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Diets of *Macrobrachium* species in Lower Orashi River, Niger Delta, Nigeria: Implication for Ecosystem Conservation and Sustainable Shrimp Fisheries

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Abstract
Food and feeding habits are crucial tools for stock management and play a significant role in investigating trophic relationships within aquatic communities. The diets of three Macrobrachium species: Macrobrachium felicinum, Macrobrachium macrobrachion, *and* Macrobrachium vollenhovenii *in the Lower Orashi River were studied over 12 months (December 2019–November 2020) using the frequency of occurrence and numerical methods. The results indicated that a total of 880 food items were observed in the guts of M. vollenhovenii. Out of which, Chlorophyta (n=339; 38.53%) was the highest and the least was Chrysophyta (n=3; 0.34%) In the Chlorophyta category, Chlorella vulgaris (n=135; 15.34%) contributed the highest. The frequency of occurrence method indicated Cyanophyta (n=31; 31.31%) as the most frequently occurred category of food item. Six hundred and ninety-seven (697) food items were found in the guts of M. felicinum with Bacillariophyta (n=400; 57.38%) recorded as the highest number of food items and the least was Crustaceans (n=6; 0.86%) Dinophyta, Charophyta and Rhodophyta were absent in the gut content. In Bacillariophyta category, Melosira varians contributed highest (n=240; 34.43%). Likewise, the frequency of occurrence method indicated Bacillariophyta (n=38; 38.77%) as the most frequently occurring food for M. felicinum. A total of 1006 food items was found in the guts of M. macrobrachion, with the highest number of food item recorded as Bacillariophyta (n=366; 36.40%) and least was Crustaceans (n=3; 0.30%). Chrysophyta, Insects, Charophyta, and Rhodophyta were absent in the gut. In Bacillariophyta category, Melosira varians contributed highest (n=223; 22.17%). For the frequency of occurrence, Chlorophyta (n=33; 33.66%) recorded the highest frequency of occurrence and least was Crustaceans (n=1; 1.02%). In conclusion, all three species of* Macrobrachium *from the Lower Orashi River are opportunistic omnivore feeder predominantly with preference for phytoplankton however, variations in their primary food items reflect differences in habitat preferences and ecological roles. These findings underscore the importance of phytoplankton as a foundational resource in freshwater ecosystems and the adaptability of* Macrobrachium *species to exploit available resources.*

Keywords: *Food and feeding habits, Gut Content, M. vollenhovenii, Shrimp,* M. macrobrachion,

INTRODUCTION

The dietary composition of aquatic species is fundamental to understanding their ecological roles and contributions to ecosystem dynamics. Studies on food and feeding habits of organisms are important because essential functions such as growth, development and reproduction depends on energy that enters in the form of food (Wootton, 1992). One standard method used to study the diet is the stomach contents analysis (Hyslop, 1980). Stomach content analysis provides vital information on feeding relationships between species (Arrington *et al*., 2002), habitat use, feeding strategies, influence of environmental factors on resource utilization, efficient utilization of resources within an ecosystem (Chea *et al*., 2017) and help in the development of management and conservation strategies that consider multiple species (Abdel-Aziz and Gharib, 2007). The frequency of occurrence method and the numerical method are two of the most often utilized techniques (Hyslop, 1980; Ugwumba and Ugwumba, 2007; Akuna and Amachree 2019; Okadi *et al*., 2024).

The palaemonid prawns of the genus *Macrobrachium* (Spence Bate, 1868) inhabit diverse aquatic environments including lakes, ponds, rivers irrigation ditches as well as in the estuaries (New, 2002; De Grave and Fransen 2011; Idung *et al*., 2013; Jimoh *et al*., 2016). The species exhibit omnivorous feeding behaviours that are central to nutrient cycling, energy transfer, and maintaining the ecological balance within riverine ecosystems (Idung *et al*., 2013; Jimoh *et al*., 2016). *Macrobrachium* species are ecologically and economically significant and of great importance to artisanal fisheries in the Niger Delta, serving as a vital source of protein and livelihood for local communities (Marioghe and Ayinla 1995). The species is loved in the Niger Delta due to its flavour and high protein content and are utilized as condiments (dried or fresh) when preparing local cuisines (Idung *et al.,* 2013). Four species of Macrobrachium viz; *Macrobrachium macrobrachion* (brackish water prawn), *Macrobranchium dux* (Congo river prawns), *Macrobranchium felicinum* (Niger river prawn) and *Macrobrachium vollenhovenii* (African river prawn) have been reported in Nigeria water bodies (Akintola and Bakare, 2011; Deekae *et al*., 2016), with *M. macrobrachion* and *M. vollenhovenii* being the largest (Bello-Olusoji *et al*., 2006; Deekae *et al*., 2016) and possesses highest commercial potential (Ajuzie and Fagade, 1992). Studies by Powell (1983) and Marioghae (1987) have shown that *Macrobrachium* species exhibit several promising traits for aquaculture, including impressive adult size, rapid growth rates, and the ability to successfully reproduce in controlled environments. Given this aquaculture potential, a crucial step towards successful farming of these prawns needs a thorough understanding of their dietary needs.

Understanding the dietary habits of a species is fundamental for comprehending its ecological role. In the case of commercially valuable species like *Macrobrachium* prawns, this knowledge is also paramount for the success of its aquaculture endeavours. Studies on stomach content can reveal important details about the diets and trophic position of a species as well as quantify its food sources and identify its preferred food. The knowledge of the diet in nature is crucial for the establishment of its nutritional needs and financial success of shrimp farming (Ayisi *et al*., 2017). In Nigeria, studies on the natural diet of *Macrobranchium* species in the literature included *M. macrobrachion* from Great Kwa River, Obufa Esuk Beach, Calabar, Cross River State (Idung *et al*., 2013); *M. vollenhovenii* from Epe Lagoon, Southwest (Jimoh *et al*., 2016); *M. felicinum* and *M. macrobranchium* from Amassoma axis of Igbedi creek, Bayelsa State (Binaebi *et al*., 2024); M. *macrobrachion* and *M. vollenhovenii* from three interconnecting lagoons (Badagry, Lagos and Epe) of Southwest (Akinwunmi *et al*., 2019); *M. vollenhovenii* from Asejire Lake and Erin-Ijesa waterfalls Southwest (Oyekanmi *et al*., 2017); *M. macrobrachion* from Ekole Creek, Bayelsa State (Deekae *et al*., 2016). All of these studies have consistently shown that *Macrobrachium* prawns exhibit a diverse diet, typically characterized as omnivore detritivore, planktivore detritivore, detritivore with preference to detritus, plankton, plant materials and crustaceans. However, the specific dietary composition of these prawns within the unique ecological conditions of the lower Orashi River remains largely unexplored.

Orashi River takes off as a stream, from the rocks in the Orashi enclave of Ezeama in Dikenafai, Imo State, and forms tributaries along its flow from Imo through Anambra, Rivers to Bayelsa state, before empting into the Atlantic Ocean. It bifurcates into two at Egbema with the larger portion (right), continued through Eluku before bifurcating further into two and emptying its waters and sediments at Edi Kalama (Degema) and Abonnema into the gulf of Biafra. The Orashi Region is home to over 35% of the oil wells in the Niger Delta States of Imo and Rivers. (Bisong *et al*., 2024). The lower Orashi River is characterised by its dynamic hydrology, abundant riparian vegetation, and nutrient-rich waters. It provides a unique habitat that supports diverse aquatic fauna, including *Macrobrachium* species. Despite the ecological and economic importance of Macrobrachium species, their feeding habits remain underexplored in this region. Therefore, this study aimed to investigate the dietary composition of *Macrobrachium* species in the lower Orashi River.

2.0 Materials and methods

2.1 Study area

The study was conducted in Engenni, Ahoada-West Local Government Area of Rivers State, Nigeria. The Engenni communities are located within the Guinea-Congolian rainforest zone on the northern part of the Niger Delta, virtually at the boundary between Rivers and Bayelsa States. Because of its position in the Equatorial climate zone (Von Chi-Bonnadel, 1973). The climate of the study area is typical of a tropical Sub-Saharan country, with well-marked dry and wet seasons and with a relatively little monthly fluctuation in maximum and minimum temperatures (Griffiths, 1972). The dry season extends from November to April whereas the wet season lasts from May to October, with the highest rainfall peak during the July. Mean monthly maximum temperature ranges between 27 ºC and 34 ºC, while the minimum varies between 22 ºC and 24 ºC (NDES, 1998). The region is one of the wettest in the world with an average annual rainfall of more than 3000mm (Odigwe *et al*., 2020). Four sampling stations: Okarki (Station 1), Okparaki (Station 2), Ikodi (Station 3) and Kunusha (Station 4) were established in the shore line of the lower Orashi River due to the active shrimping operations (Table 1 and Fig.1).

Table 1: The sampled stations and their co-ordinates along the lower Orashi River

STATION CODE	STATIONS	CORDINATES	
		NORTH	EAST
1	OKARKI	4º 59’ 7.434”	6º 25’ 46.314”
2	OKPARAKI	4º 59’ 8.43”	6º 26’ 55.854”
3	IKODI	4º 59’ 34.602”	6º 27’ 57.12”
4	KUNUSHA	4º 59’ 18.174’	6º 28’ 15.084”

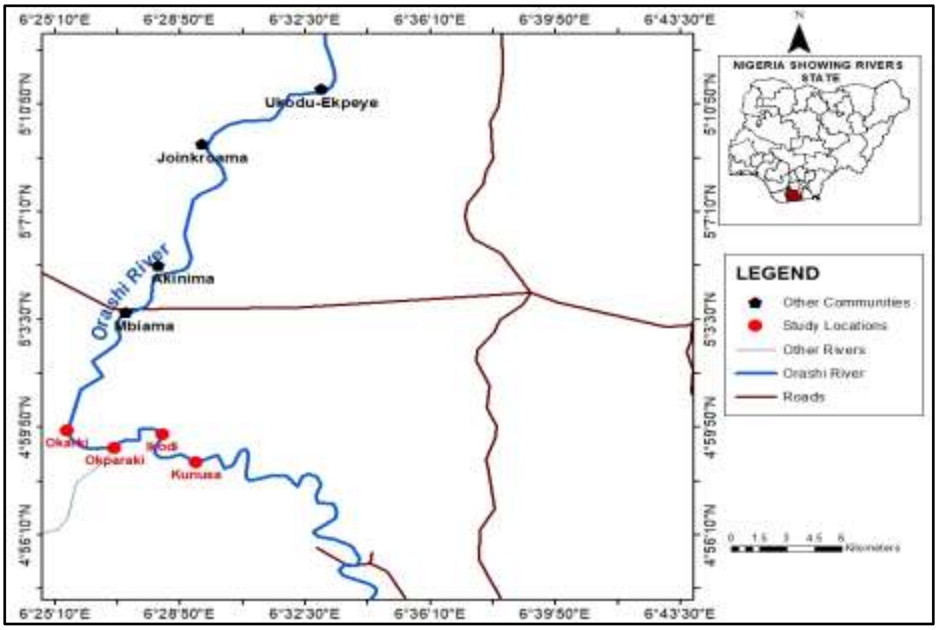

Fig 1: Map of the Study Area Showing the Study Sites

2.2 Sample collection

Macrobrachium species were collected from the four sampling stations with the help of artisanal shrimpers for 12 months (December 2019-November 2020). Woven basket traps with non-return valves and palm kernel (bait) were used to catch the prawns. The shrimps were immediately preserved in 10% formalin solution and taken to the Department of Fisheries and Aquatic Environment laboratory. Samples were identified to species level using taxonomic keys and descriptions by Powell, (1980, 1982) and Holthius, (1980).

2.3 Gut Content Analysis

After identification, 100 samples each of *Macrobrachium felicinum* (Holthuis, 1949), *Macrobrachium macrobrachion* (Herklots, 1851) and *M. vollenhovenii* (Herklots, 1857) were used for gut analysis according to Binaebi *et al*. (2024). Each gut contents of the *Macrobrachium* species examined were exposed using dissecting needle. The guts were split open using a razor blade and the entire gut content were emptied into a petri dish to which a drop of distilled water was added. It was then placed on a slide and viewed under a binocular microscope (Olympus CX31, Japan). Identification of the organisms recovered from the gut of the *Macrobrachium* species were carried out using field guides and taxonomic keys that includes; Hillary and Erica (1979) and Jeje and Fernando (1998). Stomach contents were analysed using frequency of occurrence and numerical methods as described (Hyslop 1980;

Ugwumba and Ugwumba, 2007; Okadi *et al*., 2024) while, the importance of the food items was determined with the index of food significance (Allison and Sikoki, 2013; Akuna and Amachree, 2019; Okadi *et al*., 2024) with the following equations:

2.3.1. Number method

The number of the individual food items in the gut sorted out and counted. A total of all food items was recorded and expressed as % number of individual food items in the gut with the following equation:

$$\% \text{ number of food item} = \frac{\text{Total number of the particular food item}}{\text{Total number of all food items}} \times 100$$

2.3.2. Frequency of Occurrence method

The gut contents were examined and the individual food items sorted out and identified. Thereafter, the number of guts containing the food items with the following equation:

$$\% \text{ occurrence of food item} = \frac{\text{Total number of guts with the particular food item}}{\text{Total number of guts with food}} \times 100$$

2.3.3. Index of Food Significance

The value of the number and frequency of occurrence methods were employed to calculate the Index of Food Significance (IFS) with the following equation:

$$\% \, IFS = \frac{\% \text{ Frequency of occurrence} \times \% \text{ Number method}}{\Sigma\, (\% \text{ Frequency of occurrence} \times \% \text{ number method})} \times 100$$

Where Food with IFS > 3% are regarded as primary, > 0.1 to < 3 % as secondary, whereas < 0.1% are considered as incidental.

3.0. RESULTS

3.1. Gut content analysis of *M. vollenhovenii, M. felicinum* and *M. macrobrachion*

A total of 300 *Macrobrachium* individuals (100 each of *M. vollenhovenii*, *M. felicinum* and *M. macrobrachio*n) were analysed for gut content, with five individuals having empty guts (*M. vollenhovenii*, 1; *M. felicinum*, 2; and *M. macrobrachion*, 2) were empty. The gut contents were categorised into eleven (11) groups: Bacillariophyta (diatom), Chlorophyta (green algae), Chrysophyta (golden algae), Cladocera (water fleas), Crustaceans (invertebrate animal), Cyanophyta (blue-green algae), insects (invertebrate animal), Dinophyta (dinoflagellates), Charophyta (algae), Rhodophyta (red sea weed) and unidentified items. The majority of the food items were of plant origin mainly algae. All of the categories of food items were present in *M. vollenhovenii* (Table 2) whereas Dinophyta, Charophyta and Rhodophyta were absent in *M. felicinum* (Table 3) and Chrysophyta, Insects Charophyta, and Rhodophyta were absent in *M. macrobrachion* (Tables 4).

3.1.1. Number and frequency of Occurrence for *M. vollenhovenii*

The result of the gut contents as calculated by the number and frequency of occurrence methods are presented in Table 2. The results indicated that a total of 880 food items were observed in the guts of *M. vollenhovenii*. Out of which, Chlorophyta (*n*=339; 38.53%) was the highest, followed by Cyanophyta (*n*=306; 34.77%)> Bacillariophyta (*n*=78; 8.87%) = Charophyta (*n*=78; 8.87%)> Cladocera (*n*=25; 2.84%)> Dinophyta (*n*=14; 1.59%)> Insects (*n*=7; 0.8%)> Crustaceans (*n*=6; 0.68%)> Rhodophhyta (*n*=4; 0.46%)> Chrysophyta (*n*=3; 0.34%) and the unidentified items (*n*=20; 2.27%). In the Chlorophyta category, *Chlorella vulgaris* (*n*=135;

15.34%) contributed the highest followed by *Crucigeniella rectangularis* (*n*=125; 14.21%), the least was *Chlorostella meneghiniana* (*n*=27; 3.07%).

Unlike the number method, the frequency of occurrence indicated cyanophyta (*n*=31; 31.31%) as the most frequently occurred category of food item followed by chlorophyta (*n*=21; 21.21%), the least were chrysopyta and rhodophyta with values *n*=1; 1.01% for both (Table 2).

Table 2: Diet Composition of *M. vollenhovenii* in Lower Orashi River, Niger Delta, Nigeria

Family	No of Food Items	Gut with a particular food	Numerical Method (%)	Frequency of Occurrence (%)
BACILLARIOPHYTA	**78**	**16**	**8.87**	**16.16**
Tabellaria flocculosa	14	2	1.59	2.02
Melosira distans	10	2	1.14	2.02
Synedra berolinensis	12	2	1.36	2.02
Cyclotella meneghiniana	8	1	0.91	1.01
Meridion circulare	4	1	0.46	1.01
Rhizosolenia longiseta	7	2	0.80	2.02
Synedra ulna	6	2	0.68	2.02
Nitzschia ricta	8	2	0.91	2.02
Melosira varians	9	2	1.02	2.02
CHAROPHYTA	**78**	**10**	**8.87**	**10.1**
Closterium strigosum	35	5	3.98	5.05
Closterium gracile	43	5	4.89	5.05
CHLOROPHYTA	**339**	**21**	**38.53**	**21.21**
Chlorella vulgaris	135	10	15.34	10.10
Chlorostella meneghiniana	27	2	3.07	2.02
Crucigeniella rectangularis	125	6	14.21	6.06
Palmodictyon viride	52	3	5.91	3.03
CHRYSOPHYTA	**3**	**1**	**0.34**	**1.01**
Chlorogibba astreata	3	1	0.34	1.01
CLADOCERA	**25**	**5**	**2.84**	**5.05**
Parts of antenna	20	3	2.27	3.03
Claws	5	2	0.57	2.02
CRUSTACEAN	**6**	**2**	**0.68**	**2.02**
Parts of crustaceans	6	2	0.68	2.02
CYANOPHYTA	**306**	**31**	**34.77**	**31.31**
Aphanizomenom flos-aquae	14	2	1.59	2.02
Chroococcus limneticus	124	11	14.09	11.11
Gomphosphaeria lacustris	143	13	16.25	13.13
Entophysalis spp	13	2	1.48	2.02

Aphanothece costagnei	12	3	1.36	3.03
DINOPHYTA	**14**	**4**	**1.59**	**4.04**
Akashiwo sanguinea	14	4	1.59	4.04
INSECTS	**7**	**3**	**0.8**	**3.03**
Insect wings	7	3	0.80	3.03
RHODOPHYTA	**4**	**1**	**0.46**	**1.01**
Bostrychia spp	4	1	0.46	1.01
UNIDENTIFIED ITEMS	**20**	**5**	**2.27**	**5.05**
TOTAL	**880**	**99**	**100**	**100**

3.1.2. Number and frequency of Occurrence for *M. felicinum*

The result of the gut contents as calculated by the number and frequency of occurrence methods are presented in Table 3. The results showed that 697 food items were found in the guts with Bacillariophyta (*n*=400; 57.38%) recorded as the highest number of food items followed by Chlorophyta (*n*=165; 23.68%)> Cyanophyta (*n*=65; 9.32%)> Cladocera (*n*=23; 3.30%)> Insect (*n*=10; 1.44%)> Chrysophyta (*n*=8; 1.15%)> Crustaceans (*n*=6; 0.86%) and the unidentified items (*n*=20; 2.27%). Dinophyta, Charophyta and Rhodophyta were absent in the gut content. In Bacillariophyta category, *Melosira varians* contributed highest (*n*=240; 34.43%), followed by *Aphanocapsca spp* (*n*=50; 7.17%), the least was *Fragilaria intermedia* (*n*=5; 0.72%).

Likewise, the results of the frequency of occurrence indicated that Bacillariophyta (*n*=38; 38.77%) was the most frequently occurring diet followed by Chlorophytaa (*n*=23; 23.46%)> Cyanophyta (*n*=15; 15.30%)> Cladocera (*n*=7; 7.14%)> Chrysophyta (*n*=4; 4.08%)> Insect (*n*=3; 3.06%)> Crustaceans (*n*=2; 2.04%) and the unidentified items (*n*=66; 6.12%).

3.1.3. Number and frequency of Occurrence for *M. macrobrachion*

The result of the gut contents as calculated by the number and frequency of occurrence methods are presented in table 4. The results showed a total of 1006 food items in the guts of *M. macrobrachion*, with the highest number of food item recorded as Bacillariophyta (*n*=366; 36.40%) followed by Chlorophytaa (*n*=295; 29.35%)> Cyanophyta (*n*=289; 28.74%)> Dinophyta (*n*=29; 2.88%)> Cladocera (*n*=14; 1.40%)> Crustaceans (*n*=3; 0.30%) and unidentified items (*n*=10; 0.99%). Chrysophyta, Insects, Charophyta, and Rhodophyta were absent in the gut. In Bacillariophyta category, *Melosira varians* contributed highest (*n*=223; 22.17%), followed by *Aphanocapsca spp*. (*n*=34; 3.38%), the least was *Cyclotella spp* (*n*=3; 0.30%).

For the frequency of occurrence, Chlorophyta (n=33; 33.66%) recorded the highest frequency of occurrence followed by Bacillariophyta (*n*=32; 32.64%)> Cyanophyta (*n*=24; 24.48%)> Cladocera (*n*=4; 4.08%)> Dinophyta (*n*=2; 2.04%)> Crustaceans (*n*=1; 1.02%) and unidentified items (*n*=2; 2.04%).

Table 3: Diet Composition of *M. felicinum* in Lower Orashi River, Niger Delta, Nigeria

Food Items	No of Food Items	Guts with a particular food	Numerical Method (%)	Frequency of Occurrence (%)
BACILLARIOPHYTA	**400**	**38**	**57.38**	**38.77**
Rhizolenia eriensis	12	3	1.72	3.06
Tabellaria flocculosa	17	5	2.44	5.10
Cyclotella meneghiniana	13	3	1.87	3.06
Coscinodiscus exentricus	7	2	1.00	2.04
Tabellaria fenestrata	12	2	1.72	2.04
Epithemia turgida	6	2	0.86	2.04
Fragilaria intermedia	5	1	0.72	1.02
Synedra ulna	7	1	1.00	1.02
Synedra berolinensis	31	2	4.45	2.04
Aphanocapsca spp	50	5	7.17	5.10
Melosira varians	240	12	34.43	12.25
CHLOROPHYTA	**165**	**23**	**23.68**	**23.46**
Closterium strigosum	34	4	4.88	4.08
Chlorella vulgaris	25	6	3.59	6.12
Cladophora spp	59	6	8.47	6.12
Gleochaete withrockiana	47	7	6.74	7.14
CHRYSOPHYTA	**8**	**4**	**1.15**	**4.08**
Chlorogibba spp	8	4	1.15	4.08
CLADOCERA	**23**	**7**	**3.30**	**7.14**
Parts of antenna	18	4	2.58	4.08
Claws	5	3	0.72	3.06
CRUSTACEAN	**6**	**2**	**0.86**	**2.04**
Parts of crustaceans	6	2	0.86	2.04
CYANOPHYTA	**65**	**15**	**9.32**	**15.30**
Aphanizomenom flos-aquae	32	6	4.59	6.12
Entophysalis spp	23	5	3.30	5.10
Microcoleus lacustris	7	3	1.00	3.06
Plectonema wollei	3	1	0.43	1.02
INSECT	**10**	**3**	**1.44**	**3.06**
Insect wings	10	3	1.44	3.06
UNIDENTIFIED ITEMS	**20**	**66**	**2.87**	**6.12**
Total	**697**	**98**	**100**	**100**

Table 4: Dietary Composition of *M. macrobrachion* in Lower Orashi River, Niger Delta, Nigeria

Food Items	**No of Food Items**	**Guts with a particular food**	**Numerical Method (%)**	**Frequency of Occurrence (%)**
BACILLARIOPHYTA	**366**	**32**	**36.40**	**32.64**
Melosira varians	223	7	22.17	7.14
Thalassiothrix longissima	17	4	1.69	4.08
Epithemia argus	6	3	0.60	3.06
Tabellaria flocculosa	5	1	0.50	1.02
Cyclotella spp	3	1	0.30	1.02
Nitzschia paradoxa	23	3	2.29	3.06
Aphanocapsca spp	34	3	3.38	3.06
Meridion spp	17	3	1.69	3.06
Synedra cyclopum	15	4	1.49	4.08
Nitzschia sigma	23	3	2.29	3.06
CHLOROPHYTA	**295**	**33**	**29.35**	**33.66**
Gonatozygon aculeatum	6	2	0.60	2.04
Planktophaeria gelatinosa	24	3	2.39	3.06
Chlorella eligaris	35	3	3.48	3.06
Crucigenia puadrata	33	3	3.28	3.06
Cladophora spp	24	2	2.39	2.04
Pseudendoclonium submarinum	32	3	3.19	3.06
Pseudochaete crassisetum	27	2	2.68	2.04
Chaetopeltis orbicularis	9	3	0.90	3.06
Entransia dichloroplastes	10	3	0.99	3.06
Palmellopsis spp	42	4	4.18	4.08
Crucigenia truncata	53	5	5.27	5.10
CLADOCERA	**14**	**4**	**1.40**	**4.08**
Parts of antenna	8	2	0.80	2.04
Claws of Cladocera	6	2	0.60	2.04
CRUSTACEAN	**3**	**1**	**0.30**	**1.02**
Parts of crustaceans	3	1	0.30	1.02
CYANOPHYTA	**289**	**24**	**28.74**	**24.48**
Aphanizomenom spp	34	4	3.38	4.08
Rivularia spp	19	2	1.89	2.04
Palmodictyon spp	32	3	3.18	3.06
Chroococcus spp	23	3	2.29	3.06
Diplocon heppii	26	2	2.59	2.04
Entophysalis oncobyrsa	24	2	2.39	2.04
Entophysalis spp	47	3	4.67	3.06
Gomphosphaeria lacustris	39	2	3.88	2.04
Spirulina subtilissima	45	3	4.47	3.06

DINOPHYTA	**29**	**2**	**2.88**	**2.04**
Gonyaulax polyedra	29	2	2.88	2.04
UNIDENTIFIED ITEMS	**10**	**2**	**0.99**	**2.04**
Total	**1006**	**98**	**100**	**100**

3.1.4. Index of food significance (IFS) for *M. vollehovenii, M. felicinum and M. macrobrachion*

The gut contents were categorised into eleven (11) groups: Bacillariophyta, Chlorophyta, Chryophyta, Cladocera, Crustaceans, Cyanophyta, insects, Dinophyta, Charophyta, Rhodophyta and unidentified items. All 11 categories of food items were present in *M. vollenhovenii*, while only 8 and 7 of the 11 food item categories were present in *M. felicinum* and *M. macrobranchion* respectively (Table 5). The primary food items (i.e., IFS ≥ 3%) for *M. vollenhovenii* as shown in Table 5, are cyanophyta (50.04%)> chlorophyta (37.56%)> bacillariophyta (6.59%) and charophyta (4.12%). Cladocera (0.66%)> unidentified items (0.53%)> dinophyta (0.30%) and insects are classed as secondary food items (i.e., IFS ≥ 0.1 to < 3 %). Whereas chrysophyta (0.02), crustacean (0.06) and rhodophyta (0.02) are considered as incidental (i.e., IFS≤ 0.1% Table 5). As shown in Table 5, the primary food items for *M. felicinum* were bacillariophyta (74.78%), chlorophyta (18.68%) and cyanophyta (4.79). Cladocera> Chrysophta> insect were secondary while crustacean were categorized as incidental food item. Similarly, the primary food item found in the gut of *M. macrobrachion* were bacillariophyta (41.06%), chlorophyta (34.14%) and cyanophyta (24.32%). Secondary food items were cladocera and dinophyta at 0.20% each whereas, unidentified items (0.07%)

Food item	*M. vollenhovenii*	Ranking	*M. felicinum*	Ranking	*M. macrobrachion*	Ranking
Bacillariophyta	6.59	Primary	74.78	Primary	41.06	Primary
Chlorophyta	37.56	Primary	18.68	Primary	34.14	Primary
Chrysophyta	0.02	Incidental	0.16	Secondary	-	-
Cladocera	0.66	Secondary	0.79	Secondary	0.20	Secondary
Crustacean	0.06	Incidental	0.06	Incidental	0.01	Incidental
Cyanophyta	50.04	Primary	4.79	Primary	24.32	Primary
Insects	0.11	Secondary	0.15	Secondary	-	-
Dinophyta	0.30	Secondary	-	-	0.20	Secondary
Charophyta	4.12	Primary	-	-	-	-
Rhodophyta	0.02	Incidental	-	-	-	-
Unidentified items	0.53	Secondary	0.59	Secondary	0.07	Incidental

and crustaceans (0.01) were incidental.

Table 5. Percentage index of food significance of the gut content of *M. vollenhovenii, M. felicinum and M. macrobrachion* from the lower reaches of Orashi River, Niger Delta. Food with IFS ≥ 3% are regarded as primary; ≥ 0.1 to < 3 % as secondary; and ≤ 0.1% are considered as incidental.

4. DISCUSSION

4.1. Gut content of *Macrobrachium vollenhovenii, M. felicinum* and *M. macrobrachion*

The determination of a species inherent demands and interactions with other organisms in their immediate environment depends on the understanding of the diet of such species (Albertoni *et al*. 2003; Lima *et al*. 2014). This study investigated the dietary composition of three Macrobrachium species (*M. vollenhovenii*, *M. felicinum* and *M. macrobrachion*) from the lower Orashi River. The results of the gut content analysis of 300 *Macrobrachium* individuals revealed a predominance of plant-based food primarily algae. *M. volenovenii* exhibited the most diverse diet, while *M. felicinum* and *M. macrobrachion* lacked certain algal groups. Empty guts were noted in five specimens, similar to the findings of Fredrick *et al.*, (2019) that recorded both empty stomach and predominance of plant-based materials for *M. vollenovenii* in Epe Lagos Lagoon, Nigeria. The study reported that out of 240 *M. vollenovenii*, stomach examined for the presence of food 8 had empty gut. The study also recorded the study also recorded the presence of chloropyta, chrysopyta, diatoms, dinoflagellates, insect parts and unidentified organisms which were synonymous to the diets recorded in the study for *Macrobrachium* species. The dietary habits of *Macrobrachium* species observed in this study highlight the species omnivorous and opportunistic feeding behaviour, dominated by a preference for phytoplankton (see Table2-5) and is in-line with previous studies which have demonstrated *Macrobrachium* species as omnivore detritivore, planktivore detritivore, omnivore scanvengers feeding on a wide variety of plant-based food, detritus with slight preference to food of animal origin (Idung *et al*., 2013; Deekae *et al*., 2016; Jimoh *et al*., 2016; Oyekanmi *et al*., 2017; Akinwunmi *et al*., 2019; Binaebi *et al*., 2024).

4.1.1. Feeding Ecology of *M. vollenhovenii*

The dominance of Chlorophyta (38.53%) among the gut contents of *M. vollenhovenii* indicated herbivorous tendency, particularly preferring green algae (Table 2). The abundance of *Chlorella vulgaris* (15.34%) and *Crucigeniella rectangularis* (14.21%) suggests that these prawns actively graze on benthic algae, establishing their role as primary consumers. The result of the present study is consistent with studies indicating that phytoplankton forms the primary diet of many fresh water prawns (Bello-Olusoji *et al*., 2011; Jimoh *et al*., 2011; Gangbe *et al*., 2016), but in contrast with those indicating species preference to detritus (Idung *et al*., 2013; Akinwunmi *et al*., 2019). The presence of minor groups such as *Dinophyta* and *Chrysophyta* suggests a less selective feeding habit, characteristic of opportunistic feeders (Wahab *et al*., 2016). Moreover, its opportunistic consumption of animal matter and detritus gave emphasis to its ecological versatility and occasional omnivorous tendencies. Similar studies in West Africa have reported comparable feeding patterns in other *Macrobrachium* species, emphasizing the ecological similarities within this genus (Marioghae and Ayinla, 1995). The relatively low consumption of higher trophic items such as insects and crustaceans suggested that *M. vollenhovenii* primarily occupied a lower trophic niche, critical for maintaining the balance of aquatic ecosystems. The results of the present study supports earlier studies by Bello-Olusoji *et al*. (1995; 2006), Oyekanmi *et al*. (2017) and Das *et al.* (2018), indicating that *M. vollenhovenii* can opportunistically exploit animal-based resources particularly during periods of phytoplankton scarcity or due to species high protein requisite which needs to be raised to an optimal level for better growth and feeding efficiency (Balazs *et al*., 1973).

The frequency of occurrence method suggested that *Cyanophyta* (31.31%) was the most frequently consumed category, followed by *Chlorophyta* (21.21%). The dominance of the phytoplanktonic groups emphasized the importance of autotrophic organisms in sustaining *M. vollenhovenii* populations. This suggested that the prawn plays a crucial role in energy transfer within freshwater ecosystems, linking primary producers to higher trophic levels (Frost, 1975). However, the discrepancy between the numerical and the frequency of occurrence could be as result from variations in availability of food items (Akinwunmi *et al.*, 2019). Cyanobacteria are resilient to environmental fluctuations in tropical waters (Tilman, 1982), hence their frequently occurrence highlighted their role as a stable dietary component. Furthermore, the disparity highlights the crucial need to consider both quantitative and qualitative aspects when analysing dietary composition in these prawns.

4.1.2. Feeding Ecology of *Macrobrachium felicinum*

The results of the number method in the present study indicated Bacillariophyta (57.38%, Table 3) as the most dominate food item in the gut content of *M. felicinum* with *Melosira varians* contributing the highest proportion (34.43%), highlighted the species preference for diatoms. This results is in-line with those reported earlier noting diatoms as a significant portion of the diet for freshwater prawns due to their high nutritional value and availability (Bello-Olusoji *et al*., 2011). The occurrence of *Chlorophyta* and *Cyanophyta* suggested a secondary dependence on green algae and cyanobacteria, indicating an opportunistic feeding strategy. The presence of minor animal-based food items such as Cladocerans insects and crustaceans stressed the species omnivorous tendencies. Similar patterns have been observed in other *Macrobrachium* species, where phytoplankton dominated the diet, supplemented by zooplankton and detritus (Gangbe *et al*., 2016; Binaebi *et al*., 2024). The absence of Dinophyta, Charophyta, and Rhodophyta in the gut suggests either limited availability or selective feeding behaviour that favours more nutritious and readily available food sources like Bacillariophyta and Chlorophyta indicating that the species has adapted to optimize its nutrient intake for growth and reproductive success (Hyslop, 1980; Akinwunmi *et al.,* 2019). Although, selective feeding has not be reported in *Macrobrachium* species in Nigeria waters, it has been reported in other part of the globe where species such as *Metapenaeus monoceros* (Rao, 1988); *Macrobrachium choprai* (Roy and Singh, 1997) and *Macrobrachium lar* (Sethi *et al*., 2013), may more often visit the upper water column to fulfil their dietary requirements. The absence may also reflect broader ecological dynamics within the habitat, such as suboptimal conditions for these algal groups or competition from more dominant species (Jimoh *et al.*, 2018), serving as an indicator of habitat quality and highlighting the need for targeted aquaculture practices that enhance the availability of preferred food sources to optimize growth performance (Andem and Andem, 2016).

The frequency of occurrence method revealed Bacillariophyta as the most frequently occurring food item in the gut samples followed by *Chlorophyta* and *Cyanophyta* (Table 3). This observation agrees with the numerical method, confirming diatoms as the primary dietary component. This dietary composition suggested the species role in linking primary producers (e.g., *Bacillariophyta* and *Chlorophyta*) with higher trophic levels thus, reinforcing its function as a primary consumer and detritivore in the ecosystem, facilitating nutrient recycling and energy transfer within aquatic ecosystems (Marioghae and Ayinla, 1995). The prevalence of phytoplankton in its diet indicated that *M. felicinum* thrives in habitats with high primary productivity, making it an excellent indicator of ecosystem health. Also, the species ability to incorporate zooplankton and other animal-derived items (cladocerans, insects and crustaceans) reflected the occasional consumption of animal-based food items characteristic of omnivore scavenger (Sethi *et al*., 2013).

4.1.3. Feeding Ecology of *Macrobrachium macrobrachion*

The numerical analysis of gut contents showed that *M. macrobrachion* exhibited a more balanced dependence on Bacillariophyta (36.40%), Chlorophyta (29.35%), and Cyanophyta (28.74%) compared to other *Macrobrachium* species such as *M. felicinum* and *M. vollenhovenii* in this study area. This balanced diet may reflect its adaptability to varying environmental conditions and resource availability. The high numerical abundance of Bacillariophyta, particularly *Melosira varians* suggests a significant dependence on diatoms as a food source. (Bello-Olusoji *et al*., 2011; Das *et al*., 2018). The dominance of phytoplankton e.g., Chlorophyta and Cyanophyta in the diet of *M. macrobrachion* highlights its role as a primary consumer in freshwater ecosystems, reflecting the high primary productivity of its habitat. Its feeding behaviour facilitates energy transfer from primary producers to higher trophic levels, contributing to ecosystem stability (Frost, 1975). The minor contributions of *Dinophyta* (2.88%), Cladocera (1.40%), and Crustaceans (0.30%) suggested occasional consumption of zooplankton and detritus, indicative of opportunistic feeding behaviour and the species role in nutrient recycling. The absence of *Chrysophyta*, insects, *Charophyta*, and *Rhodophyta* might be due to their low abundance in the environment or selective feeding. Similar patterns have been observed in other *Macrobrachium* species, where phytoplankton constituted the primary diet, with zooplankton and detritus acting as supplementary food sources (Gangbe *et al*., 2016).

The frequency of occurrence method indicated *Chlorophyta* (33.66%) as the most frequently encountered food category, followed closely by *Bacillariophyta* (32.64%) and *Cyanophyta* (24.48%). This indicated that while diatoms dominated numerically, green algae (*Chlorophyta*) were more consistently present across gut samples. Such variations might result from differences in temporal availability and/or environmental conditions affecting the distribution of phytoplankton (Tilman, 1982).

4.2. Comparison of the diets of *M. vollenhovenii, M. felicinum and M. macrobrachion*

The analysis of the Index of Food Significance (IFS) emphasizes the relative importance of different food items in the diets, reflecting their feeding ecology and adaptability in the aquatic habitat. In the present study, the index of food significance (IFS) for *Macrobrachium vollenhovenii*, *M. felicinum*, and *M. macrobrachion* revealed distinct dietary preferences and ecological adaptations among these species reflecting their feeding behaviour in relation to food availability in their habitats, with *M. vollenhovenii* exhibiting a diverse diet. The primary (IFS < 3%) food item for *M. vollenhovenii* was predominantly composed of *Cyanophyta*> *Chlorophyta*> *Bacillariophyta*> *Charophyta* indicating a strong preference for algae, particularly cyanobacteria and green algae suggesting that these species thrive in environments rich in these primary producers (Jimoh *et al*, 2011; Bello-Olusoji *et al*., 2006). The result is similar to the findings that freshwater prawns often exploit nutritionally rich phytoplankton in eutrophic environments (Gangbe *et al*., 2016). The presence of *Charophyta* as a primary food item suggested local availability or habitat-specific feeding adaptations. In contrast, *M. felicinum* exhibited a more focused dietary dependence on *Bacillariophyta*, highlighting its adaptation to diatom-rich habitats that provide essential nutrients for growth and reproductive success (Hyslop, 1980; Cortes, 1999; Bello-Olusoji *et al.*, 2011). *Chlorophyta* and *Cyanophyta* complemented its diet and showed its preference for diatoms but with adaptability to include other algal groups. Similarly, *M. macrobrachion* demonstrates a balanced consumption of *Bacillariophyta* (41.06%), *Chlorophyta* (34.14%), and *Cyanophyta* (24.32%) as primary food items. This balance suggested a generalist feeding strategy, likely influenced by its ecological niche and the availability of diverse phytoplankton in its habitat (Marioghae and Ayinla, 1995), depicting a broader dietary flexibility that enhances its adaptability to varying ecological conditions (Andem and Andem, 2016).

The presence of secondary food items (IFS ≥ 0.1% to < 3%) for all three species such as Cladocera, Dinophyta, and insects in varying proportions indicates some dietary overlap. These items represented occasional zooplankton and detritus contributions, reflecting opportunistic feeding behaviour. The presence of *Cladocera* is in line with previous reports highlighting the inclusion of zooplankton as a supplementary protein source in freshwater prawn diets (Das *et al*., 2018). The Incidental Food Items (IFS ≤ 0.1%) for *M. vollenhovenii* were Chrysophyta (0.02%), Crustaceans (0.06%) and Rhodophyta (0.02%) suggested minimal ingestion which might be due to low availability or low preference (Akinwunmi *et al*., 2019). Both *M. felicinum* and *M. macrobrachion* had Crustaceans as their incidental food item with minor contributions from unidentified items. This indicated accidental ingestion or a negligible role of these items in their diet. The classification of certain food items as incidental reflects the opportunistic feeding, strategies employed by these prawns to maximize nutrient intake from available resources (Toto *et al.*, 2018; Jimoh *et al.*, 2015).

4.3. Implication for ecosystem conservation and sustainable shrimp fisheries

The differences in primary food items among the three species indicated resource partitioning, which consequently reduces interspecific competition and allows coexistence in shared habitats. *M. vollenhovenii* relied heavily on Cyanophyta, *M. felicinum* showed a pronounced preference for Bacillariophyta, whereas *M. macrobrachion* demonstrated a more balanced diet, reflecting flexibility in resource used. All three species played crucial roles as primary consumers, facilitating the transfer of energy from primary producers (phytoplankton) to higher trophic levels. Their feeding behaviour supported nutrient recycling, particularly through the consumption and digestion of algae and detritus (Frost, 1975). The dietary composition, particularly the prevalence of specific phytoplankton groups, can serve as an indicator of water quality and habitat productivity. For instance, the dominance of Cyanophyta in *M. vollenhovenii* suggested eutrophic conditions, while the high reliance on Bacillariophyta in *M. felicinum* indicated habitats with abundant diatoms (Tilman, 1982). Hence, changes in water quality, such as nutrient enrichment or pollution, could significantly impact the species food resources and population dynamics. In terms of habitat protection, maintaining the quality of water and ensuring the availability of primary producers are critical for the sustenance of these *Macrobrachium* species population. Anthropogenic activities such as nutrient enrichment, pollution, and habitat alteration could disrupt the food web and affect population dynamics. As a good candidate for aquaculture, understanding their dietary preferences can guide feed formulation (e.g., promotion of algal blooms in culture systems) and management practices.

Conclusion

In conclusion, *Macrobrachium vollenhovenii, M. felicinum* and *M. macrobrachion* from lower Orashi River are opportunities omnivore with preference for phytoplankton and the variations in their primary food items reflected differences in habitat preferences and ecological roles.

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REFERENCES

Abdel-Aziz, N. and Gharib, S. (2007). Food and feeding habits of round sardinella (*Sardinella aurita*) in El Mex Bay Alexandria, Egypt. *Egyptian Journal of Aquatic Research*, 33: 202-221.

Ajuzie, C.C and Fagade, S.O. (1992). African River Prawn has commercial potential. Fish Farmer, 33-34pp.

Akintola, S. L. and Bakare, S. B. (2011). Microbiological Changes in Freshwater Prawn (*Macrobrachium vollenhovenii*, Herklots 1857) Stored in Ice. *American Journal of Food Technology*, 6: 500-506.

Akinwunmi, M. F., Lawal-Are, A. O. and Ayoola, S. O. (2019). Food composition, preference and feeding habits of two caridean species in the interconnecting lagoons of South-Western Nigeria. *Egyptian Academic Journal of Biological Sciences*, 11 (1): 77-84.

Akuna, V. O and Amachree, D. (2019). Food of African butterfish, *Schilbe intermedius* (Rüppel, 1832) from Agbura landing site, Bayelsa State, Nigeria. *Global Scientific Journal*, 7 (3): 24-30.

Albertoni, E. F., Palma-Silva, C. and Esteves, F. A. (2003). Natural diet of three shrimp in a tropical coastal lagoon. *Brazilian Archives of Biology and Technology*, 46: 395-403.

Allison, M. E. and Sikoki, F. D (2013). Food and feeding habits of *Parailia pellucida* (Boulenger, 1901) (Schilbeidae) in the freshwater reaches of the Nun River of the Niger Delta, Nigeria - *International Journal of Advanced Fisheries and Aquatic Science*, 1(1), 1-14.

Andem, A. B. and Andem, S. A. (2016). Food and feeding habits of *Macrobrachium macrobrachion* in the Cross River, Nigeria. *Journal of Aquatic Sciences*, 31(1): 1-10.

Arrington, D.A., Winemiller, K. O., Loftus, W. F. and Akin, S. (2002). How often do fishes "run on empty"?. *Ecology*, 83: 2145-2151.

Ayisi, C. L., Hua, X. M., Apraku, A., Afiriye, G. and Kyei, B. A. (2017). Recent studies toward the development of practical diets for shrimps and their nutritional requirements. *HAYATI Journal of Biosciences* 2 (3): 1-7.

Ayekanmi, F. B., Omoniyi, I. T and Akegbejo-Samsons, Y. (2017). Gut Contents and feeding pattern of *Macrobrachium vollenhovenii* (HERKLOTS, 1857) and *Caridina africana* (Kingsley, 1882) at Asejire Lake and Erin-Ijesa waterfalls, Southwest, Nigeria. *Madridge Journal of Aquaculture Research and Development*, 1 (1): 18-23

Balazs, G. H., Ross, E. and Brooks, C. C. 1973. Preliminary studies on the preparation and feeding of crustacean diets. *Aquaculture*, 2: 369-377.

Bello-Olusoji, O. A., Bankole, M., Sheu, A. and Oyekanmi, F. B. (2006). Availability, diet composition and feeding behaviours of some commercially important Palaemonidae prawns in fresh and brackish water of Nigeria. *Journal of Biological Sciences*, 6 (1): 15-21.

Bello-Olusoji, O. A., Oyekanmi, F. B., and Adeosun, O. (2011). Gut content analysis of *Macrobrachium* species in Nigerian freshwater ecosystems. *Nigerian Journal of Fisheries*, 8 (1): 51-56.

Bello-Olusoji, O.A., Balogun, A.M., Fagbenro, O.A., Ugbaja, N. (1995). Food and feeding studies of the African River Prawn *Macrobrachium vollenhovenii (*Herklots, 1857). *European Aquaculture Society* 24: 425-427.

Binaebi, E. D., Obomunu, B and Kainga, J. S. (2024). Food and feeding habit of *Macrobrachium felicinum* and *Macrobrachium vollenhovenii*, at the Amassoma axis of Igbedi creek, Bayelsa State. *Nigerian Journal of Agriculture and Agricultural Technology*, 4 (2) (Online): www.njaat.atbu.edu.ng;2811-1893.

Bisong, A. E., Oku, H. B., Willabo, M., Wodu, P. D., Wike, P. N., Okara, E. S. (2024). Morphometric characteristics of the lower Orashi River, Niger Delta Region, Nigeria. *Nigerian Journal of Applied Science and Environmental Management*, 28 (4): 1305-1314.

Chea, R., Lek, S., Ngor, P. and Grenouillet, G. (2017). Large-scale patterns of fish diversity and assemblage structure in the longest tropical river in Asia. *Ecology of Freshwater Fish*, 26 (4): 575-585.

Cortes, E. (1999). Standardized diet composition statistics for sharks and their implication for conservation. *Journal of Environmental Biology of Fishes*, 56 (3): 345-353.

Das, P., Mukherjee, S., Kar, S., Das, U., Kar, D and Aditya, G. (2018). Zooplankton as dietary component of selected freshwater fish: network analysis based on gut content, *AACL Bioflux*, 11 (1): 232-244.

De Grave, S., and Fransen, C. H. J. M (2011) Carideorum catalogus: the recent species of the dendrobranchiate, stenopodidean, procarididean and caridean shrimp (Crustacea: Decapoda). *Zoologische Mededelingen Leiden*, 89 (5): 195-589.

Deekae, S.N., Ansa, E. J. and Davidson, E. B. (2016). Foods of the Brackish River Prawn *Macrobrachium macrobrachion* (Herklots, 1851) from Ekole Creek, Bayelsa State, Niger Delta. *Continental Journal of Applied Sciences*, 11(1), 11-26.

Fagade, S.O. and Olaniyan, C.I.O. (1972). The biology of the West African shad *Ethmalosa fimbriata*(Bowditch) in the Lagos lagoon, Nigeria. *Journal of Fish Biology*, 4, 519-533

Fredrick, A., Bumni, H.S., and Patrick, O. (2019). Analysis of the stomach content of African River Prawn (*Macrobrachium vollenhovenii*) in Epe, Lagos Lagoon, Nigeria. *Advances in Aquaculture and Fisheries Management*, 7(6), 001-006

Frost, T. M. (1975). The role of zooplankton in energy transfer in freshwater ecosystems. *Ecological Monographs*, *45*(3), 367-389.

Gangbe, L., Agadjihouèdé, H., Chikou, A. Senouvo, P., Mensah, G. A. and Layele, P (2016). Biologie et perspectives d'élevage de la crevette géante d'eau douce *Macrobrachium vollenhovenii* (Herklots, 1857). Journal of Biological and chemical Sciences, 10: 573-598.

Griffith, J. F. (1972). Climates of Africa. In: Lansburg, H.E. (Ed). World Survey of Climatology. New York. Elsevier.

Hillary, B. and Erica, S. (1979). A beginner guide to freshwater algae: Institute of Terrestrial Ecology and Environmental Research; Centre of Algae and Protozan studies, Cambridge.

Holthuis, L. B. (1980) FAO Species Catalogue: Shrimps and Prawns of the World. An Annotated Catalogue of Species of Interest to Fisheries. FAO Fisheries Synopsis, 1, 271 p

Hyslop,. E. J. (1980). Stomach content analysis: a review methods and applications. *Journal of Fish Biology*, 17, 411-429.

Idung, J., Andem, B,. Eni, G., George, U. (2013). Food and Feeding Habits of the Brackish River Prawn (*Macrobrachium macrobrachion*, Herklots, 1857) from Greak Kwa River, Obufa Esuk Beach, Calabar, Cross River State, Nigeria. *Journal of Natural Science Research*, 3(9): 1-7.

Jeje, C.Y. and Fernando, C. H. (1988). *A practical guide to the identification of Nigerian zooplankton (Cladocera, Copepoda and Rotifer*. Published and Printed by Kainji Lake Research Institute. Kainji, Nigeria. 142pp.

Jimoh, A. B., Clarke, E.O. Whenu, O. O. and Adeloye, H. B. (2011). Food and Feeding Habits of the African River Prawn (*Macrobrachium vollenhovenii*, Herklots, 1985) in Epe Lagoon, South West, Nigeria. *International Journal of Fisheries and Aquaculture,* 3 (1): 10-15.

Jimoh, W. A. and Adebayo, O. T. (2005). Natural diet and feeding habits of a freshwater prawn (*Macrobrachium vollenhovenii*) in Epe Lagoon, Nigeria: Implications for aquaculture practices. *International Journal of Science and Research (IJSR)*, 4 (8): 11-17.

Lima, J. F., Garcia, J. S and Silva, T. C. (2014). Natural diets and feeding habits of a freshwater prawn (*Macrobrachium carcinus*: Crustacea, Decapoda) in the estuary of the Amazon River. *Acta Amazonica*, 44 (2): 235-244.

Marioghae, I. E. and Ayinla, O. A. (1995). The reproductive biology of *Macrobrachium vollenhovenii* (Herklots, 1857) and *Macrobrachium macrobrachion* in the Lagos lagoon. Technical paper 100, African Regional Aquacultural Centre, Nigerian Institute for Oceanography and Marine Research, Port Harcourt, Nigeria, 16pp.

Marioghae, I.E. (1987). An appraisal of the cultivability of Nigerian Palaemonid Prawns. *ARAC/87/WP/4. UNDP/FAO/NIOMR* Lagos. Working Paper, 12pp.

New, M.B. (2002). Farming freshwater prawns: A manual for the culture of the giant river prawn (*Macrobrachium rosenbergii*). FAO Fisheries Technical Paper, 428: 212pp

Niger Delta Environmental Survey (NDES) (1998). Biological Characteristics. Survey Part 2.

Odigwe., M., Efe., S.I. and Atubi, A.O. (2020). A statistical discourse of the climate of the Niger Delta region of Nigeria. *Journal of Management and Social Science Research*, 1(1/2): 15-33.

Okadi, D., Amachree, D and Kingdom, T (2024). Diets of Largescaled Mullet, *Parachelon grandisquamis* (Valenciennes, 1836) from St. Nicholas River, Bayelsa State, Nigeria. *International Journal of Agriculture and Earth Science*, 10 (10): 94-105.

Oyekanmi, F.B., Omoniyi, I.T. and Akegbejo-Samsons, Y. (2017). Gut contents and feeding pattern of *Macrobrachium vollenhovenii* (Herklots, 1857) and *Caridinia Africana* (Kingsley, 1882) at Asejire Lake and Erin-Ijesa waterfalls Southwest Nigeria, *Madridge Journal of Aquaculture, Research and Development*, 1(1), 18-23.

Powell, C. B. (1982). Fresh and brackish water shrimps of economic importance in the Niger Delta. Proceedings of the 2nd Annual Conference of Fisheries Society of Nigeria 254-285pp.

Powell, C. B. (1983). The decapods crustaceans of the Niger Delta. In: Wilcox, H.B.R and Powell, C.B. (ed) Publication committee, University of Port Harcourt. 226-238pp.

Powell, C. B. (1980). Key to Shrimp and Prawns (Crustacea; Decapoda, Natantia) of the Niger Delta Basin Development Authority Area. Consultancy Report, University of Port Harcourt, 34pp.

Rao, G. S. (1988). Studies on the feeding biology of *Metapenaeus monoceros* (Fabricus) along the Kakinada coast. *Journal of Marine Biological Association of India*, 39 (1 and 2): 171-181.

Roy, D. and Singh, S. R. (1997). The food and feeding habits of a freshwater prawn *Macrobrachium choprai*. *Asian Fisheries Science*, 10: 51-63.

Sethi, S.N., Ram, N and Venkatesan, V. (2013). Food and feeding habits of *Macrobrachium lar* (Decapoda, Palaemonidae) from Andaman and Nicobar Islands, India. *Indian Journal of Fisheries*, 60 (4): 131-135.

Tilman, D. (1982). *Resource competition and community structure*. Princeton University Press.

Toto, K., Goorè Bi G., and Djirièoulou, C. K. (2018). Comparative study of the diet of three species of freshwater shrimp: *Macrobrachium vollenhovenii, M. macrobrachion*, and *M. dux* (Crustacea, Palaemonidae) in Cavally River, Côte d'Ivoire, *Journal of Biological and Environmental Sciences*, 13 (5): 142-152

Ugwumba, A.A., and Ugwumba, O.A. (2007). *Food and feeding ecology of fishes in Nigeria*. Crystal Publishers Ajah, Lagos, 91pp

Von Chi-Bonnadel, B. (1973). *The Atlas of Africa*. New York, Free Press-Macmillian. 13pp.

Wahab, A., Zafar, M. and Islam, M. A. (2016). Feeding ecology of riverine crustaceans in Bangladesh. *Journal of Aquatic Ecology, 5* (3): 121-130.

Wootton, R. J. (1992). *Fish Ecology*: Tertiary Level Biology. Blackie, London: 212p