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SOME ASPECTS OF THE BIOLOGY OF *HEMISYNODONTIS MEMBRANACEUS* (GEOFFREY ST- HILAIRE, 1809) IN ZARIA, KADUNA STATE, NIGERIA.

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ABSTRACT

Some aspects of the biology of *Hemisynodontis membranaceus* (Geoffrey St- Hilaire, 1809) in Zaria were examined between the months of May and July, 2006. A total of 134 specimens were observed with the sex ratio of 1:1.23 males to females in all the months together. The mean standard length was 14.05cm while the body weight ranged from 22.8g to 318.5g with a mean of 75.3g. The length- weight relationship indicated positive and high correlation in both males (with 0.8809) and females (with 0.8479) and all the sexes combined (with 0.8269). The fish exhibited isometric growth in both sexes. The condition factor for both males and females indicated that the well-being was high through-out the period of study. The mean condition factor ranged from 2.50 to 2.84. The analysis of the stomach contents indicated that *H. membranaceus* is an omnivore with algae (which constituted 40.29%), plant material (29.10%) and insects (22.38%) as its main diets. Since *H. membranaceus* is an omnivore it can be used in large aquarium set-up to feed on mollusc, algae, insects and other aquatic organisms.

Key words: Hemisynodontis membranaceus, Fishes, Biological studies, Stomach Content, Growth.

INTRODUCTION

Fishes are the most numerous species of the vertebrate animals and about 27,650 species of extant fishes are known, and approximately 11,300 species, or 41% of all fish species live in fresh water (ACSI, 1998) unlike the marine species which are more numerous and diverse. Fish like any other aquatic organisms depend heavily on the level of dissolved oxygen, dissolved salts, light penetration, temperature of the medium, presence and amount of toxic substances, concentration of disease causing agents, and the opportunity to escape easily from predators or enemies. Apart from above, availability of food is very important as this determines the ability to spawn, develop gonads and energy for escape from predators.

Increase in length and weight of a fish is determined by the availability of food, which in turn determines the growth of the fish. It is well known that length increases with increase in weight of the fish (Layèyè (2006), Ayoade and Ikulala (2007)). Food may be classified as energy and growth food (carbohydrates, fats and proteins); and non-energy food (minerals, vitamins, water and oxygen) that serve as supporting role in the energy food. Fisheries management parameters such as length-weight

relationship, condition factor and sex composition are essentially used to predict the potential yield and determination of size at capture for obtaining optimum yield (Offem *et al*., 2008). Food studies reveal the status of foraging, rate of growth and seasonal life history changes in fish species which are useful for rational exploitation of the species (Ugwumba and Ugwumba, 2007).

Fish serve as an important source of protein to man, by providing about 17-40% of the total protein intake in various parts and countries of the world. Fish also constitute about 40% of the animal protein intake of the average Nigerian. Nigeria is also the largest consumer of fish and fish products in Africa (Dada and Gnanados, 1983). The body of an individual requires 60g of protein per day and the body of the fish contain 13- 20% of protein and has energy value of 300-1000 calories per kilogramme. Apart from serving as source of food, fish can also be used in many biochemical and pharmaceutical products when organs and tissues of the fish are used. For instance; protamine can be derived from fish sperms and combined with insulin to treat diabetic patients (Windsor and Staurts, 1981). It can also be used as fish meal for both poultry and livestock.

Hemisynodontis membranaceus belongs to the family Mochokidae, order Siluriformes and class Actinopterygii (ray- finned fish). It is synonymous with *Synodontis membranaceus, Pimelodus membranaceus* and *Synodontis guntheri* (Sands, 1986). The species of Synodontis are commonly called “squeakers” because of the rather grunting sound they make through the pectoral spines moving in their sockets especially when they are caught. Other common names include upside-down catfish, mustache catfish and “Kurungu” in Hausa language.

There are three genera and twenty-three species under the family Mochokidae. The three genera are: *Mochocus, Synodontis* and *Chiloglanis,* amongst these three, the genus *Synodontis* is the most numerous and prominent.

These scales-less catfish are distributed through-out the country (especially fresh waters of the North) _ Nile Basin through Chad, Niger, Senegal, Volta and Gambia Basins in Africa (Sands, 1986). And can be encountered through-out the year but much more available during the rainy season. It can reach a length of 350cm and about 1 kg of weight. They are usually bottom dwellers and are very common in swamps. The behavioural adaptation of the species includes: juveniles differ in colour from adults; and some are used as aquarium exhibits because they are colourful and attractive. They are also simple to keep because of their extreme toughness. These upside-down catfish are highly gregarious, travelling in school of dozens to hundreds of individuals. This protection- in- number strategy is particularly prominent among the juveniles but as these catfish mature and grow in size; they may travel in smaller and smaller schools. They are devoutly nocturnal, spending the daylight hours tucked under a riverbank or piece of sunken debris. They prefer to feed, hunt, sleep, travel and even mate in this upside-down posture. They feed on a wide variety of food including shrimps and prawns, bloodworms, excetra (Sands, 1986). The position and shape of the mouth and even the dentition of a species could be correlated with its usual food (Wootton, 1992). There are very little works that have been done on the biology of the genus *Hemisynodontis* and Synodontis species in general unlike other members of the catfish families. Previous works were mainly on their taxonomy base on their anatomical and physiological characteristics. However, the nutrition of the species seems to be the most important. Sands (1986) reported that the usual feeding for Synodontis species are good quality flake food, tablet food, frozen blood worms, shrimps and prawns especially those kept in captivity. A good many fishes feed on detritus, particles of broken-down organic matters that fall to the bottom. Together with detritus, bacteria, algae and protozoans and other small invertebrate animals may also be ingested. Willoughby (1974) recorded about 22 species of *Synodontis* in Lake Kainji.

In biological studies WLRs (Weight-Length Relationships) allow the assessment of seasonal variations in fish growth and the calculation of condition indexes (Richter *et al*., 2000). In fisheries studies WLRs have many different uses, including the estimation of weight from length (Froese *et al*., 2011). For instance, the results of length – weight relationships for *Hemisynodontis membranaceus* in Lake Volta showed that there was high correlation between the weight and standard length of both males and females. The exponent b is closer to 3 in males indicating that weight growth is isometric. Also, the asymptotic weight ($W\infty$) calculated from length- weight relationships and the estimated $L\infty$ were significantly different ($p<0.05$) and this suggested that there were differences between the growth in weight of males and females (Ofori-Danson *et al*, 2001).

The condition factor of the fish determines whether the fish is healthy or not. It is the measure of the fish’s wellness and this is affected by a number of factors within the environment of the fish. The condition factor of fish can be affected by a number of factors such as stress, sex, season, availability of feeds, and other water quality parameters (Khallaf *et al*., 2003).

Little of the biology of this popular and commercially important species is known unlike other species of the catfish families that have been extensively studied. Since this species is important for our protein intake and it is readily available through-out the year coupled with its unique aesthetic features in aquarium the exploration of its biology is inevitable especially in terms of its feeding habits, the types of food contents of the guts, weight-length relationships and its well-being; thereby providing adequate knowledge of the parts of its biology and will help in food formulation of the species especially those that are kept for aesthetic reasons in aquarium.

MATERIALS AND METHODS

Specimen Description

Hemisynodontis membranaceus has wide based maxillary barbels confluent with the lips and with a broad membranous border almost to its extremity (hence, the scientific name). It is silvery-grey on the back and sides, and charcoal- black on the belly and

maxillary barbels- suggesting the upside-down characteristics. The caudal and anal fins are yellowish sometimes tinged with black, but there are no dark spots as in *S. batensoda*. Just as in other members of the family they have a pair of maxillary and two pairs of mandibular barbels. They have bony (cephalonuchal) shield on top and sides of the head. They have strong serrated pectoral spine and short dorsal fin; Adipose fin was present with deeply forked caudal fin, which are lobed.

Sample Collection

A total of 134 specimens of *Hemisynodontis membranaceus* (Geoffrey St. Hilaire, 1809) were purchased from Sabon Gari market in Zaria. These were transported to the fishery Laboratory of the Department in clean polythene bags. The specimens were purchased weekly between the months of May and July.

Measurements of Morphometric Parameters

The following morphometric parameters were taken: Total lengths and Standard lengths; these were obtained with the aid of measuring board, which was equipped with metre rule graduated in centimetres. The weight was obtained in gramme with the aid of Metler's weighing balance. Total length was measured from the tip of the snout to the tail end of the fish while the standard length was taken from the tip of the snout to the caudal peduncle of the fish.

Sex Determination

The sex of the fish was determined and the distinguishing morphological features used were: the males had slight projection of the gonads from the vent while the females have almost roundish vent without projection. That is, the males had conical anal papillae. This was further confirmed by the dissection of the gonadal regions, which showed the features clearly. The sex ratio was determined monthly and the combined sex ratio was also taken.

Stomach Content Analysis

To determine the feeding habits of the fish via stomach contents each of the fish was dissected (from the anal end up the stomach to the opercula end) and the projecting lobe-like stomach of the gut was removed and placed directly in petri-dish containing 5% formalin solution. This was to preserve the stomach till the following day. Each of the preserved stomach was now dissected to expose the contents and displayed on a separate petri-dish containing little quantity of distilled water. And close examination and identification were made with the aid of stereo (dissecting) microscope. Light microscope was also used for algal identification. Observations were also made with the naked eyes. The following methods of analysis were used: Fullness method and frequency of occurrence method.

Fullness Method

The stomach fullness was determined according to Olatunde (1983) and this method entails the classification of the stomach into full, half, three-quarter, one-fourth and empty stomach sizes respectively. The stomachs without food in them were considered empty or 0%; those with food up to half of the stomach size with particular portion bulging were classified as half or 50%; and those with food almost the entire size of the stomach were classified three-quarter (3/4) or 75%; and those with the stomach fully distended were considered full or 100%. This method gives the quantitative estimate of contribution of each item for the total volume of the stomach (Hynes, 1950).

Frequency of Occurrence Method

This is a method that indicates the importance of the number of individual fish of the specimens examined that ate the particular food item. In this method, the numbers of stomachs in which various food items occurred were recorded and expressed as percentage of the total stomachs examined.

Length-Weight Relationship

The length-weight relationship was calculated using the formula according to Le-Cren, 1951

$$W = al^b \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(i)}$$

Where W = weight in grams; L= standard length in centimeters; a = constant (intercept of the graph); b= exponent (gradient of the graph). The Le- Cren equation and the data (weight and standard length) were transformed into logarithm before the calculations were made.

Thus, the equation becomes:

$$\text{Log } W = \log a + b \log l \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(ii)}$$

The sum of log W and log standard length were made and used in the calculations. The correlations between the weight and length were calculated separately from males and females then, combined.

Condition Factor

The condition factor for each specimen was calculated using the conventional formula reported by Worthington and Richards (1930)

$$K = W \times 100 \,/\, L^3 \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(iii)}$$

Where K is the condition factor, W is the weight measured in gramme and L is the standard length in centimetre. This was used to determine the well-being of the fish.

Statistical Analysis

The statistical tool used was regression analysis and correlation coefficient to determine the relationship between the length and weight of the species.

RESULTS

Size Distribution

A total number of 134 specimens were examined within the months of May, June and July. There were a total number of 74 females and 60 males of the fish. The total number examined each month and the number of males and females for each month is shown in Table 1. The weight and lengths (total and standard) are as shown in Table 2. The body weight ranged from 22.8g to 318.5g with a mean of 75.3g for all the specimens examined. The body weight of males ranged from 44.5g to 318.5g with a mean of 65.1g. The body weight of females ranged from 22.8g to 194.8g with a mean of 75.1g. The total length of females ranged from 10.6cm to 25cm with a mean of 18.4cm. The total length of males ranged from 15.6cm to 28.0cm with a mean of 19.4cm. The standard length of females ranged from 8.6cm to 18.5cm with a mean of 13.8cm. The standard length of males ranged from 12.0cm to 20.0 cm with a mean of 14.3cm.

Table 1: Number of *Hemisynodontis membranaceus* examined per month

Month	Sex	Number of Fish Examined	Total Number of Fish Examined
May	M	20	36
	F	16	
June	M	22	51
	F	29	
July	M	18	47
	F	29	
Total	M	60	134
	F	74	

Table 2: Size Range of H. membranaceus in Zaria

	Sex	Number of Fish Examined	Minimum	Maximum	Mean
Total Length (cm)	M	60	15.60	28.00	19.41
	F	74	10.60	25.00	18.43
Standard Length (cm)	M	60	12.00	20.00	14.32
	F	74	8.60	18.50	13.82
Body Weight (g)	M	60	44.50	318.50	65.09
	F	74	22.80	194.80	75.10

Food and Feeding Habit

Of a total of 134 stomachs examined 17 were empty, 56 with full sized stomachs, 17 with three quarter sized stomachs, 15 with half and 29 with one-quarter sized stomachs. Altogether, a total of 117 stomachs were with food.

Frequency of Occurrence

The observed dietary components in the stomach with their percentage of occurrence are as shown in (Table 3). The various food items found in the stomachs of *H. membranaceus* are as follow:

Algae: constituted the major component of most stomach examined (formed 40.29%). Green algae (chlorophytes) constituted the major algal flora especially in those examined in June.

Plant materials: Guinea corn grains and some strands of plant stem and leaves occurred in some stomachs (constituted 29.10%) Insects and insect remains formed 23.38%. The larval stages seen were mostly those of dipterans and majorly chironomids and few of those of orthopterans and those of dragonfly (odonata) and very few cases of isopterans. The major insect remains were those of orthopterans with hind legs serving as the major mark of identification. Amongst the orthopterans grasshoppers were most dominant. Other insect parts were seen and these insects' parts include: dragonfly (wings) and beetles. Annelids, earthworms and leeches were also observed with leeches associated with algae in most cases.

Molluscs: shells of mollusks constituted the major mark of identification and small clam and bivalve shells were observed.

Crustaceans: crustaceans such as shrimps were observed but constituted only 2.98%

Fish remains: though of little occurrence distinct skeletons and skulls of fishes were seen. These were Tilapia skeletons, which formed 1.49%. Sand grain occurred but very rarely.

Other Materials: Already processed material beyond the level of recognition and identification were also observed (formed 30.59%).

Table 3: Frequency of Occurrence of Dietary Components

Dietary items	% Frequency of Occurrence
Algae	40.29
Plant and plant remains	29.10
Insects: Larvae and insect remains	22.38
Annelids, Earth worms and Leech	9.70
Molluscs	8.96
Crustaceans (shrimp like)	2.98
Fish remains	1.49
Sand grains	1.49
Others/indistinguishable materials	30.59

Condition Factor

Table 4: Monthly Mean Condition Factor for *H. membranaceus* in Zaria

Month	Total No. of Fishes Examined	Range of K Factors	Sex	Mean condition Factor
May	20	2.44-3.98	M	2.73
	16	2.12-3.07	F	2.52
June	22	2.03-3.53	M	2.64
	29	2.40-3.75	F	2.84
July	18	1.97-3.40	M	2.50
	29	1.97-3.96	F	2.83

Sex Ratio

The sex ratio for each month and all the months together were determined as shown in Table 5. A sex ratio of 1:1.23 (male and female) was obtained.

Table 5: Sex Ratio of *Hemisynodontis membranaceus* in Zaria

Species	Sex	May	June	July	Total
Hemisynodontis	M	20	22	18	60
Membranaceus	F	16	29	29	74
Sex	M:F	1.25:1	1:1.32	1:1.61	1:1.23

Length- Weight Analyses

The results of the length-weight regression analysis as indicated in Table 6 and in the figures (I-III) showed that the "b" values for both sexes were far below 3. The fish therefore, exhibits isometric growth. The correlation coefficients were highly and positively correlated for females and males; also for both females and males combined. The graph indicated linear relationship.

Table 6: Length-Weight Regression Analysis

Sex	Number of Fish Examined	Log a	Log b	Correlation Coefficient (r)
Male	60	0.2410	1.4105	0.8809
Female	74	0.2964	1.4299	0.8479
Both	134	0.2694	1.4229	0.8290

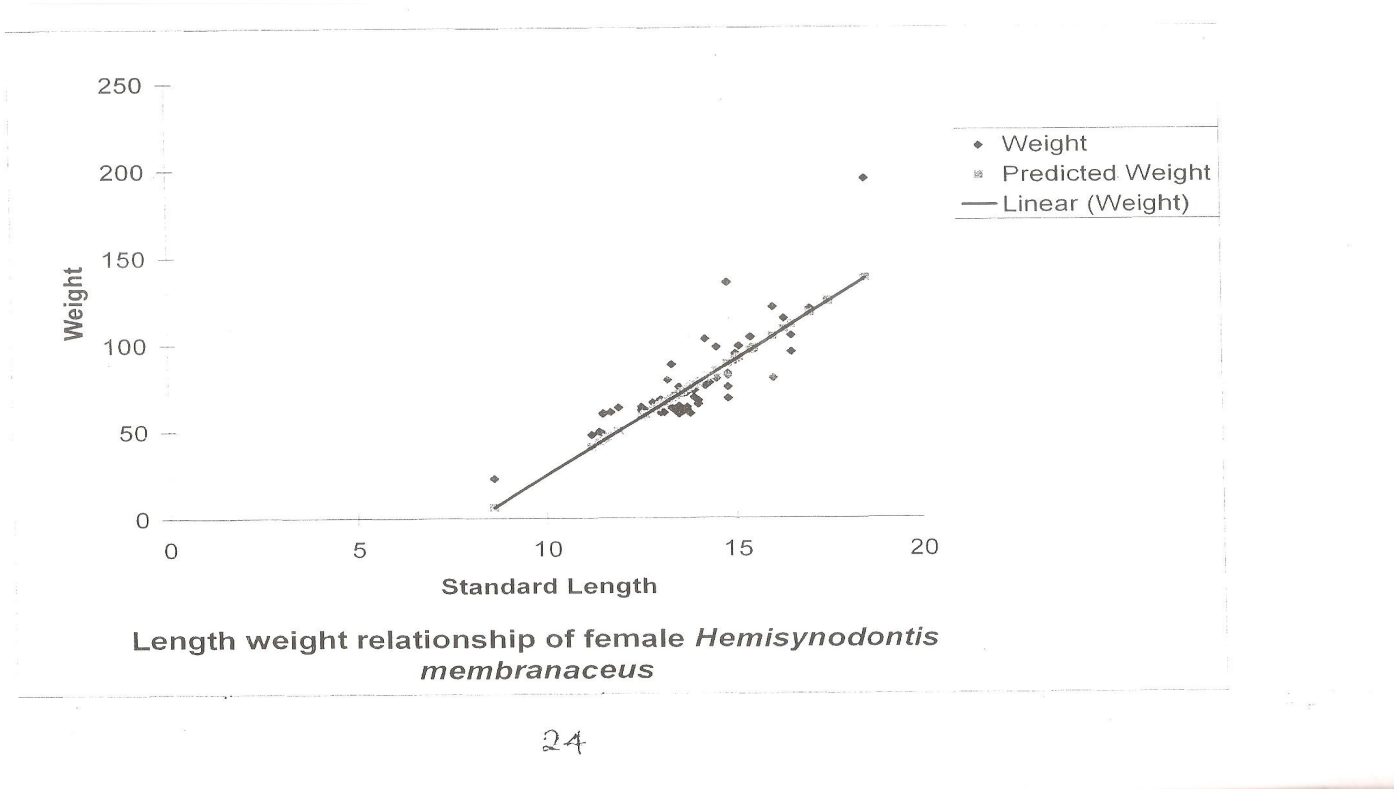

Figure 1: Length weight relationship of male *Hemisynodontis membranaceus*

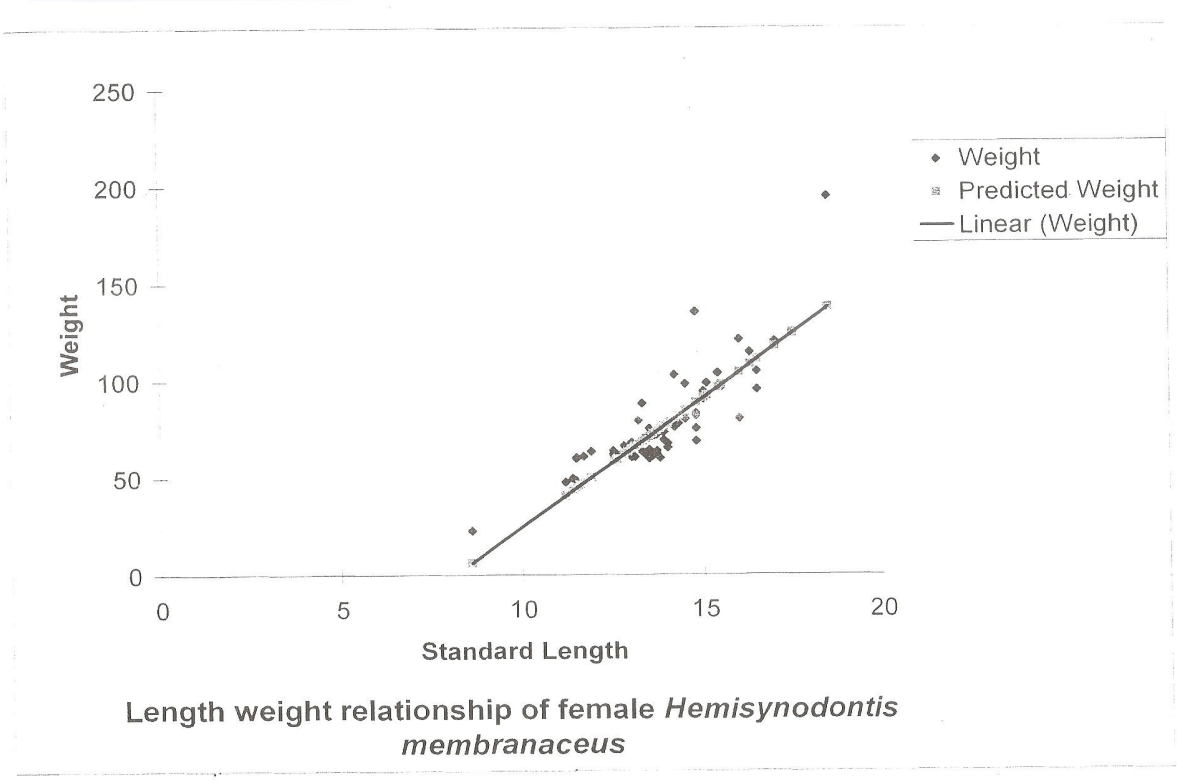

Figure 2: Length weighht relationship of female *Hemisynodontis membranaceus*

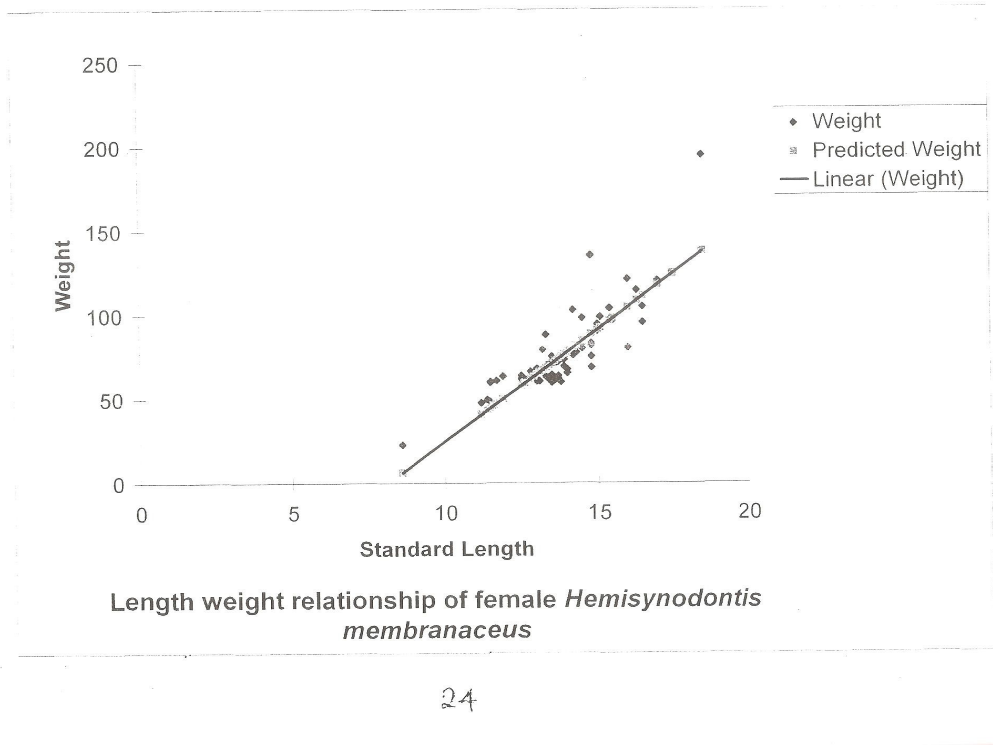

Figure 3: Length weight relationship of male and female combined *Hemisynodontis membranaceus*

DISCUSSIONS

The size range of *H. membranaceus* indicated that the males were generally bigger than the females from all the specimens examined while the females are more in number compared to the population of males. The following reasons could be inferred to explain the disparity in sizes and these include: The various sizes obtained may not represent the actual overall situation in the wild because the size ranges depend on the type of fishing gears used by the fishermen; the season of the year, and other structural and physiological adaptations which might make one fish more vulnerable to catch than the other. Most of the females were with eggs during the period of study. They must have used much of their energy derived from available food in their environment for egg development. Also, the analysis of sizes based on what was obtained from the market, as sample may not reflect the true picture of the size ranges present in the wild population, and as such, the result should be accepted with some degree of caution (Olatunde, 1983).

Length-weight analysis: there were strong and positive correlation between the length and weight of sexes combined; males and females separately. This is in conformity with the works of Ndimele *et al*. (2010) when they reported that Length – Weight relationship (LWR) had significant correlation in the fish species and the growth exponent (b) was isometric, condition factor (k) of the fish species for each year was higher than 1; and that dietary composition using frequency of occurrence and numerical methods revealed that *S. melanotheron* is a planktivore depending mostly on the divisions; Chlorophyta, Bacillariophyta, Cyanophyta and Ochrophyta. *H. membranaceus* was however, an omnivore in contrast to the above report. There was also high correlation between the length and weight, and the "b" values indicated isometric growth in the work reported by Ofori-Danson *et al*., (2001) on *H. membranaceus* in Lake Volta in collaboration with the out-come of this research.

H. membranaceus in Zaria was found to feed largely on algae, plant material and insects. There was great diversity in the items found in the stomach. Sands, (1986) reported (in the Northern Area Catfish Group, Information sheets. African and Asian Catfishes) that they feed amongst other things on prawns and shrimps, bloodworms. Conforming to these were shrimps that were observed in this research in a very rare occurrence.

H. membranaceus can be said to be or classified as an omnivore since it feeds on wide variety of food ranging from worms, crustaceans, seeds, decaying vegetal matters and algae. This conforms to what was reported by Olatunde (1989) in his work on *S. schall*. Olatunde (1989) in his work on some aspects of the biology of *S. schall* in Zaria reported that the fishes examined were omnivores, feeding principally on immature insects, seeds and algae and that the length-weight relationship indicated an isometric growth; maturity was attained during the on-set of rains while, spawning occurred towards the end of the raining season.

Amongst the algal matter the chlorophytes and particularly the filamentous forms were the most dominant while other forms of algae occurred occasionally. Amongst the insect observed in their diet, Orthopterans were the dominant types and the dragonflies were also found. These could be as a result of the perching of the insects on water surfaces or could be due to accidental fall of insects into water body, which then serve as food for the catfish. Empty stomachs found during the course of the study could be as a result of the fact that the fish has not fed or the food had already been digested before it was caught.

On general note, all the fishes were in good condition. However, the condition factors of those specimens examined in May were low compared to those examined in other months. There was abundance of food materials and increased oxygen dissolution in the water body especially in the months of June and July. It was also observed that the larger the size of the fish the higher the K (condition factor) values. Condition factors reported for some other species include: Alfred – Ockiya (2000) for *Chana chana* in fresh water swamps of Niger Delta and Hart (1997) for *Mugil cephalus* in Bonny estuary. Similarly, the work of Lawal *et al*. (2010) corroborated this when they reported that the value of the coefficient of regression 'b' for this species (*Chrysichthys nigrodigitatus*) was nearly 3 thus, indicating isometric growth, the mean condition factors ranged from 1.68 to 1.76 and that the food of the organism consisted of phytoplankton, crustaceans, molluscs, plant materials and fish parts. However, the two species studied by Omogoriola (2011) exhibited negative allometric growth ($b < 3$) with the mean $b = 2.78$ at $p < 0.001$ in their work on "Length-weight relationships, condition factor (K) and relative condition factor (Kn) of *Sparids, Dentex congoensis* and *Dentex angolensis".*

Abowei (2009) showed that the regression equation for the length weight relationship was Log W = 0.0157+2.86logL and correlation coefficient was 0.966 at $P<0.05$; there was no temporal variation in the condition of the fish throughout the year with condition index value ranging from 0.83 – 1.00 and condition factor value of 0.94, all species studied exhibited isometric growth ($b = 3$) except *S. maderensis* and *C. senegalensis* with $b = 3.6$ and 3.5 respectively that exhibited positive allometric growth, the condition factor ranged from 0.917 (*I. africana*) to 0.985 (*C. senegalensis*). This is also in conformity with the findings of this work. In like manner, the b values in the relationship W = aLb varied between 2.816 (for *Pagellus bogaraveo*) and 3.395 (for *Scomber scombrus*), and showed a mean value of 3.076 (±0.147 SD) (Luca *et al*., 2013).

Sex ratio indicated higher number of females to males and the ratio was 1:1.23 (M: F) in conformity with this, Araoye (2001) in his work on the morphology of the gonads in the reproductive cycle of *S. schall* in Asa Lake, Ilorin reported that there were positive correlation between the gonad and body length relationship in male and female; there was also significant difference between the size of males and females; and that the length-weight regression analysis indicated isometric growth of the species sampled; the correlation between weight and length was highly significant. Also, the fish species exhibited diversity in their diets with insect parts, larvae and algae as the main diets; and the overall sex ratio showed proximity of 1:1 ratio in upper Benue River Basin, Yola (Abubakar and Edward, 2002).

CONCLUSION

The growth of *H. membranaceus* in Zaria is isometric. The males were generally bigger in size than the females; and there were more females than the males. The sex ratio was 1:1.23 (M: F). The fish was found to feed largely on algae, plant materials and insects suggesting that *H. membranaceus* was an omnivore.There was high and positive correlation between the length and weight of both sexes combined, and also in males and females separately.

Recommendations

Further research should be done to ascertain the food preference of the species over a longer period of time covering both wet and dry season. This will enable definite conclusion on its food preference. *H. membranaceus* can be effectively used to check the population of molluscs and algae in large aquaculture since it feeds on wide variety of food.

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