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Diet composition and length-weight relationship of *Tilapia mariae* in Lower River Ogun, Akomoje water reservoir, Nigeria

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ABSTRACT

Some aspect of the biology of *Tilapia mariae* from lower River Ogun, Akomoje water reservoir with emphasis on its food habits were studied between the months of February and June. A total number of 100 fish specimens were collected on monthly basis from the landings of artisanal fishermen around the water body. The length and weight relationships and the well being of the species were investigated. The contents of their stomach were examined. Mean standard lengths of fish sample were ranged from 15.12±0.81cm in male while female ranged from 17.83±0.76. The species from this water body revealed negative allometry growth pattern. There was variation in condition factor (k) for both sexes. The well being of the females revealed better condition than the males in all months of study. The results of monthly variation in food items showed that *Bacillariophyta*, *Chlorophyta*, *Cyanophyceae*, Crustacean, Detritus, plant tissues, and unidentified food all occurred in varying quantities from February to June. *Bacillariophyta* (diatoms) appeared as the dominant food of *Tilapia mariae* accounting for 14.72% and 78.10% by number and occurrence. *Cyanophyceae* constituted 11.43% and 59.63% by number and occurrence and was second most important food item. Crustaceans occurred least in order of importance (2.34% in numbers and 27.12% in frequency of occurrence. The sex ratios of *Tilapia mariae* in the Reservoir was 1:3.12 (M:F), with highest abundance of females in March (1:3.17) and April showing the least 1:2.05 (M:F). The study concludes that there is large population of algae in the water body. It also confirms the herbivorous feeding habit of the species.

INTRODUCTION

Interest in farming of the Cichlids has continuously been on the increased (Atindana *et al*., 2016). They have been widely cultured and are recorded as species of high economic importance in Tropical Africa (Soyinka and Ayo-Olalusi, 2009). This importance could be attributed to their hardy nature and prolific breeding ability. The Cichlids are opportunistic feeders in their environment and feed on any available food organism of plants and animals origin (Popma and Masser, 2012). Cichlids generally can be cultured in crowded ponds (earthen, concrete and tanks), and cages.

In terms of nutrition, these species (tilapia) have high protein content (26 g/100 g of muscle). Also, they are rich in vitamins and minerals especially niacin, vitamin B12, phosphorus, selenium and potassium (Pearson, 2017). According to Agbabiaka (2010) their distribution is wide in Nigeria waters. They are of high economic viability and play important role in the ecology of freshwater bodies in African (Ikomi and Jessa, 2003).

Studies conducted on food and feeding habits and length-weight relationships of Cichlids in Nigeria and Africa, include those of Atindana *et al*. (2016) on the food ecology of three Cichlid species in the Mankessim reservoir, Central Region of Ghana. Uneke (2017) on food and feeding habit and condition factor of Tilapia Species in Ebonyi River. Dan-Kishiya (2013) on length-weight relationship and condition factor of five fish species from a tropical water supply reservoir in Abuja. Atama *et al.* (2013) on Cichlids species from Anambra River.

There are no recent data on the biology of *Tilapia mariae* from Nigeria waters. Existing facts from the world Conservative Union for the Cichlids is that, 43 species are extinct. Of the wild species, five have gone into extinction, 37 species are critically endangered, 11 species are endangered, 34 species of high vulnerability to extinction, and one species is at least concern (The World Conservation Union, 2002). This study was therefore designed to investigate diet composition and growth pattern of *Tilapia mariae* for rational exploitation, cultural practice and domestication purposes.

MATERIALS AND METHODS

Study area

The Lower River Ogun, Akomoje in Abeokuta Ogun state was the study location. The river lies between 3° 21´E 7° 21´N North of Abeokuta with a surface area of 1000 hectares. River Ogun is a perennial river with coordinate of 3° 28´E and 8° 41´N from its source in Oyo State and 3° 25´E and 6° 35´N in Lagos state where it flows into the Lagos Lagoon. Akomoje reservoir takes its source of water from River Ogun, the reservoir not only serves as a source of fishing, but also serve as a source of portable water processed by the Ogun State Water Cooperation.

Specimes collection

100 specimens of *Tilapia mariae* were collected fortnightly from artisanal fishermen using gill nets of 75 mm and 105 mm mesh sizes. Fish caught were transported to the laboratory in ice box to reduce posthumous deterioration to a minimum before subsequent analyses. The specimens were later preserved in the refrigerator to avoid further decline in quality before use.

Laboratory analysis

In the laboratory, fish specimens were arranged serially and given identification number. Total and standard lengths of each specimen were measured in centimeter. Fish were drained of water using dry towel, and the weight of each were taken using a Mettler Toledo Model PM1200 Precision Balance (0.1 g). Sexes of each specimen were identified and recorded, by observing through the papilla. Individual fish was dissected using a sterile scalpel and a pair of scissors from a dissecting kit to open fish up ventrally from the anal opening to the head. The stomach was removed with care so that its contents remain intact and their fullness observed and recorded. The degree of fullness of each stomach was categorized using the method of Ugwumba and Adebisi (1992). The stomach was weighed and recorded; likewise the intestine was carefully stretched out and the length measured and recorded. After the removal

of the entire gut, each fish was then re-weighed and recorded. Each stomach and its content were preserved in 10% formalin in a correspondingly tagged specimen bottle.

Stomach content determination

Stomach content of each specimen was poured into a sterile petri dish and placed under different magnifying lens of a binocular microscope. The dietary items were identified to taxonomic categories using check-lists.

For the occurrence method, estimates of the percentage of stomachs in a sample containing a given food items was recorded and expressed as the % of the food type found in all fish examined. Occasionally, some food were observed crushed and others were at various stages of digestion. Consequently, it was impossible to identify such food items at the species level (Oloja *et al.,* 2003).

$$\%\ \text{occurrence} = \frac{\text{total number of stomachs with specific food item}}{\text{total number of stomach examined}} \text{ x } 100$$

(adopted from Adeosun *et al*., 2017)

In this method, number of a particular food item in the stomach of fish samples are counted and summed up to obtain the total number of each food item found in the stomach.

While for the numerical method, number of particular food item was expressed as a percentage of the total number of food items found in the stomachs.

$$\%\ \text{number} = \frac{\text{Total number of the particular food item}}{\text{Total number of all food items}} \text{ x } 100 \text{ ……. (Adeosun, 2018)}$$

In this method, the importance of different food items in terms of number is expressed.

Length-weight relationship determination

Length-weight relationship was calculated by the conventional formular described by LeCren (1974). This is expressed as W= aL^b. The relationship was transformed into logarithms graphically by plotting the observed lengths and weights as a dot diagram. Thus, the formula becomes

LogW = Log a + bLog L

Where W = weight of the fish (g)

L = standard length of the fish (cm)

a = a constant

b = an exponent

Sex differentiation

Sexes were distinguished manually based on external sexual anatomy as described by Balarin and Hatton (1979). Male have one opening and a protruded genital papilla present just before the anal fin. Female have two body openings, one is the anus, second is the urethra from which eggs are discharged

RESULTS

Length-weight relationship

Length-weight relationship for *T. mariae* is as shown in the figure 1 below. The length–weight relationship revealed a general increase in weight with corresponding increase in length. The least squares common fit of the transformed data gave a linear equation of Log W= 1.3344LogL + 0.4731 with an r^2 value of 0.7968 (n=100).

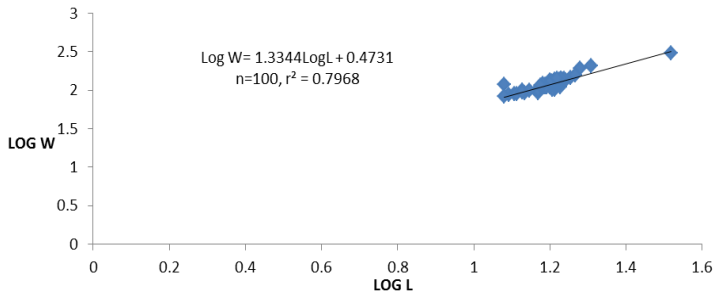

Fig. 1: The length- weight relationship for *Tilapia mariae* in Akomoje water Reservoir.

Well being of experimental fish

Condition factor of the experimental *T. mariae* ranged between 2.113±0.12 and 3.01±0.62 (Figure 2) with May and February having the least and highest condition factor for males. In June, the female *T. mariae* had the least condition factor (2.811±0.91) but was highest in April. From Table 2, the mean condition factor was 2.438±0.62 and 2.87±0.71for both male and female *T. mariae*.

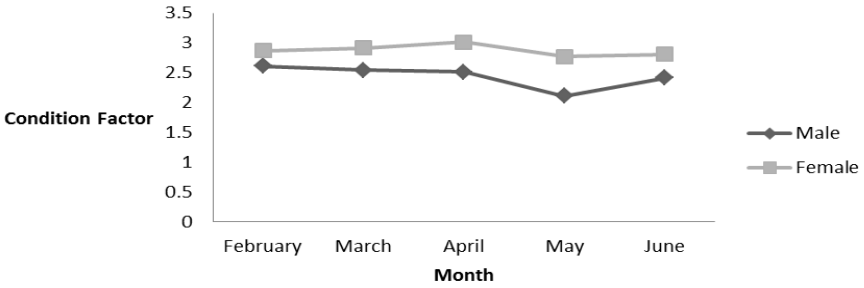

Fig. 2: Monthly Variation in Condition Factor (K) for Male and Female *Tilapia mariae* in Akomoje water Reservior.

Diet composition

Table 1 showed the summary of monthly variation in food items. *Bacillariophyta*, *Chlorophyta*, *Cyanophyceae*, Crustacean, Detritus, plant tissues, and unidentified food items occurred in varying amounts from February to June. Also, out of the 100 stomachs examined 15%. 25%, 20%, 35% and 15% were empty in February, March, April, May and June respectively. Figure 3 revealed *Bacillariophyta* (diatoms) was the most important food item in the stomach of *Tilapia mariae*. Crustaceans occurred least in order of importance (2.34% in numbers and 27.12% in frequency.

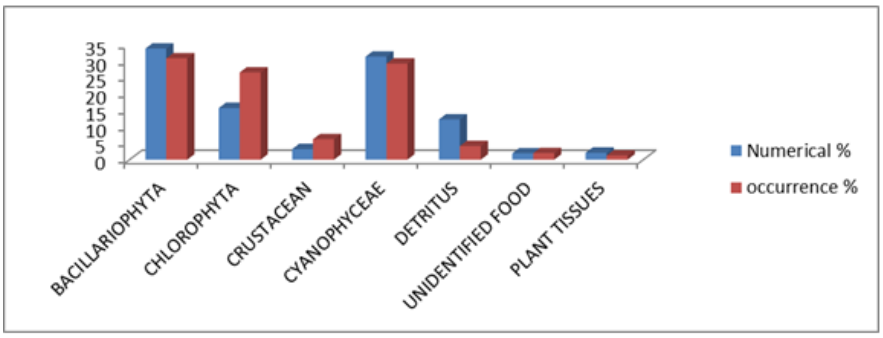

Fig. 3: Distribution of food items in the stomach of *Tilapia mariae* from Akomoje water Reservoir.

Table 1: Monthly variations in food items in the stomach of *Tilapia mariae* from Akomoje water Reservior

	February		**March**		**April**		**May**		**June**		**Total**	
No. of fish examined	**20**		**20**		**20**		**18**		**20**		**98**	
% empty stomach	**15**		**25**		**20**		**35**		**15**		**32.65**	
Food items	**%N**	**O%**	**%N**	**O%**	**%N**	**O%**	**%N**	**O%**	**%N**	**O%**	**%N**	**O%**
BACILLARIOPHYTA											33.74	30.84
Cyclotellacomta	7.2	30.8	1.7	28.6	4.8	32.9	7.9	34.8	-	-		
Melosira	4.5	28.1	0.3	19.6	2.7	78.1	3.3	67.2	7.5	29.7		
Frustulia	8.3	39.3	10.8	100	7.7	35	-	-	9.8	40.5		
Gyrosigma	4.3	32.2	4.5	70.6	5.3	27.5	4.4	32.9	3.2	69.2		
Diatoma sp.	3	51	8.5	71.4	2.6	91.1	-	-	-	-		
Nitzchia sp.	2.1	32.4	2.9	59.2	-	-	2	89	3.9	81		
CHLOROPHYTA											15.68	26.5
Gonatozygon	0.4	26.5	-	-	-	-	10.8	100	-	-		
Coelastrum	0.5	34.2	6.4	34.6	4.3	70.2	7.2	28.9	-	-		
Microspora	2.3	20.2	7.2	28.9	3.2	100	3.5	67.9	-	-		
Cladophora	5.3	98.2	3	78.1	4.5	70.6	5.3	27.5				
Spirogyra	12.3	100	5.9	47.2	-	-	-	-	-	-		
Sphaeoplea sp.	7.2	72.4	-	-	-	-	-	-	2.3	34.4		
CRUSTACEA											3.21	6.218
Diaptomus spp.	-	-	2.3	41.2	-	-	0.3	19.6	2.7	56.2		
Bosmonia spp.	-	-	2.1	24.2	-	-	10.8	100	7.7	21.7		
Daphnia spp.	9.8	21.8	-	-	8.5	71.4	-	-	-	-		
CYANOPHYCEAE											31.29	29.2
Aphanocapsa sp.	7.7	29.2	-	-	4.3	32.2	4.5	70.6	5.3	27.5		
Oscillatoria sp.	5.7	81	3.2	67.3	-	-	-	-	-	-		
Microcystis sp.	9.8	37.3	2.3	34.7	8.3	39.3	9.8	21.8	-	-		
Closterium sp.	8.2	21.8	6.9	21.9	4.3	32.2	3.9	98.1	-	-		
Polycystis sp.	3.2	100	3.5	67.9	-	-	-	-	-	-		
DETRITUS	5.7	35.2	4.7	43.2	8.3	39.3	10.8	100	7.7	35	12.21	4.133
UNIDENTIFIED FOOD	3.2	78.2	3.8	38.2	-	-	4.4	32.9	3.2	69.2	1.92	1.989
PLANT TISSUES	3.8	67.4	6.9	56.2	4.5	70.6	5.3	27.5	4.4	32.9	2.11	1.26

Monthly sex distribution and condition factor

Table 2 revealed total mean length of *T. mariae* examined was 16.26±0.53cm and 17.02±0.89cm for male and female. The mean weight of *T. mariae* examined was highest in May (111.98±0.32g) and least in February (109.18±0.52) for males while it

was highest in March (112±0.43g) and least in April (108±0.87g) for Females examined. Sex ratio of the male to females among the 100 *T. mariae* examined was 1:3.12. Condition factor was higher in females than in males with mean 'k' of 2.438±0.62 and 2.87±0.89 for male and female.

Table 2: Monthly Variation in Condition Factor, Mean Weight and Sex ratio

Month	MM (cm)	MF (cm)	MwtM (g)	MwtF (g)	M:F	k(M)	k(F)
February	17.01±0.12	16.47±0.23	110.64±0.43	112±0.43	1:2.11	2.61±0.23	2.87±0.89
March	16.12±0.27	16.48±0.48	109.18±0.52	110±0.32	1:3.17	2.54±0.43	2.91±0.71
April	15.12±0.81	17.83±0.76	109.34±0.57	108±0.87	1:2.05	2.51±0.42	3.01±0.62
May	16.23±0.42	16.98±0.72	111.98±0.32	109±0.72	1:3.01	2.11±0.12	2.77±0.78
June	16.83±0.73	17.32±0.67	110.67±0.42	109±0.91	1:3.16	2.41±0.51	2.81±0.91
Mean	16.26±0.53	17.02±0.89	109.80±0.72	109.6±0.8	1:3.12	2.43±0.62	2.87±0.71

MM (cm): mean lenght for male, MF(cm): mean lenght for female, MwtM(g): mean weight for male, MwtF(g): mean weight for female , M:F: sex ratio, K(M): condition factor of male, K(F): condition factor of female.

DISCUSSION

The summary of the result showed that food items consumed by *T. mariae* are predominantly aquatic microscopic plants and confirms the herbivorous food habit documented for the species Ikomi and Jessa (2003). Generally, the importance of the plant materials; *Bacillariophyta*, *Cyanophyceae* and *Chlorophyta* in the diet of *T. mariae* from this water body was clearly demonstrated from both the frequency of occurrence and numerical methods of gut content analyses throughout the study months. This observation agreed with previous studies on other Cichlid species such as Uneke (2017) on the food habits of *Tilapia zilli*, Ekpo *et al*. (2014) on *Tilapia guineensis* and *Sarotherodon melanotheron*. This is because the gill rakers morphology of Tilapia, Oreochromis and Saroherodon favours consumption of phytoplankton and it's also a pointer to the abundance of its preferred food items in this water body. High percentage of substrate detrital materials (algae and plants) found in the stomach of the species confirms that the species are substrate dwellers and spawners and thus are deposit feeders. This could be attributable to its dentition (Bradford *et al*., 2011). Similar result was reported by some other authors (Osho *et al*., 2006; Atindana *et al*., 2016). Welcomme (1985) reported that detritus in the food of fish is a major contributor of energy for fish.

The study by Bradford *et al*. (2011) on the food consumed mainly by the species and other Cichlids revealed the low presence of animal sources, comprising fish remains, free-swimming invertebrates, Protozoa, benthic invertebrates, fish eggs, allochthonous invertebrates, Rotifera and invertebrate larvae. Atindana *et al*. (2016) reported the presence of benthic invertebrates and fish scales/parts in other Cichlids species from the central region of Ghana. Also, Ikomi and Jessa (2003) and Fagade 1971 documented that *T. mariae* are benthic herbivores as 85% of their food comprise diatoms, algae, aquatic macrophytes and detritus with 5% comprising benthic invertebrates and terrestrial insects. The findings of this study agreed with these studies as crustaceans were observed in low proportions. This may be due to high populations of the planktons in this water body and the preference for phytoplankton by this species.

Low percentage of empty stomach reported during the study period is an indication that the species is more or less a continuous feeder and agreed with the review of the biology of the species by Bradford *et* al. (2011). Monthly variation observed in the food habits of the species as the diet breadth was expanded during the wet season, and a number of food items like crustaceans were excluded from the diet in the dry months and in the beginning of the wet months. This was also the case in the study by Ikomi and Jessa (2003) who reported high diversity of food item during the wet season in this species from the River Ethiope, Niger. The reason for the expanded diet breadth during the wet season is not clear as the wet season would be expected to be the period of greatest resource abundance phytoplankton. It could however be due to the flowing nature of the water (lotic) with plankton well dispersed and resident life low. The larger occurrence of these food items may be as a result of large phytoplankton distribution in the water body, and the reduced number of food consumed may be a result of the gut size or reproductive physiology of the fish. As observed by Ikomi and Jessa (2003), *T. mariae* is a substratum spawner and spawns throughout the year; this therefore may limit the number of food consumed.

The length exponent 'b' of the length-weight relationship for the species from this water body indicated a negative allometric growth pattern. Negative allometry recorded for this species in this study indicated that the species do not grow symmetrically, meaning as the species grows in length, it grows thinner and thus reduce in weight which could be due among other factors to gonad maturity, diet (Bradford *et al.,* 2011), sex, seasons, growth increment, sample size, temperature and salinity of the environment, fishing, individual metabolism, habitat suitability, age and maturity (Atama *et al*. 2013; Uneke *et al*., 2017). Other studies that reported similar findings are that of Atama *et al*. (2013), who reported negative allometry for both male and females in both wet and dry months, and Dan-Kishiya (2013), also reported similar allometry for both males and females of the species. Ikomi and Jessa (2003) reported an isometric growth for this species from the Ethiope River. This difference could be due to the above listed factors.

Condition factor was higher for females than the males and in the dry months and onset of the wet months (April) than the months of May and June. This agreed with the findings of Ikomi and Jessa (2003) in their study on aspects of the biology of *T. mariae* in Ethiope River and could be because the female samples were either gravid or on high vitellogenic phase. Generally, 'k' values recorded for the species in this water body were higher than '1' which indicated availability of good quality food and environmental conditions during the study. Bagenal and Tesch (1978) posited that condition factor "k" $\geq$ 0.5 indicates proper well being of the fish. Sex ratio recorded revealed a higher number of females than males. Anene and Okorie (2008) in their study of the sex ratio of *T. mariae* from Umuoseriche Lake reported the preponderance of female sex. Similar finding was reported by King (1994) for the same species of fish from a tropical rain forest stream.

CONCLUSION

The study concludes and confirms previous reports that *Tialpia mariae* is an herbivorous fish species. It revealed that the fish does not feed on zooplankton. Also, the sizes of the species were juveniles to sub adult which is indicative of overfishing of the species. It could also be concluded that the water body is rich in natural foods. Further studies should be carried out to ascertain the direct competition of the fish with respect to the food items in the water. The proper management and conservation

of fish in the river should be done by mesh size regulation. The water quality of the reservoir should be managed so as to ensure an environment conducive for survival of the species.

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Authors' contributions

EOA, ITO and FIA designed the study and sample collection and data analysis were done by EOA. OMTO and EOA participated in results, statistics and interpretation. EOA wrote the draft manuscript, while OMTO and FIA edited it.

Conflict of interest Declaration

The authors declare no conflict of interest.

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