Food items and general conditions of *Hyperopisus bebe occidentalis* (Lacepede, 1803) caught in Warri River, Nigeria

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SUMMARY

Knowledge of the food items consumed by the fish enables farmers have a clear understanding of the fish' dietary requirement so that feeds could be compounded as supplementary alternatives in aquaculture. Food items when consumed in sufficient amount–aid optimal growth in fish species. The food items identified in the gut of *Hyperopisus bebe occidentalis*, in their decreasing order of abundance are as follows: Bacillariophyta> Dinoflagellates> Crustaceans> Chlorophyta among others. *Navicula* spp contributed the highest percentage (8.5%) while the least percentage (2%) was contributed by *Coscinodiscus* spp, analyzed by numerical method. Amongst the Dinoflagellates; *Gomyaulax* spp contributed the highest food item by the point method, while the least was contributed by *Ceratium* spp (3.5%). Also, the occurrence of *Closterium* spp was the highest (6%) while *Spirogyra* spp. recorded the least percentage (3%) both by the frequency of occurrence method. A total number of 202 specimens, comprising 75 female and 127 male specimens of this species were caught from Warri River. This gave a 1:1.7 female to male sex ratio. The total length range measurement for male specimens was 189.2 to 355.0 mm while that for female was 246.0 to 379.0 mm. A body weight range of 50.0 to 499.0 g was recorded for male specimens, while that recorded for female specimens was 106.0 to 400.0 g. Length-weight relationship revealed significant differences ($P<0.05$) with an 'r' value of 0.77 for male and 0.51 for female specimens. The slope of regression co-efficient '*b*' was (2.68) for males and (1.76) for females. Both values were less than 3 implying that the fish increased more in total length than in body weight. The condition index was more favourable to male (4.64) than female (4.14) specimens based on mean value calculated on fresh and gutted body weights in both sexes.

Keywords: food items, *Hyperopisus bebe occidentalis*, Warri River, general condition

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INTRODUCTION

Hyperopisus bebe occidentalis of the Mormyridae family was formally placed under the genus *Mormyrops* (Olaosebikanand Raji, 1998; Malami, Ipinjolu, Hassan and Magawutu 2002). The species is well distributed in swamps, lakes and rivers of most Nigerian fresh water bodies (Idodo-Umeh, 2003; Babatunde and Aminu, 2004; Ogbeibu and Ezeunara, 2005); where they are far more abundant than other mormyrids. This species has always been consumed for its oily and tasty flesh. Various researchers (Kouamelan, Juegels and Ollevier 2002; Nwani, 2004; Malami et al., 2002, 2004) studied the food and feeding habit of this species in different bodies of water. They reported higher occurrence of plant materials in the gut of juvenile than in adult specimens examined. Food items were consumed indiscriminately especially when the preferred ones were scarce. In Anambra River for instance, this species consumed benthos and allochthonous invertebrates mixed with limited amount of mud (Malami et al., 2002, 2004; Nwani, Ezenwanji, Maduka, Effiong, and Emmanuel 2006). The study of food and feeding habits enables farmers have clear understanding of the fish's dietary requirements and to compound supplementary feeds in aquaculture (Malami et al., 2004). Sufficient food intake aids optimal growth in fish, resulting in production increases and subsequent economic benefits. Pius and Benedicta (2002) reported on the benefit of gut content analysis for reducing intra-and inter-specific competition of fish in the ecosystems.

Literature review revealed that information on food and feeding habit of *H. bebe* harvested from the Warri River was lacking. The present study therefore investigated the recent diet composition, and general conditions of this commercially important fish species harvested from Warri River.

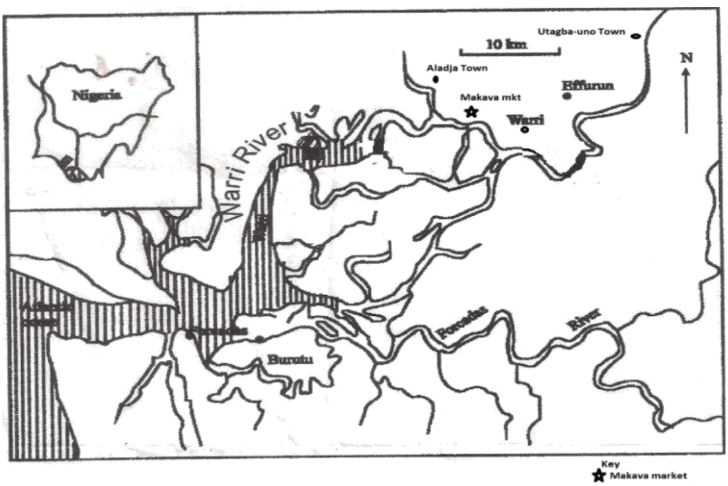

Figure 1. Map of Warri River showing the sample collection station (Markava market)

MATERIAL AND METHODS

Description of study area

Warri River is one of the most important coastal rivers of the Niger-Delta region. It takes its source about 10 km away from Utagba-Uno which lies North and East of the Equator within latitude $6^0\ 0^I$ N and longitude $5^0\ 2^I$ E (Figure 1). It covers a surface area of 255 km^2 with a length of about 150 km^2 (Olomukoro and Egborge, 2004).

Fish sampling

Fish sampling was conducted on a monthly basis, between April and September 2010. The gears used were cast nets, traps, fleets of nylon multifilament set gill nets of diverse mesh sizes and other traditional fishing gears, pitched at strategic locations overnight on each sampling day. Specimens harvested the next morning were injected with 5% formalin (in the abdominal region) in order to stop food digestion during their transportation to the fisheries laboratory located in Asaba Campus of the Delta State University, where gut content identification was carried out, using keys and monographs according to Idodo-Umeh (2003) and Nwani (2004).

Fish identification, length/weight measurements and gut content analysis

Fish specimens were identified to species level with the aid of keys according to Idodo-Umeh (2003) and Nwani (2004) before specimens were sorted into male and female sex. Total length and body weight measurements were recorded to the nearest ± 0.01 mm and ± 0.1 g using a measuring board and a triple beam balance (OHAUS 210 Model), respectively. Length weight relationship was calculated by using the formula W = aLb according to (Ricker, 1975 and Bernacsek, 1984). Bodyweight increased more rapidly than total length; hence, the formula was logarithmically transformed for the purpose of data analysis; thus:

Log W = Log a + b Log L; where ‘a’ was the proportionality constant, ‘W’ was the weight of fish in grams (g), ‘L’ was the total length of fish in millimetres (mm) and ‘*b*’ was the allometric growth coefficient.

Guts were opened surgically, and weighed with and without food materials contained in them. Food items in those guts that could not be examined immediately were preserved in sterilized labelled vials containing 4% formalin. Large food items, easily recognized with the naked eyes, were counted, while microscopic ones were teased to disperse their aggregates in a counting chamber. Food materials were examined and counted under a binocular microscope at a magnification of × 10. All recognizable food items were identified according to methods described by Kadiri (1987, 2002). Food items were analyzed using three methods of gut content analysis described as follows:

a) Frequency of occurrence method

The number of guts in which each food item occurred was listed and expressed as a percentage of the total number of guts examined. The proportion of the fish population that fed on a particular food item was estimated according to Odun and Anuta (2001).

b) Numerical method

The total number of each food items from each gut was summed up for all guts and expressed as a percentage of the total number of all food items according to Inyang and Nwani (2004).

c) Point method

One hundred points was shared amongst the food items present in each gut according to their sizes. Such estimates were expressed in percentage according to Inyang and Nwani (2004).

Condition factor

The condition factor (K), describing the wellbeing of a fish was calculated according to Bagenal, (1978) thus:

$K = 100\ W/L^3$; where K = condition factor, L = standard length of fish in mm, and W = body weight of fish in grams.

Feeding intensity

Feeding intensity of each specimen was calculated according to Bagenal, (1978) thus:

Feeding Intensity = Gut weight x 100 **/** Body weight x 1.

RESULTS

Identified food items, their seasonal variation and gut fullness

The three methods used for the analysis of gut contents revealed that the most dominant food item identified was Bacillariophyta. This family contributed 22.8% by numerical method and 23.4% by frequency of occurrence method. Dinoflagellates contributed 16.2%, by the numerical method and 20.4% by the point method. Chlorophyta made up 10.4% by numerical method, while insect parts were the least dominant food item contributing (0.7%) both by numerical and frequency of occurrence methods (Table 1). No strong seasonality in food items consumed was observed as the gut contained variety of food items suggesting that those were the ones available at such periods.

Table 1. Food items identified in the gut of specimens using three methods of analysis of gut content

Food items	Numerical method		Frequency of occurrence		Point method	
	No	%	No	%	No	%
BACILLARIOPHYTA:						
Navicula spp	182	8.5	103	7.9	120	8.5
Ulothrix spp	159	7.4	118	9.1	120	8.5
Tabellaria spp	144	6.7	77	5.9	101	7.1
Coscinodiscus spp	6	0.2	6	0.5	15	1.0
Total	491	22.8	304	23.4	356	25.1
CHLOROPHYTA:						
Closterium spp	116	5.4	78	6.0	55	3.9
Cosmarium spp	63	2.9	42	3.2	30	2.1
Spirogyra spp	46	2.1	34	2.6	21	1.5
Total	225	10.4	144	11.8	106	7.5
DINOFLAGELLATES:						
Gomyaulax spp	185	8.6	114	8.8	125	8.8
Ceratium spp	27	1.3	23	1.8	50	3.5
Merismopedia spp	136	6.3	88	6.8	115	8.1
Total	348	16.2	225	17.4	290	20.4
CRUSTACEANS:						
Shrimp parts	10	0.5	9	0.7	21	1.5
Crayfish parts	71	3.3	42	3.2	70	4.9
Total	81	3.8	51	3.9	91	6.4
Chironomid larva	186	8.6	113	8.7	65	4.6
Coleoptera: Whole beetle	100	4.6	71	5.5	70	4.9
Beetle parts	94	4.4	38	2.9	58	4.1
Total	194	9.0	109	6.4	128	9.0
INSECTS: Whole parts	15	0.7	9	0.7	25	1.8
Root hairs	179	8.3	96	7.4	120	8.5
Sand and stones	146	6.8	51	3.9	44	3.1
Seed grains	141	6.6	68	5.4	98	6.9
Unidentified	145	6.7	117	9.0	95	6.7
GRAND TOTAL	2,151	100	1,297	100	1,418	100

The fish guts were generally full with food items occurring throughout the study period. The fullest guts were found during the months of April, May and June, when the specimens fed more on green algae, seed grains *Navicula* spp *Ulothrix* spp *Tabellaria* spp and *Coscinodiscus* spp. Specimens equally fed on dinoflagellates and root hairs within the months of July, August and September. Variations in diet composition were found to be size rather than sex dependent. This observation suggests that the plasticity in food abundance and diet composition exhibited by both sexes enabled them to switch to predominant and available food materials, in their habitat. Thus, they are capable of not only maintaining their distribution in the present habitats, but also colonized other habitats as the need arises.

Out of the 202 guts of specimens examined for the presence of food items, only four guts were empty, accounting for 1.9%. Twenty-four specimens had full guts accounting for 11.9%, 46 specimen had three quarter full guts (22.8%), 87 specimen had half-full guts (43.1%), and 41 specimens had quarter-full gut content, accounting for 20.3%.

Sex ratio and length-weight relationship

Two hundred and two (202) specimens, comprising 127 males and 75 females were examined. This, gave an overall sex ratio of 1:1.7 which described the female to male proportion of specimens caught (Table 2).

Table 2. Mean value for total length and body weight of *Hyperopisus bebe* sampled

Month	Sample size: male	$\bar{x}$TI (mm)	$\bar{x}$BW (g)	Sample size: female	$\bar{x}$TI (mm)	$\bar{x}$BW (g)	Sex ratio
April	19	279.0	210.0	1	281.0	210.0	1:0
May	25	274.4	163.0	3	280.0	165.0	8.3:1
June	16	313.0	262.0	18	302.7	249.0	1:12
July	20	292.0	187.0	20	312.3	276.0	1:1
August	27	288.7	177.0	13	293.8	176.0	2:1
Sept	20	285.7	191.0	20	288.5	209.0	1:1
Total	127			75			1:1.7

Key=MM= Millimetre, g = gram, $\bar{x}$TI= mean total length and $\bar{x}$BW mean body weight

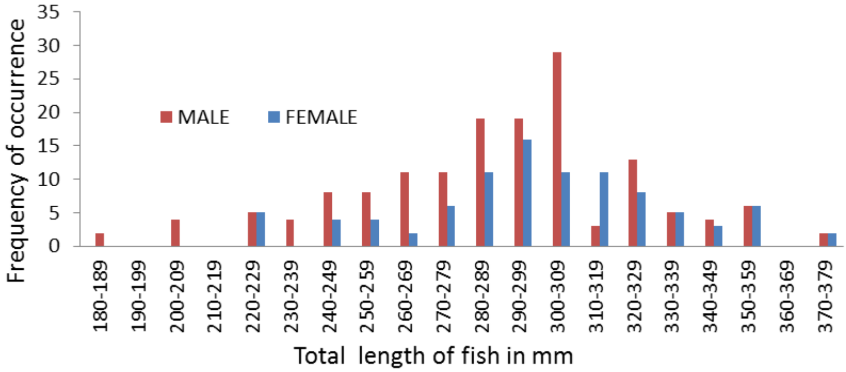

Fig. 2. Length frequency distribution of male and female specimens of *H. bebe*

For both sex, total length ranged between 189 to 379 mm, while their body weights varied from 50 to 499 g. The male specimens exhibited the highest and lowest total length frequency measurements as follows: 300 to

309 and 180 to 189 mm, respectively, (Figure 2). At the weight range of 200 to 249 g, male specimens accounted for the highest population numbering (37 specimens), while at a weight range of 400 to 449 g, only one male specimen was encountered. Body weight ranges for 231 female specimens, at the highest (350 to 399 g) and lowest (150 to 159 g) measurements are as shown in Figure 3, respectively.

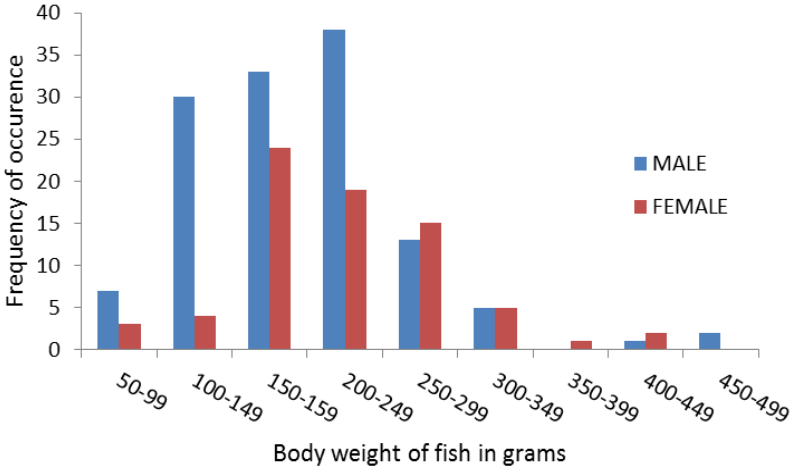

Fig. 3: Body weight frequency distribution of males and females

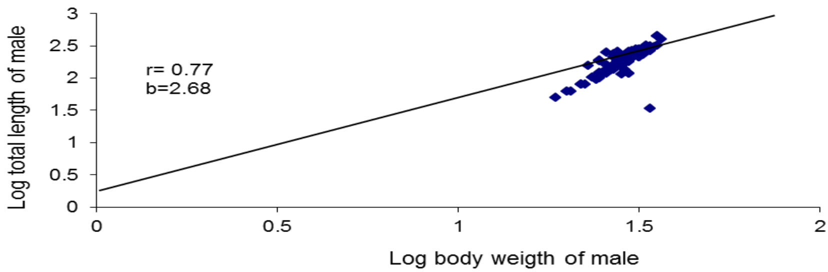

Fig 4. Log relationship between total length and body weight of male of *H. bebe*

Features of *H. bebe* involving body weight and total length relationships was described by correlation coefficient, initially transformed logarithmically and expressed as log W = aLb, where the ‘r’ value was 0.77 for males (Figure 4) and 0.51 for females (Figure 5). Both values were statistically significant at $p<0.05$. The ‘*b*’ value for males (2.68) was higher than those for females (1.76). However, both values indicated negative allometric growth, because they were lower than the value of three (3).

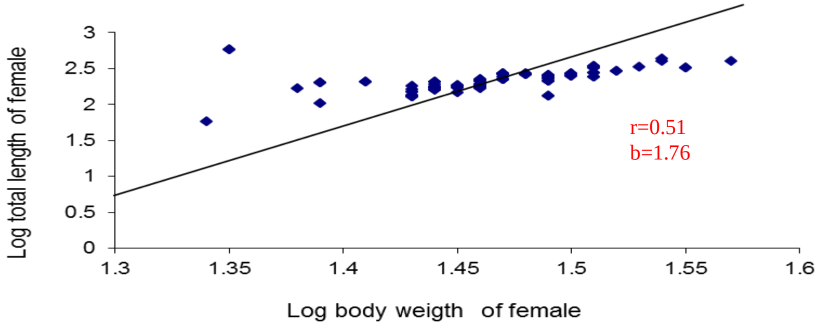

Fig. 5: Log relationship between total length and body weight of female *H. bebe*

Condition Factor

Calculation on the wellbeing of specimens revealed that male specimens were in a better condition (K = 4.64) than the female specimens (K = 4.14) based on mean values calculated for fresh and gutted body weights (Table 3).

Table 3: Mean condition factor for fresh and gutted body weights of *H. bebe.*

Sex	No of specimens	Mean k for fresh body weight	Mean k for gutted body weight
Male	127	0.87	4.64
Female	75	0.68	4.14
Male + Female	202	1.55	8.78

K = Condition factor

DISCUSSION

Food items identified in specimens

Hyperopisus bebe occidentalis used in this study feed on a wide variety of food items (mainly green algae, insect parts, seed grains, *Navicula* spp, *Ulothrix* spp, *Tabellaria* spp and *Coscinodiscus* spp among others) available during the sampling period, (Malami et al. (2004); Ogbeibu and Ezeunara, 2005). This observation suggests that the fish acted as omnivores. On the contrary, the observation is in contrast with those reported by Ugwumba, Ugwumba and Mbu-Oben (1990) who opined that the mormyrids of Lekki Lagoon fed only on insects and crustaceans. Ugwumba and Ugwumba (2007) are of the view that the differences in food items consumed could be attributed to differences in food availability between the different habitats. Such a view was also supported by Kouamelan, Teugels, Gourene, Ollevier and Thys Vanden Audenaerde (1999) who opined that *M. rume* in River Bia consumed invertebrates, plant parts, sand grains and detritus. According to the later authors, the occurrence of sand grains and detritus suggests that these were probably ingested along with food items while feeding at the river bottom. This observation revealed that they also feed on benthic organisms, in line with the report of (Paugy, 2002). In order to optimize the energy content of their prey's, the specimens ingested food based on the maximization of their size in relation to their mouth gape size (Ugwumba, Ugwumba and Mbu-Oben, 1990).

Among other authors that studied this fish family, Omotosho (1993), reported that *M. rume* fed on detritus, algae and macrophytes in Oyunmini-dam, Ilorin (Nigeria), while Fawole (2002) reported that the major food items of the same species sampled from Lekki Lagoon was detritus and plant parts. Food items isolated from the stomachs occurred irrespective of size and season. This sentiment is shared by Kouamelan et al. (1999), in line with those of present study. However, during the dry season, chironomid larvae dominated the insect fauna while chaoborid larvae became more abundant in the rainy season in line with that reported (Nwani, 2004). The only plausible reason for this happening is because during the rainy season, there is a continuous input of materials of allochthonous origin, notably insects (coleopterans, dipterans, ants, termites), seeds, leaves and pollen from flooded/inundated forests, which settled at the bottom where they are decayed by bacterial and fungal activities, (Nwani, 2004; Ogbeibu and Ezeunara, 2005)) so that they could become more available as food to the species.

Fullness of gut content

The overall results of gut fullness analyses revealed that 2% of guts were empty, while varying quantities of food materials were found in 98% of guts. The observance of high non empty guts may be due to the immediate stoppage of food digestion at the specimen collection site, when formalin was injected into the gut region of the fish before their conveyance to the laboratory for food item isolation and identification. Similar observation was reported by Malami, Ipinjolu, Hassan and Magawata (2004) on the same species. The greater number of guts with food was also, generally attributed to a successful feeding pattern adopted by the specimens (Haroon, 1998 and Nwani, 2004) who additionally benefitted from good food abundance during the sampling season.

It was observed that more food items were consumed during the rainy and flood seasons, when insects, grains, and seeds occurred in higher numbers. This observation is supported by the study of Nwani (2004), who reported on active feeding behaviour of *H. bebe* in River Rima during the early rainy season.

Length weight relationship

Determination of length–weight relationship is important for the estimation of weight where only length data was available, as well as a condition index for fauna (Haimovici and Velasco, 2000). Length-weight relationship was also useful in estimating standing stock biomass and densities of various organisms in the aquatic habitat. There was a significant correlation between body weight and total length of specimens used for this study. Fagade and Adebisi (1979) reported that in cichlids, an increase in body weight was associated with an increase in total length. This is because increases in total length resulted in corresponding increase in body weight, as also reported (Nwani et al., 2006) in mormyrid species.

According to Olurin and Aderibigbe (2006), differences in total length and body weight distributions are dependent on sex and developmental stages of the fish. Aliakbar and Ali (1978) and Kunda, Dewan, Uddin, Karim, Kabir, and Uddin (2008) opined that fluctuations observed in certain length groups might be due to variation in sample size, sex, gonad condition and quantity of gut content.

Specimens used for this study exhibited negative allometric growth having a '*b*' value lower than 3. Olele and Obi (2004) reported positive allometric growth where the '*b*' value for *Citharinus citharus* caught in Onah Lake was higher than 3 (3.1). Other '*b*' values reported were either lower or higher than 3. For instance, Arawomo (1981) reported a value of (2.8) while (Baijot, Moreau, and Bouda (1997) reported values of (2.5 to 3.5). Fagade and Adebisi (1979) reported a '*b'* value of 2.9 and 3.4 for *Tilapia melanotheron* and *T. guinensis*, respectively. Differences in '*b*' values may be influenced by sex, maturity stages, seasonality and the time of day the food was consumed by the fish when fullness of gut content is determined (Baijot et al., 1997).

The size class frequency distribution of specimens used for this study revealed differences in body weight, size class and maturity stages within the population of specimens examined. This observation is similar to those of previous studies (Nwani, 2004; Ogheneochuko, 2007; Omorinkoba and Fatuiti, 2009). Omorinkoba and Fatuiti (2009) stated that the size class or body weight of a fish determines the spectrum of food items it will consume. Understanding the relationship between body size and fish food is therefore important for interpreting diet types and feeding mechanisms of fishes. Hence, the type of food available in an area influences the distribution, abundance and rate of growth of the fish (Ogheneochuko, 2007).

Sex ratio

Male rather than female specimens were caught more in the months of April and May. Such observation may be due to season and the habitat of the fish at the time of capture. This assertion is in line with those of (Nwani, 2004), who explained the reason for this happening this way; that the female migrated into deeper waters for spawning; hence they were not caught during that period. According to Fagade, Adebisi and Atanta, 1984), breeding activity plays a considerable role in sex ratio. This preponderance of males over females suggests that either the males live longer or that their abundance is a mechanism for population control.

Generally, the weight lose experienced by the female sex (brood) in the month of May is noteworthy. It was the general understanding that since this is the period of spawning, female specimens were most likely to experience reduction in weight, occasioned by reduced feeding and probable release of eggs from their gonads. Both reasons gave rise to weight loss experienced in the month of May. This idea also agrees with those of Sene, De-Silver and Chandransoma 1980; and Nwani, 2004.

Condition factor

The condition factor calculated for *Hyperopisus* specimens based on fresh and gutted body weight analysis revealed that such values were not only high but those for males were higher than the ones for females. This observation could mean that the former sex had more access to food or fed better than the latter, at all times. Lagler, Bardach, and Miller, 1977) attributed differences in seasonal values of condition factor to different reasons, including: availability and abundance of food supply, timing and duration of breeding cycle; physiological stress caused by changes in water quality properties within the habitat; sexual differences, age; changes in seasons; and gonad maturity stages in fish. These conditions may have been responsible for the better survival recorded in male specimens, in support of that stated by (Nwani, 2004). Various researchers including (Mgbenka and Eyo, 1992; Fawole, 2002; Odedeyi, Fagbenro, Bello-Olusoji, and Adebayo, 2007) stated that differences in condition factor results from the deposition of materials for gonad formation, which led to an increase in weight while actual spawning led to a reduction in weight. According to Nikosky (1963) high conditions were more beneficial to the fish than low values. Such high values were those recorded in the present study. On the contrary however, the female rather than the male specimens of (*M. rume)* were in better condition than the males. According to Oben, Ugwumba and Fagade, 1999), there was a general decrease in condition factor with increasing length of *M. rume* specimens caught in Lekki lagoon, showing that increase in length did not bring about proportional increase in weight.

Nazeef and Abubakar, (2013) reported the condition factor of fifteen fish species. He stated that 9 out of the 15 species, had K values within 0.1 to 1.0, while the remaining six fish species had values greater than 1.0 According to Lagler (1958), K values are not constant for individual species or populations, it was subject to a wide variations in fish conditions. An ideal K-factor is equals to 1, while those less than or equal to 1, shows average conditions.

The variation in fish condition as observed in this study also agrees with that of (Odedeyi, Fagbenro, Bello-Olusoji, and Adebayo, 2007). These researchers reported that the available natural food items in the habitat during the rainy season washed out during the flood, resulted in the inundation of previously dry ground. Such happening altered a number of water quality properties in favour of the growth and production of natural food availability.

CONCLUSIONS

H. bebe belongs to the family of Mormyridae, which is one of the largest groups of fishes in the Nigerian waters. Their ability to feed on a wide range of organisms at different trophic levels (food chain) is the most likely reason for full guts in the majority of specimens analysed. Thus, they may be described as euryphagous, feeders that consume any food item that came their way, particularly when their favoured food items were not readily available. This pattern of food consumption was probably the reason for their fast growth.

This knowledge on the food items of this species will be of tremendous benefit for the formulation of supplementary diets necessary for enhanced yield in aquaculture. Such practice will encourage faster growth, boost local demand as well as encourage the generation of foreign exchange earnings for the country.

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