1.48	0.45	0.81	1.25	2.04	0.97	0.91
Fish eggs	0.31	2.96	0.23	1.36	0.59	3.01	0.61	1.58
Unidentified	0.85	1.27	1.13	1.63	0.95	1.46	0.91	1.58
Unidentified	0.85	1.27	1.13	1.63	0.95	1.46	0.91	1.58

ST: Stomach condition, PL: Postlarval; A: Adult stage; D: Day collections, N: Night collections.

from freshwater. The same observation was made on the *M. macrobrachion* from lagoon with fuller stomach than the freshwater species. Fish eggs were found in 321 stomachs (22.90%) of the 1400 excised stomachs investigated. Some unknown dietary items were difficult to identified and thus were included in the unidentified food items. Stomach volumes ranged from 0.002 L in the PL sampled to 0.0035 L in the *M. macrobrachion* and between 0.002 L in the PL to 0.0045 L in *M. vollenhovenii*. *M. vollenhovenii* had a slightly higher percentage of stomachs with food than *M. macrobrachion*, 54 and 46%, respectively. There were no appreciable dietary differences between the two prawn species in relation to the size and the habitat. Unidentified food items formed an important part of the diet by volume, particularly in adult prawn throughout the rainy and dry season. These items represent heavily digested and therefore unrecognizable parts and their interpretation is slightly different.

DISCUSSION

The EMI was 6% within the whole stomachs (2.71% *M. vollenhovenii* and 3.29% *M. macrobrachion*). Higher percentage was observed in some aquatic animals' studies such as shark species[11,12]. However, the proportion of empty stomachs were low, the percentage may reflect that the periods of 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 particles may be difficult to observed or identify if the prawn has been caught in the traps for several hours, while digestion during this time should also reduce stomach fullness. These may account for the reduced stomach fullness found among the evening (17:00-19:00 pm) 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. Most aquatic animal's species appear to be opportunistic feeders consuming a large diversity of prey[13]. Present results indicate that the Africa river prawn and brackish water prawns are non-selective opportunistic feeders and their diets include a diverse species spectrum of Cyanophyceae, Chrysophyta, Cyanophycota Bacillariophyta, Dinoflagellate, Amphipods, Cladocera, Copepods, Rotifers, Protozoa, Polychaetes, fish eggs and unidentified food items. The animals feed on the available edible plankton in their environment with the exception of *Nostoc* species (Cyanophyceae) that were absent in the diets of the brackish PL and adults *M. macrobrachion*. Diet changes were noted as the season progressed and samples were derived from different locations. The strong change in the diet observed was linked to the distribution, showing Cyanophyceae with highest RA (37.57) for freshwater *M. vollenhovenii* and a low RA (1.93) for the brackish *M. vollenhovenii,* though Cyanophyceae is more of freshwater species than brackish water habitat.

PL consumed diverse range of plankton species, as in the adults thus becoming difficult to group as either herbivore or carnivore. Both adults and PL of the two species feed mainly on Cladocera while Bacillariophyta and Dinoflagellates formed the major phytoplankton in the diets of the prawns. Thus showing the animals as non selective feeder. Though lobsters have been found to be selective at times, favouring certain prey items over others when food is abundant[13]. Moreover the PL showed to be more of phytoplankton feeder than zooplankton with Bacillariophyta and Dinoflagellates having the highest

RA, with highest percentage of occurrence 47% ($p<0.05$ Mann-Whitency U-test) in the diet. It was observed that, PL were predominantly planktivorous, with algae (*Nostoc*, *Coscinodiscus* and *Chaetoceros*) and diatoms (*Diatoma*) having the highest relative abundance among the food items found in the stomach of *M. vollenhovenii*, ($p<0.001$ Mann-Whiteney U-test)[7]. Thus it shows that there is no significant change in feeding habit from planktivorous in the PL as well as in the adults. These result also confirmed the report that penaeid prawns are not selective in their feeding[15]. This may be the case with the *M. vollenhovenii* and *M. macrobrachion*. Studies on white sharks have also shown prominent size-related shifts in diet[13,16,17]. Diet often changes with geographic area and this was observed for the two species.

The stomach contents of the PL prawn contained some unidentified food organisms and fish eggs. Adult prawns feed on a wide variety of organisms both plants and animals, but with little increase in Copepods and Cladocerans consumption. Mature prawns exhibited various feeding habits; this was also observed for *M. rosenbergii*[17].

In this study, Bacillariophyta, Dinoflagellates and Cladocerans with the exception of Cyanophyceae in the adult freshwater *M. vollenhovenii* accounted for more than 47.85% ($p<0.01$ Mann-Whiteney U-test). Similar report was also observed, that polychaetes, Cladocerans and fish remains accounted for more than 40% in the diet of *M. vollenhovenii*[7]. They also observed increase in the animal matter and decrease in the amount of plant matter indicates the adults prawn's relative preference for animals' food items[18]. This shown that a prawn can function as a primary consumer, secondary consumer and detrivorve in the aquatic system and hence be classified as omnivores; *M. rosenbergii* also readily accepts a variety of food types.

Periodicity variation: More prawns were caught in the night than the morning collection (Table 3). Prawns collected during the rainy period especially at the peak of the rainy season (August-October) had fuller gut contents than collections made during the dry season (February-April). More food availability occurs during the rainy season than dry season. This perhaps suggests increase in the prawn population during rainy 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 nuptional and night feeders when they are more active searching for food unlike in the day when they hide. In other words, the stomachs fill up earlier and remain full over a longer period. Thus increase in food abundance during the rainy season, justified fuller stomach contents than dry season catches. Moreover another possible reason why there was higher amount of food in their guts was due to the heavy and incessancy rains, there is a lot of nutrient 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. These over-night periodicity tests show that prawns' stomach is cleared each day when they buried themselves in the bottom sediment, or hide during the day, when hey were less catcheable and came out to feed at night when most of them were caught. In addition to confirming the main dietary components, this study has shown four important features: a) the periodicity of feeding and the apparent effect of seasons on feeding patterns, b) the changes in the diet as the prawn gets larger, c) the apparent lack of habitat differences in diet from the two systems; fresh and brackish water systems considered in this research and d) the similarities of the diets and feeding patterns of the prawns irrespective of species, age and the environment.

From this study it is concluded that the brackish water environments are important microhabitat for PL *Macrobrachium* with more diets of high RA, though exposed to predators. *Macrobrachium* are more numerous in the brackish water than in freshwater.

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