International Journal of Fisheries and Aquatic Studies 2017; 5(4): 210-216

E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2017; 5(4): xx-xx
© 2017 IJFAS
www.fisheriesjournal.com
Received: 19-05-2017
Accepted: 20-06-2017

John E Ukpatu
Department of Fisheries and Aquatic Environmental Management, Faculty of Agriculture, University of Uyo, Uyo, Nigeria

James P Udoh
Department of Fisheries and Aquatic Environmental Management, Faculty of Agriculture, University of Uyo, Uyo, Nigeria

Correspondence
James P Udoh
Department of Fisheries and Aquatic Environmental Management, Faculty of Agriculture, University of Uyo, Uyo, Nigeria

Seasonal variation in the proximate composition of size groups of *Nematopalaemon hastatus* in Okoro River estuary, southeast Nigeria and the influence of environmental factors

John E Ukpatu and James P Udoh

Abstract
The study investigated the influence of environmental factors in the proximate composition of *Nematopalaemon hastatus* shrimp in Okoro River estuary, Nigeria. The studied shrimp were 48.24% rich in crude protein; their proximate compositions being significantly affected by size, temporal and seasonal variations. Crude fibre and lipid contents decreased, while crude protein attained maximal level in the rainy season ($P<0.05$), peaking in April. Ash and lipid contents increased with size ($P<0.05$), while protein content was higher in younger than in adult shrimps ($P< 0.05$). Salinity, temperature and rainfall were the key environmental factors that exert significant ($P>0.05$) influence on shrimp properties. Temperature and salinity promote ($P < 0.05$) dry matter excluding moisture, lipid and crude fibre; rainfall promotes ($P < 0.05$) lipids, ash and carbohydrate contents excluding crude protein; and digestible carbohydrates showed positive affinity with moisture content, dry matter and protein. The interrelationships and pathways were summarized in a dendogram and general implications established.

Keywords: Crayfish, ecosystem pathways, habitat characteristics, nutritional quality

1. Introduction
Nigeria's coastal zone is endowed with numerous fin and shellfish species, particularly shrimps. Shrimp catch composition in the artisanal sector depends greatly on the area where the shrimping takes place. Shrimps are particularly abundant offshore the Niger Delta owing to a wider coastal shelf, coupled with frequent rainfall accompanied with rich organic debris input brought down the various river systems [1]. Local shrimping crew of between 3-4 persons/boat using motorized and non-motorized dugout or plank-built canoes usually harvests this species in large quantities [2]. The estuarine prawn, *Nematopaleamon hastatus,* popularly called "crayfish", dominate the artisanal catches from coastal waters and in estuaries, together with the highly-priced penaeid shrimp *Penaeus notialis*. Other river prawns and shrimps exploited include *Palaemon maculatus, P. africanus, Macrobrachium vollenhovenii* and *M. macrobrachium* [3]. Shrimp production in Nigeria is estimated at 12,000 tonnes of which 8,000 tonnes are exported valued at about 20 million dollars annually [4].
The shrimp is an important food condiment in Nigeria and is mostly sold in bags as dried 'crayfish'. They constitute vital sources of animal protein along with other decapod crustaceans such as lobster and crabs [5]. Apart from the supply of good quality proteins and vitamins A and D, shrimps also contain several dietary minerals such as calcium (Ca), Iron (Fe), etc., which are beneficial to man and animals [6].
Biochemical or proximate composition of organisms like shrimps are known to vary from species to species with season, age and size of animal, stages of maturity, availability of food and feeding habit; and environmental factors, particularly, temperature, habitat salinity and rainfall pattern [7 - 10]. Proximate composition of fish even varies within the same species from one individual to another. The variation in the proximate composition of shrimp is important both for its nutritive value, processing and preservation. Lipid contents of 0.1 to 2.01% were obtained in crustaceans [7-8]; while seasonal variations were observed in lipid contents of fresh water prawn *Macrobrachium dayanum* with higher lipid value (3.83 ± 0.11%) obtained in December (dry season) and lower value (0.23 ± 0.11%) in the raining season month of

September [11]. Inverse seasonal variations were observed between protein and carbohydrate values of Gangetic Sillago, *Sillaginopsis panijus* [12].

Changes in nutrient composition of crustaceans (*Penaeus notialis*) such as moisture, protein, and ash are a function of body weight [13] and size – it was reported that as protein content increases, fat decreased with age of shrimp [14]. Higher protein content (61.86%) was obtained in lower size groups (25 - 45 mm) than in the larger size groups (50-70 mm), 58.36% [15]. The carbohydrate values varied between 1.93% and 2.33%, respectively, in both groups; while the lipid content was higher in the larger size groups (5.60%) than the lower (3.53%).

The nutrient composition of shrimps and other crustaceans is very important to different users including food processors, nutritionists, cooks and the consumers because of their high patronage and intake by Nigerians across the coastal and hinterlands. This study therefore provides estimates of biochemical composition or nutritional status of different size groups of *N. hastatus* of Okoro River in Niger Delta area of Nigeria and their seasonal fluctuations. It further identifies the interrelationships among proximate composition of the shrimps and the environmental gradients that best explain such variations. The information provided here will aid proper and timely selection, harvest and utilization of suitable size groups of *N. hastatus* for consumption, processing and preservation.

2.0 Materials and Methods

2.1 Study area and sampling

The study was undertaken in the Okoro River estuary located in the Niger Delta, Nigeria (latitude 4º 33ʾN and 4 º 55ʾ N and longitude 7º45ʾE and 7⁰ 55ʾE, Fig. 1). Ten shrimp specimens were randomly sampled monthly over 12 consecutive months (n = 120) from April 2011 to March 2012, covering both dry and rainy seasons from fishermen at Elekpon landing site along Okoro River estuary (Fig. 1). The fishermen utilized traditional beam trawl nets (*Uduut*) in shrimp capture.

The specimens were washed of debris, allowed to drain, embedded in ice chest and transported to the laboratory for analysis. The carapace lengths and weights of the shrimps were measured with vernier calipers and electronic weighing balance to the nearest 0.01cm and 0.01g, respectively, and separated into of two size groups of 10-50 mm and 50-90 mm carapace lengths, for proximate analysis; each comprising 60 specimens.

2.2 Laboratory analyses

Sixty (60) samples of each size group x season were oven dried at 75 ˚C for 72 hours to ensure complete dryness; ground to fine powder in an electric blender, packed in labeled polythene bags and stored at 4˚C in refrigerator till chemical analysis. All the parameters were determined in triplicate samples (n = 3) following the method of [16]. Moisture was determined [16] by the loss in weight of sample after drying to constant weight in oven for 103 ºC for 4 hours and calculated as % of moisture weight loss x100/original weight of the sample taken. The percentage moisture content was subtracted from 100% to obtain % dry matter (DM = 100 - % Moisture). Nitrogen (N) for crude protein (CP) was determined by the micro-Kjeldahl method and converted to crude protein as %N x 6.25 [16]. Lipids (fat) content was determined with the Soxhlet procedure [17-18] with ether as solvent to obtain ether extract (EE) fraction. Crude fibre (CF) was determined using muffle furnace. The percentage ash content was measured with corning flame photometer (UK model 405) after charring at 400-600ºC for 4hours. Carbohydrate was determined as Nitrogen Free Extract (NFE) by subtracting the sum of percentages of all the nutrients already determined from 100 (NFE = 100 – (%moisture ±%CF±%CP±%EE±Ash) [16].

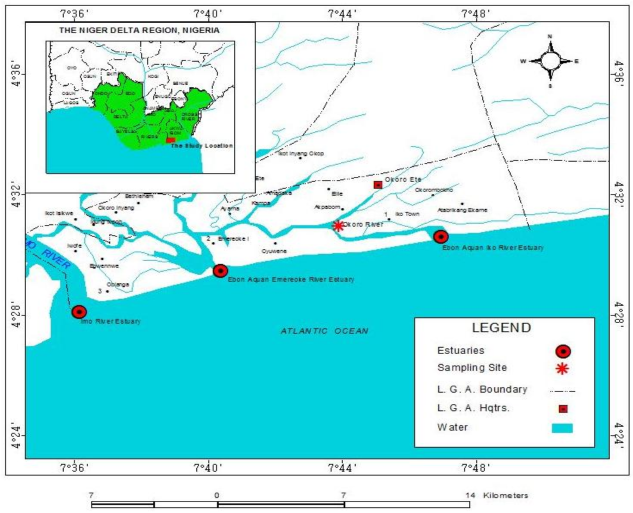

Fig 1: Location of sampling site in Eastern Obolo River estuary, southeast Nigeria

2.3 Data analysis

Means ± standard deviation of proximate parameters based on size groups and season were calculated and subjected to one way analysis of variance, ANOVA [19-20] with statistical significance set at $p < 0.05$. In addition the coefficient of variation (CV), which is the standard deviation expressed as a percentage of the mean, was calculated.

The Bray Curtis two-way paired group cluster analysis was performed on each pair of biochemical parameters to obtain an index of similarity or dissimilarity for each, and to yield a dendrogram identifying natural grouping or clustering of biochemical parameters [20-21]. Correlation and multiple regression analyses were performed to establish the relationships between proximate parameters and environmental factors (water temperature, salinity and rainfall); and between proximate parameters and size structure of shrimps in the ecosystem. All statistical analyses were performed using SPSS 19.0 and Microsoft Excel packages.

3.0 Results

The mean proximate composition of *N. hastatus* in Okoro River estuary is presented in Table 1; indicating as much as 48.24% Protein, 23.11% Carbohydrate, 4.461% Lipid with a mean metabolizable energy of 325.54 calories $100g^{-1}$. Results of monthly and seasonal variation, and size and seasonal variations in the body composition of the shrimp are summarized in Fig. 2 and Table 1, respectively. Seasonal variations were significant ($P < 0.05$) in Lipid ($F = 21.443$, $P = 0.01$) and crude fibre ($F = 37.172$, $P = 0.000$) contents, higher in the dry than in the rainy season; while crude protein ($F = 25.113$, $P = 0.01 < 0.05$) was maximal in the rainy season (Table 1). Carbohydrate, total ash, dry matter and moisture did not differ significantly ($P > 0.05$) with season; the first three parameters were maximal in the dry season, while moisture content was maximal in the rainy season. In addition, moisture, dry matter, crude fibre and carbohydrate did not differ significantly ($P > 0.05$) between the two size groups ($P > 0.05$). Ash and lipid contents increased with size ($P < 0.05$), while protein content was the reverse: higher in younger than in adult shrimps ($P < 0.05$). High moisture values correlated with low dry matter (Table 1).

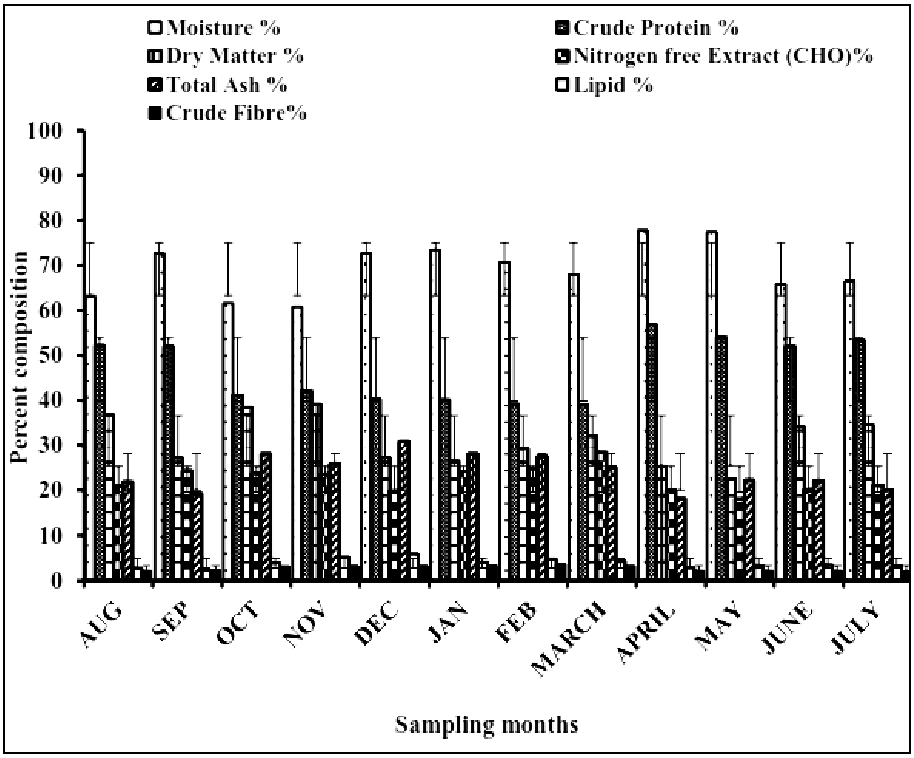

Fig 2: Monthly variation in the proximate composition

Multiple regression analyses established strong relationships ($P < 0.05$) between crude protein and crude fiber levels ($R^2 = 0.4 – 0.5$) with body size (Carapace length, CL and body weight, BW) as presented in Table 3. Weak associations ($P < 0.05$) were also established between body size and three parameters: moisture, total ash and nitrogen free extract ($R^2 = 0.2 - 0.3$). In addition, lipid exhibited very weak association ($R^2 = 0.180$) with body size (Table 3). Multiple regression analysis also established water temperature, habitat salinity and rainfall pattern as the main environmental forces that govern or determine nutritional quality (proximate composition) of *N. hastatus* shrimps in Okoro River estuary, Nigeria (Table 3). The results show a perfect relationship between digestible carbohydrates (NFE) and environmental factors ($R^2 = 0.621, P < 0.05$). The (3) environmental factors exercise strong influence ($P < 0.05$) on four body constituents of the shrimp, namely moisture content, dry matter, protein and crude fibre ($R^2 = 0.4-0.6$). While lipid and total ash contents recorded weak associations ($R^2 = 0.2-0.3$) with environmental factors (Table 3).

Table 1: Size and seasonal variations in the body composition of *Nematopalaemon hastatus* shrimps in Okoro River estuary, Nigeria (mean ± standard deviation of triplicate measurements)

Proximate Composition (%)	Smaller group (10-50 mm) CL)		Larger group (51-110 mm) CL)		Probability *(P)*	
	Dry season	Rainy season	Dry season	Rainy season	Season	Size
Moisture	60.37-71.16 (67.16 ±1.94)	61.22-73.35 (68.17±1.82)	62.59-74.48 (69.7±2.11)	63.22-74.68 (69.32±1.75)	0.999	> 0.05
Dry Matter	28.84-39.63 (32.84±1.94)	26.65-38.72 (31.8±1.82)	25.52-37.41 (30.3±2.11)	22.56-36.78 (29.67±2.10)	0.903	> 0.05
Crude protein	40.22-54.17 (45.4±2.86)	44.31-56.08 (51.67±1.37)	37.31-42.18 (39.12±0.85)	38.22-46.38 (43.52±1.37)	0.01*	< 0.05*
Lipids	2.32-3.28 (3.04±0.182)	2.143.41 (2.60±0.17)	4.28-5.37 (4.80±0.21)	2.88-3.81 (3.28±0.13)	0.01*	< 0.05*
Crude fibre	3.08-3.34 (3.22±0.04)	2.1-3.16 (2.46±0.16)	3.18-3.64 (3.35±0.09)	2.01-3.3 (2.53±0.19)	0.000*	> 0.05
Ash content	19.21-26.26 (23.19±1.22)	17.11-22.16 (19.86±0.73)	25.04-27.31 (26.36±0.41)	19.42-26.65 (24.10±0.97)	0.06	< 0.05*
Nitrogen free extract (carbohydrate)	20.04-29.82 (25.22±1.99)	20.46-28.39 (23.24±1.20)	23.09-28.15 (26.34±0.91)	22.13-32.58 (26.61±1.54)	0.078	> 0.05

CL = carapace length (mm) Dry season = November – March Rainy season = April – October *= significant (P<0.05)

Table 2: Multiple regression model between proximate composition of *Nematopalaemon hastatus* shrimps and body size (Carapace Length CL and Fresh Body Weight BW) in Okoro River estuary, Nigeria

Parameters	Mean	R	R^2	Adjusted R^2	S. E.	P	Regression Model: Y_0=a+ b_1Cl + b_2BW+e
Moisture	65.09	0.447	0.200^w	0.22	5.80	0.366	Y_0=62.475+0.786 CL-5.670 BW+e
Dry Matter	34.77	0.447	0.200^w	0.022	5.46	0.366	Y_0= 37.326- 0.745 CL+ 5.488 BW+e
Protein	48.24*	0.649	0.421*^{s}	0.292	5.89	0.086	Y_0=49.134-0.768 CL+10.590 BW+e
Lipid	4.461*	0.424	0.180 ^{vw}	-0.002	1.06	0.409	Y_0=3.171+0.114 CL-1.206 BW+e
Crude fibre	3.00	0.708	0.501* ^{s}	0.390	0.47	0.044	Y_0=2.359+0.085 CL-1.052 BW+e
Total Ash	21.22*	0.507	0.257^w	0.091	3.87	0.263*	Y_0=23.984+0.258 CL-268 BW+e
Carbohydrate (NFE)	23.11	0.580	0.337 ^{w}	0.190	2.61	0.157*	Y_0=21.352+0.312 CL-4.064 BW+e

NFE = Nitrogen free Extract *P* = Probability Level * = significant ($P < 0.05$) CL = Carapace Length, BW = Body weight, Strength of association - w = Weak (R^2 = 0.1 - 0.40), s = Strong (R^2 = 0.4 - 0.6), vw = Very weak (R^2 = 0.1 - 0.20)

Table 3: Multiple regression model between proximate composition of *N. hastatus* shrimps and environmental factors (temperature, salinity and rainfall) influencing their occurrence in Okoro River estuary, Nigeria

Parameters	R	R^2	Adjusted R^2	S.E.	P	Regression Model: Y_o = a + b_1T + b_2S + b_3R′ + e
Moisture	0.644	0.415^{*s}	0.195	5.2617	0.210	Y_o = 112.461+1.033T-2.668S+0.05R′ +e
Dry Matter	0.643	0.413^{*s}	0.193	4.9589	0.212	Y_o = 6.795+1.089T+2.534S+0.04R′ + e
Protein	0.664	0.440^{*s}	0.231	6.1449	0.179	Y_o = 81.527+0.563T-1.669S- 0.021R′ + e
Lipid	0.527	0.278^w	0.007	1.0571	0.431	Y_o= 8.448-0.254T+0.083S+0.001R′ + e
Crude fibre	0.761	0.579^{*s}	0.421	0.4551	0.063	Y_o= 1.130-0.123T+0.190S+0.002R′ + e
Total Ash	0.4299	0.184^w	-0.122	4.2983	0.632	Y_o= 13.324+0.130T+0.190S-0.08R′ + e
Carbohydrate (NFE)	0.788	0.621^{**p}	0.479	2.0924	0.042	Y_o= 4.428-0.315T+1.228S-0.011R′ + e

NFE = Nitrogen free Extract P = Probability Level *= significant (P<0.05) T=Temperature, S= Salinity, R′ = Rainfall Strength of association: w = Weak (R^2=0.1-0.40), s = Strong (R^2=0.4-0.6), P = perfect (R^2=0.6-1.0)

The overall correlation matrix between proximate composition and body size of shrimp with environmental factors are presented in Table 4. The correlation matrix indicates 169 associations in all with 38 negative and 131 positive associations. Seventeen (17) of the negative associations and 12 of the positive associations are statistically significant. Table 4 indicates temperature and salinity were the most significantly influential environmental factors, including rainfall, responsible for most of the variations observed in shrimp moisture, dry matter, crude protein, lipid, ash and carbohydrate contents. Of all the proximate properties, crude protein showed the highest number (six) of significant and strong correlations with proximate composition (lipids, crude fibre, ash and carbohydrate contents), environmental factors (rainfall) and biometric condition (body weight). Moisture exhibit significant negative or inverse relationship with dry matter (r = - 0.990, p < 0.001), temperature (r = -0.428, p < 0.05) and salinity (r = -0.595, P < 0.05). Similarly, protein exhibit significant inverse relationship with lipid (r = -0.791, P < 0.05), carbohydrate (r = - 0.662, P < 0.001).

Table 4: Correlation matrix of proximate composition and environmental parameters influencing occurrence of *Nematopalaemon hastatus* shrimps in Okoro River estuary, Nigeria

Parameters	*M*	*DM*	*CP*	*LP*	*CF*	*A*	*NFE*	*TEM*	*SAL*	*RF*	*CL*	*BW*
Moisture	1.000											
Dry matter	-0.990**	1.000										
Crude protein	0.263	-0.208	1.000									
Lipids	-0.164	0.126	-0.791**	1.000								
Crude fibre	-0.117	0.078	-0.963**	0.802	1.000							
Ash content	-0.189	0.129	-0.905**	0.863	0.866**	1.000						
NFE	-0.285	0.261	-0.662**	0.172	0.614**	0.293	1.000					
TEM	-0.428*	0.420*	0.248	-0.489*	-0.416*	-0.194	-0.062	1.000				
SAL	-0.595*	0.595*	0.188	-0.417*	-0.314	-0.206	0.052	0.874	1.000			
RF	0.282	-0.298	-0.585*	0.457*	0.697	0.413*	0.524*	-0.662	-0.695	1.000		
CL	0.269	-0.255	0.330	-0.061	-0.280	-0.325	-0.262	-0.283	-0.476	0.147	1.000	
BW	0.087	-0.070	0.540*	-0.238	-0.536	-0.462*	-0.461*	-0.003	-0.194	-0.230	0.900	1.000

M=Moisture DM=Dry matter CP=Crude protein LP=Lipids CF=Crude fibre A=Ash NFE= Nitrogen free extract TEM=Temperature SAL=Salinity RF=Rainfall CL=Carapace length BW=Body weight crude fibre (r = - 0.963, P < 0.001), ash content (r = - 0.90, P < 0.001), rainfall (r = - 0.585, P < 0.05) and salinity (r = - 0.55). Inverse relationships were also established between the pairs of lipid and moisture, temperature, salinity and carapace length. The amount of protein in the shrimp was influenced by the lipid and moisture content of the shrimp. Crude fibre is inversely related to temperature, salinity, and carapace length and body weight. Similarly, body weight is inversely related to ash content and nitrogen free extract or carbohydrate; as well as carapace length is inverse to salinity (Table 4). The positive relationships include those of dry matter to temperature and salinity; lipid to crude fibre, ash content and rainfall; crude fibre to nitrogen free extract as well as high positive correlation between carapace length and body weight of shrimps (r = 0.901, $P < 0.001$). Other associations were statistically insignificant.

Cluster analysis (Table 5) and dendograms (Fig. 3) present the degree of associations between parameters and parameterize the variables into domains of possible combinations in the ecosystem pathways. Five (5) cluster groups were established; the largest (group A) having 4 members. The cluster grouping further confirm temperature and salinity as the key environmental factors influencing protein, moisture and dry matter contents of *N. hastatus* shrimps (group A). There was a strong relationship between carapace length and body weight of shrimp (group B). Lipid content strongly influenced the ash content (group C), nitrogen free extract (NFE) showed independent cluster group (group D), while moisture content had strong affinity with rainfall (group E).

Table 5: Cluster groups and their members

Groups	Cluster Members	Nearest neighbours
A	Temp, Sal, crude protein, dry matter	Temp and Sal, Temp and crude protein, dry matter dry matter and Sal
B	CL, BW,	CL and BW
C	Lipid, Ash Content, crude fibre	Lipid and crude fibre, Ash Content and crude fibre
D	Nitrogen free extract	Nitrogen free extract
E	Moisture, Rainfall	Moisture and Rainfall

4.0 Discussion

The average protein content in shrimp is estimated at 46.99% ± 5.268 [22] with *N. hastatus* in Okoro River estuary achieving a higher protein limit (48.24%), indicating it could be a valuable replacement to other expensive protein sources in feed formulation for animals and children. The protein content in *N. hastatus* shrimps could supplement 40-50% of the 65% crude protein requirement in fishmeal for animal feed production.

The shrimp samples in Okoro River estuary possess high level of ash content (26.40%) similar to the report of Adeyeye & Adubiaro [23] for the shell (exoskeleton) portions of Palaemon species (25.52% ash) in the Lagos Lagoon, southwest Nigeria. The ash portion of the shrimp samples from this study could provide a significant proportion of calcium, magnesium and potassium if consumed regularly. The minerals play important roles in bone formation, blood clotting, muscle contraction and in certain enzymatic and metabolic processes or activities. Protein is the most prominent biochemical components of crustaceans from eggs to adult and is strikingly dominant in younger phases. Protein content was higher in younger shrimp than adults. The fall in protein content in the adult shrimp suggested that the protein in the muscle may be mobilized for the gonadal development as reported in shrimp, *Penaeus merguiensis* [24]. While the high protein content in the lowest size groups may be attributed to increased protein synthesis during the active growth phase as reported elsewhere in shrimps [24-27]. Carbohydrate content rose gradually with size, peaking in the bigger size group. Naeem *et al.* [14] attribute this phenomenon to more synthesis and accumulation of carbohydrates in the higher size groups and senility, than in younger ones. The variation of

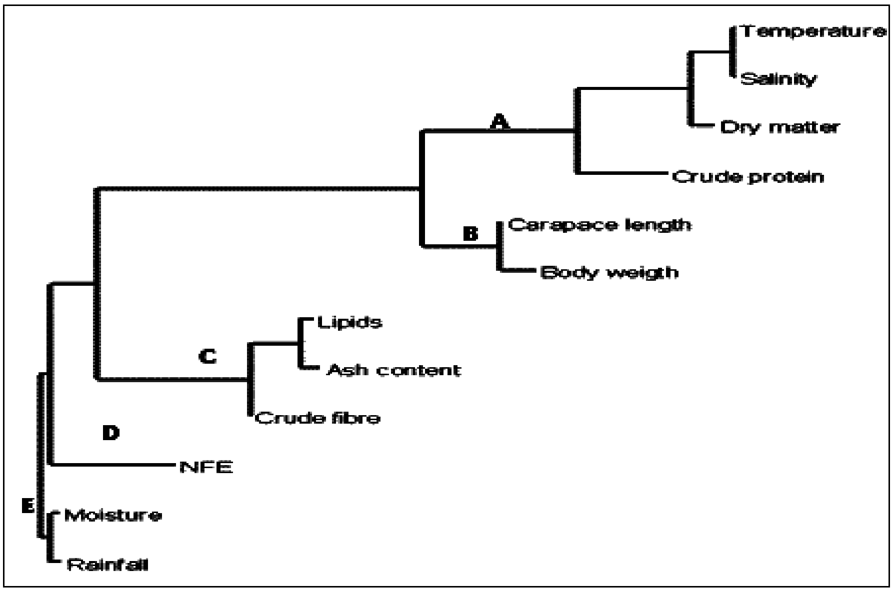

Fig 3: Neighbour joining clusters

carbohydrate between sizes groups recorded in this study was however not statistically significant. Ash and lipids contents also increased with shrimp sizes ($p<0.05$), regardless of sex. Sriraman & Reddy [28] also observed slight increase in ash content with increase in the size of juveniles of *P. monodon* while Gill *et al*. [29] support the assertion that lipids contents of fish are affected by the age (size). The average lipid content of fresh shrimp was 3.28± 0.11%; smaller than the 6.87% value recorded by [30] for *M. vollenhovenii***.** The high content of lipid in smaller-sized shrimp is crucial to early larval development because lipids are known to play several essential roles in the metabolism of crustaceans as sources of metabolizable energy, supply of essential fatty acids needed for the maintenance of the integrity of cellular membranes and serving as precursors of steroid and molting hormones [12].

This study recorded strong inverse relationship between protein and carbohydrate. This implies that the high protein content ensures a relatively low heat of nutrient metabolism, also called specific dynamic action (SDA); through the "protein-sparing" action of limited amounts of inexpensive carbohydrate as source of energy for deamination process [31]. Protein and carbohydrate of *N. hastatus* shrimps during the study period also showed high seasonal variation ($P < 0.05$) in line with the assertion of previous authors [24, 26, 29]. Carbohydrate has a weak positive relationship with salinity ($r = 0.052$) but inversely related with temperature ($r = -0.862$). The biochemical composition of *N. hastatus* shrimps depends on their environmental condition. Protein is not significantly affected by temperature, but has inverse affinity with rainfall ($r = -0.585$, $P < 0.05$). Lipid content in this study exhibited inverse relationship ($r = -0.489$, $P < 0.05$) with temperature as earlier reported [24]. The inverse relationship between lipids and protein was also earlier reported [26]. The inverse association between protein content and salinity in this study implies that NaCl may diffuse into seafood muscle due to the osmotic pressure [32]. High salt content of water causes dehydration of protein [33] and protein denaturation [34]. The average moisture content of fresh shrimp ranging (71 to 80%) was similar to previous reports [33-34].

The crude protein levels of shrimps sampled in December, March and July were estimated at 40.28± 0.21%, 39.06± 0.17% and 53.46 ± 0.13%, respectively, which was lower than those of *Sillaginopsis panijus* (57.79±0.12%, 73.93±0.71% and 64.55 ± 0.21%) for the same period, respectively [12]. The average lipid 3.74±0.11% obtained in this study is also lower compared to the average of 9.03% observed in *Cirrhinus reba* from tropical Bangladesh [9]. The lipid content obtained in this study is lower compared to that of fish, indicating shrimp is a better quality food for human diet.

Significant seasonal variations ($p < 0.05$) were observed in protein and lipid contents of *N. hastatus* shrimps (crayfish) in this study similar to earlier report [24]. Lipids along with proteins act as major food reserves and are subjected to periodic fluctuations under the influences of environmental variables like temperature. Fat contents in fish also vary with season, species and geographical region [35-36]. In addition, age variation and stage of maturity in the same species contribute significantly to variations in total lipid contents. The decline in lipid content between July to October (rainy season) coincides with the breeding season of *N. hastatus* shrimps during which energy reserves are deployed for gonadal activities. This nutrient demand is furnished by the leaching out of these nutrients from muscles and hepatopancreas to ovaries where it is mobilized as a precursor for gonad development [12]. The mobilization of lipids from other storage organs to ovaries suggests energy allocation or fuel transfer to enable the organism cope with reproductive efforts. Some authors [15, 37] have documented mobilization of lipid reserves from storage sites to the gonads for the buildup of gametes in other crustacean species. Seasonal differences in the availability of food and changes in the reproduction cycle have considerable effect on the tissue biochemistry of fish species, particularly fat.

The results showed a perfect relationship between nitrogen free extract (digestible carbohydrates) and environmental factors ($R^2 = 0.621$ $P < 0.05$). This implies that carbohydrate content of the shrimp is affected by some environmental factors like temperature, rainfall salinity and season. Strong associations of environmental factors with moisture content, dry matter, protein, crude fibre observed in this study is in accord with the reports of other researchers [9, 10, 38, 39]. This confirms the assertion that proximate composition vary with some factors such as size, age, season and environment. In addition, the proximate composition of the shrimps and other crustaceans vary with seasonal factors, environmental factors and habitat characteristics [12, 40, 41].

5.0 Conclusion

Proximate content of shrimp has an unbroken relationship with environmental factors (water temperature, habitat salinity and rainfall profile). The relationship is non-linear with seasonal interjections. There is a progressive loss in protein and lipid content in respect to the size of shrimp and season of the year. The dendrogram gave a panoramic view of all possible combinations of proximate variables in the pathways of the ecosystem.

6.0 References

1. Dublin-Green CO, Tobor JG. Marine resources and activities in Nigeria. Nign. Inst. Oceanog. Mar. Res. (NIOMR) Technical, 1992, 84.
2. Enin UI, Lowenberg U, Kunzel T. The *Nematopalaemon hastatus* (estuarine prawn) fishery in the outer estuarine region of the Cross River Nigeria. Arch. Fischwiss. 1991; 41(1):67-88.
3. Nsentip NU. A review of the crayfish fishery of Nigeria with special reference to the Cross River State. In: Proc. of the 4th Ann. Conf. Fish. Soc. Nig., Port Harcourt, November, 1985, 42-46.
4. FAO. Report of the FAO-World Fish Center. Workshop on Small-scale Aquaculture Target Group Paradigm. FAO, Rome, 2005. Publication.ftp://ftp.fao/docrep/ FAO/008/.a000380/003800.pdf.
5. Yoloye VL. *Basic Invertebrate Zoology*. 1st ed. Printed by Ilorin University Press. Ilorin, 1988, 182-278.
6. Adeyeye EI. Bio-concentration of mineral and trace minerals in four prawns living in Lagos Lagoon. Pak. J. Sci. Industr. Res. 2000; 43(96):367-374.
7. Rosa R, Nunea ML. Nutritional quality of red shrimp, *Aristeus antennatus* (Risso), pink shrimp, *Parapenaeus longirostris* (Lucas), and Norway Lobster, *Nephrops norvegicus* (Linnaeus). J. Sci. Fd. Agric. 2004; 84:89-94.
8. Huang GQ, Dong SL, Wang F. Growth energy allocation and biochemical composition of the body of Chinese Shrimp. *Fenneropenaeus chinensis* fed different diets. Crustaceana. 2005; 78(2):141-162.
9. Mridha MAS, Lipi Y, Nareji NT, Uddin MS, Kakbir MS,

Karim M. Determination of biochemical composition of *Cirrhinus reba* (Hamilton 1822) from Jessore, Bangladesh. J. Sci. Techn. 2005; 29(1):1-5.

10. Ferdose A, Hossain MB. Nutritional value of wild, cultured and frozen prawn *Macrobrachium rosenbergii* (De Man, 1878). Intnl. J. Nat. Sci. 2011; 1(2):52-55.
11. Samyal A, Bakhtiyar Y, Verma A, Langer S. Studies on the seasonal variation in lipid composition of muscles, hepatopancreas and ovary of freshwater prawn, *Macrobrachium dayanum* (Henderson) during reproductive cycle. Adv. J. Fd. Sci. Techn. 2011; 3(3):160-164.
12. Azim MA, Islam MR, Belal Hossani M, Minar MH. Seasonal variation in the proximate composition of Gangetic sillago, *Sillaginopsis panijus* (Perciformes: Sillaginidae). M – East J. Scient. Res. 2012; 11(5):559-562.
13. Abulude S, Abdullahi SAD, Ega RA. Nutrient quality of four oven dried freshwater catfish species in Northern Nigerian. J. Trop. Biosci. 2001; 1(1):70-76.
14. Naeem M, Salam A, Tahir SS, Rant N. The effect of fish size and condition of the contents of twelve essential and non-essential elements in *Aristichthys nobilis* from Pakistan. Pak. Vet. J. 2011; 31:109-112.
15. Dinakaran GK, Soundarapandian P. Biochemical status of edible palacemonid prawn *Macrobrachium idella* (Hilgendort, 1898). Adv. J. Fd. Sci. Techn. 2009; 1(1):19-26.
16. AOAC. Official Methods of Analysis (18th Edn.). Association of Official Analytical Chemists International, Maryland, USA, 2005, 2002.
17. Bligh EG, Dyer W. Total lipid extraction and purification. Can. J. Biochem. Physiol. 1959; 37:99-11
18. AOAC. Official Methods of Analysis (17th Edn.), Association of Official Analytical Chemists International, Washington DC, USA, 2000, 2000.
19. Sokal RR, Rohlf FJ. Introduction to biostatistics, 2nd edition, Freeman publication, New York, 1995; 23.
20. Udofia EP. Applied Statistics with Multivariate Methods. Immaculate Publications Ltd, Enugu, Nigeria, 2011, 510-516.
21. Ter Braak CJF. Canonical correspondence analysis, a new eigenvector technique for multivariate direct gradient analysis. Ecology. 1986; 67:1167-1179.
22. FAO. Production Year Book, FAO, Rome, Italy, 1992, 36.
23. Adeyeye EI, Adubiaro HO. Chemical composition of shell and flesh of three prawn samples from Lagos Lagoon. Zoologist, 2004; 5:62-78.
24. Sriraman K. Biological and biochemical studies on the prawns of Porto Nova coast (Crustacea: Decapoda: Macrura). Ph.D. Thesis, Annamalai University, India, 1978.
25. Ajakaiye CO, Bawo A. Comparison of the chemical composition of *Trinevitermes germinatus* (Wasmanu) with that of its feed. Nign. J. Entomol. 1990; 2:90-99.
26. Ravichandran S, Rameshkuma G, Rosario Prince A. Biochemical composition of shell and flesh of the Indian white shrimp *Penaeus indicus* (H.Milne Edwards 83). American-Eurasian J. Scient. Res. 2009; 4(3):191-194.
27. Ehigiator FAR, Nwangwu IM. Comparative studies of the proximate composition of three body parts of two freshwater prawns' species form Ovia River, Edo State, Nigeria. Austr. J. Basic Appl. Sc. 2011; 5(12):2899-2903.
28. Sriraman E, Reddy P. Biochemical studies on planktonic juveniles and adult of *Peneaus indicus* and *Peneaus monodon*. Proc. Symp. Warm Water Zoopl., NTO/UNESCO, 1977, 693-699.
29. Gill HS, Weatherley AH. Protein, lipid and caloric content of bluntnose minnow, *Pimephales notatus* rafinosque, during growth at different temperatures, J. Fish Biol. 1984; 25:491-500.
30. Ehigiator FAR, Oterai EA. Chemical composition and amino acid profile of a cardiean prawn (*Macrobrachium vollenhovenii*) from Ova River and tropical periwinkle (*Tympanotonus fuscatus*) from Benin River, Edo State, Nigeria. *IJRRAS*, 2012; 11(1):162-167.
31. Lovell T. Nutrition and Feeding of Fish. Van Nostrand Reinhold, New York, NY, 1988, 260.
32. Homer WFA. Salting. In: Hall GM (Ed.) Fish Processing Technology and Perseveration of Fish. Chapman and Hall Publishers, London, 1997, 32-72.
33. Balogun AM, Akegbejo-Samsons Y. Waste yield, proximate and mineral composition of shrimp resources of Nigeria's coastal waters. Bioresource Techn. 1992; 40:157-161.
34. FAO. Handling and Processing of Shrimps. Department of Trade and Industry Torry Research Station, Torry Advisory Note, No. 54, SIFAR, 2001. http://www.fao.org/wairdocs/tan/x5931e/x5931eoo.htm.
35. Piggott GM, Tucker BW. Effect of technology on nutrition. Marcel Dekker, Inc. New York, 1990, 137-175.
36. Kandemir S, Polat N. Seasonal variation of total lipid and total fatty acid in muscle and liver of Rainbow Trout (*Oncorhynchus mykiss* W., 1792) reared in Derbent Dam Lake. Turk. J. Fish. Aq. Scs. 2007; 7:27-31.
37. Mourente G, Rodriguez ZA. Variation in the lipid content of wild caught females of the marine shrimp *Penaeus kerathurus* during sexual maturation. Mar. Biol. 1991; 110:21-28.
38. Stansby M. Fish or Fish oil in the diet and heart attack. Mar. Fish. Rev. 1985; 46(2):60-63.
39. Stansby ME. Proximate composition of fish. In. Heen, E, Krenzer R. (eds.), Fish Nutrition. Fishing News, London, 1962, 231-234.
40. Mazumder MSA, Rahman MM, Ahmed ATA, Begum M, Hossain MA. Proximate composition of some small indigenous fish species in Bangladesh. Int. J. Sust. Croup Prod. 2008; 3(4):18-23.
41. Chakwa O, Shaba IM. Effect of drying method on proximate composition of eatable fish (*Clarias gariepinus*). J. World Agric. Scs. 2009; 5(1):114-11.