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Relative Abundance, Length-Weight Relationship, Condition Factor and Sex Ratio of Cichlid Species (Pisces: Cichlidae) from Weija Reservoir in Ghana

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Abstract
Cichlids from Weija Reservoir were assessed for relative abundance, length-weight relationship, condition factor and sex ratio to provide better knowledge of the Cichlidae family to enhance their sustainable management for reservoir fishery development, food security and sustainable development. Two out of four genera identified namely Tilapia and Hemichromis together dominated the Cichlid family accounting for over 90% and over 80% of total number and weight respectively. The two most abundant species out of seven species identified namely *Hemichromis fasciatus* and *Tilapia guineensis* constituted almost half of total number and over one-third of total weight respectively. Females were in better condition and therefore better adapted to the Weija environment than males for four species namely *Hemichromis bimaculatus*, *Hemichromis fasciatus*, *Tilapia guineensis* and *Tilapia zillii*. Similarly, for *Oreochromis niloticus* and *Sarotherodon melanotheron* males were in better condition and, therefore, better suited to the environment than females. With the exception of male *Hemichromis fasciatus* and male *Oreochromis niloticus* which showed isometric growth and female *Sarotherodon melanotheron* which showed positive allometeric growth, the remaining species showed negative allometric growth for both sexes. Monthly differences in sex ratio were variable for all species at 95% confidence interval except for *Oreochromis niloticus*. Significant differences in sex ratio were observed for each species except for *O. niloticus* which was not significant at 95% confidence interval. With few exceptions, all species showed strong correlation between length and weight while males generally had stronger correlations than females. Though *S. melanotheron* and *O. niloticus* had good size characteristics, they were found in limited abundance and therefore may require management intervention to increase their relative abundance.

Keywords: Relative abundance, Length-weight relationship, Condition factor, Sex ratio, Weija Reservoir, Cichlid species

Introduction

Fish length and weight data constitute the standard result of fish sampling programmes and have commonly been analysed to yield important biological information including relative abundance, length-weight relationship (LWR) and condition factor (CF). Consequently there are several reports on length-weight relationship and condition factor of Cichlids from different regions of the world. Reports from the African region include Anene (2005) [3], Haruna (2006) [19], Bala *et al*. (2009) [8], Imam *et al*. (2010) [20] and Mahomoud *et al*. (2011) [26]. According to Anene (2005) [3] similar studies pertaining to Cichlids that have been reported include Siddiqui (1977) [39]; Fagade (1978, 1979, 1983) [15, 16, 17]; Dadzie & Wangila (1980) [10]; Arawomo (1982) [4] and Oni *et al* (1983) [31]. In Ghana, Entsua-Mensah *et al*. (1995) [14] and Palomeras *et al*., (1996) [32] reported on length-weight relationship of several fishes including Cichlids from the tributaries of the Volta River while Dankwa (2011) [12] reported on length-weight relationship of grey mullets of two estuaries in Ghana. Length-weight relationship can be used to predict weight from length measurements made in the yield assessment (Pauly, 1993) [33] and is important in proper exploitation and management of fish populations (Anene, 2005) [3], fish stock assessment (Morey *et. al*., 2003) [27] and providing information on the habitat where fish lives (Oni *et al*., 1983) [31]. Condition factor is used to compare the condition, fatness or well-being of fish and is a useful index for monitoring feeding intensity, age and growth rates in fish (Ndimele *et al*., 2010) [27] as well as assessing the status of the aquatic ecosystem in which fish live (Anene, 2005) [3]. It is influenced by both biotic and abiotic factors and based on the hypothesis that heavier fish of a particular length are in a better physiological condition (Bagenal & Tesch, 1978) [6]. Condition factors of different tropical fish species that have been reported include Bakare (1970) [7], Saliu (2001) [38] and Lizama *et al.* (2002) [24]. Sex ratio and size structure constitute some of the basic information required for assessing reproductive potential and estimating stock size (Vazzoler, 1996) [41].

The Weija Reservoir is one of the potable water production sources in Ghana which also supports thriving fisheries and irrigation. Various aspects of the fish and fisheries of the Weija Reservoir reported include fish species composition, relative abundance, potential fish yield and community structure (Abban, 1979; Dassah & Abban 1979; Balarin 1988; Ofori-Danson *et al.* 1993; Quarcoopome & Amevenku 2006, 2010) [1, 13, 9, 29, 36, 35].

Cichlids are among the five most commercially and socio-economically important fish taxa which also contribute significantly to the total estimated annual yield of inland fisheries in West Africa, including Ghana (Abban *et al*., 2004) [2]. The diversity of the family Cichlidae from Ghanaian inland and coastal waters comprises nine genera and 17 species (Dankwa *et al.*, 1999) [11]. Although Cichlids contribute significantly to the socio-economies of inland fisheries and have been studied, there is limited information on the length-weight relationship, condition factor and sex ratio of Cichlids from Ghanaian reservoirs. This study is aimed at addressing the paucity of information on reservoir fishes in Ghana by assessing the relative abundance, length-weight relationship, condition factor and sex ratio of Cichlids from Weija Reservoir. This should provide information for the conservation and management of Cichlids and the development of reservoir fisheries for food security and sustainable socio-economic development.

Materials and methods

Study area

The Weija Reservoir (Fig. 1) is located 17 km to the west of Accra on 5º35'– 5º 40' N and 0º20'–0º24' W. Though once a virtually small settlement on the outskirts of Accra, Weija has developed into a peri-urban community with several modern amenities of its own. The Weija Dam was built across the River Densu at Weija in 1974 resulting in the formation of the Weija Reservoir in 1977 to serve as source of raw water for potable water production and supply by Ghana Water Company Limited (GWCL). The main inflow source into the reservoir is the River Densu which takes its source from the Atewa-Atwiredu mountain range in the Eastern Region of Ghana. The reservoir discharges into the Gulf of Guinea partly through the Sakumo 1 Lagoon at Bortianor which is 10 km from the mouth of the sea. The reservoir has a surface area of 33.61 km^2 with mean depth of 14.1 m (Balarin, 1988; Vanden Bossche & Bernacsek, 1990) [9, 40]. The soils are sodium vleisols, coastal savanna ochrosols and lithosols (Ayibotele & Tuffour-Darko, 1979) [5]. The Weija Reservoir lies in the coastal savanna zone and has low and erratic bi-modal rainfall pattern with peaks in June and September. The reservoir supports several uses such as the provision of treated water to western parts of Accra, irrigation and fisheries. The riparian communities also use the reservoir water for many domestic, agricultural and other diverse purposes.

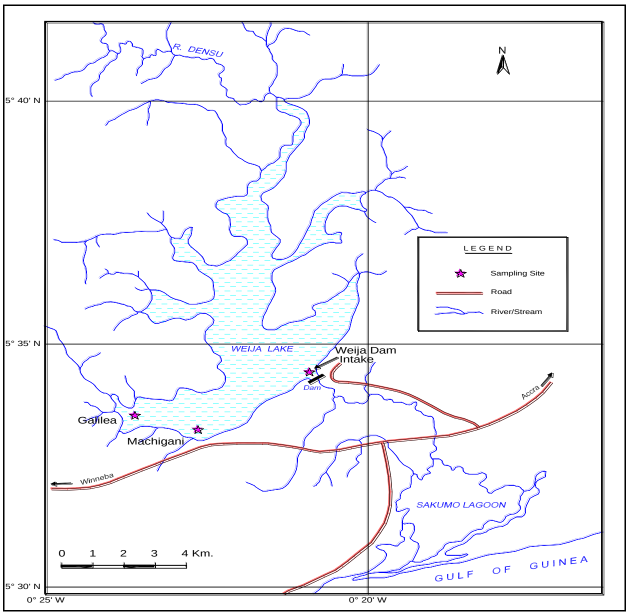

Fig 1: Map of Weija Reservoir showing sampling stations

Sampling and data collection

Samples of Cichlid fishes were obtained monthly over a period of 10 months from experimental fishing with different sets of monofilament and multifilament gill nets as well as from commercial catches of fishermen who use assorted fishing gear in both inshore and open waters. All sampled fish were individually identified with the aid of Lévêque *et al.* (1992) [23] and their sexes determined by visual inspection of gonads after dissection. Each specimen was measured for body weight to the nearest 0.1 g, total length and standard length to the nearest 0.1 cm and 1.0 mm respectively. All data analyses were performed with Microsoft Excel version 2007 to obtain estimates of relative abundance, length-weight relationship, condition factor and sex ratio.

Relative abundance

The number and type of fish species comprising the Cichlid community was determined by the identification of fish specimen at each station. The relative abundance of each species was determined in terms of weight and number as percentage composition of the total number and weight of sampled fish to help establish the importance of each species in the Cichlid community.

Length-weight relationship

Length-weight relationship (LWR) was computed to determine the growth patterns of Cichlids according to species and sex by the application of the equation of Ricker (1975) [37] as follows: $W = aL^b$ (Ricker, 1975) [37] where W was the weight (g), L the standard length (mm). The constant '*a'* is the intercept while the constant '*b*' is the slope or the growth constant and represents the growth pattern of the fish. Fish can exhibit isometric growth, negative allometric growth or positive allometric growth patterns. The correlation coefficient 'r' for each equation was computed to determine the relationship between length and weight.

Condition factor (CF)

The condition factor (CF) was calculated from the formula $CF = 100 \times W/L^3$ (Ricker, 1975) [37], where W was the body weight (g) and L was the standard length (mm) to determine how robust, healthy or well the different Cichlid species are and how well suited to the environment they are.

Sex ratio

Monthly sex ratio for each species was computed and tested for statistical significance to determine conformity or departure from the null hypothesis of 1:1 male to female using the chi-square method at 95% confidence interval (CI). Sex ratio for various size groups of the different species was computed and tested for significance at 95% CI.

Results

Relative abundance

Seven species belonging to four genera were identified from the Weija Reservoir. The seven species are *Hemichromis bimaculatus*, *Hemichromis fasciatus*, *Oreochromis niloticus*, *Sarotherodon galileus*, *Sarotherodon melanotheron*, *Tilapia* guineensis and *Tilapia zillii*. The most important of these species were *T. guineensis* (42.95% of number and 43.42% of weight) and *H. fasciatus* (38.11% of number and 32.59% of weight) (Fig. 2a & 2b). The rest of the species together accounted for 18.95% of number and 23.99% of weight. On the other hand, the contribution of *S. galileus* to both number and weight was below 1% and was therefore not included in further analyses of length-weight relationship, condition factor and sex ratio.

The four genera are *Hemichromis*, *Oreochromis*, *Sarotherodon* and *Tilapia*. Two of these genera namely Tilapia (46.74% of number and 46.25% of weight) and Hemichromis (46.32% of number and 37.02% of weight) together accounted for 93.06% and 83.27% of total number and weight respectively.

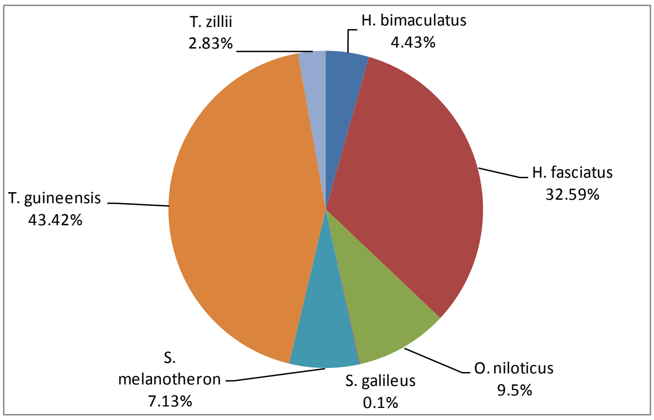

Fig 2a: Relative abundance of Cichlids from Weija Reservoir in terms of Weight

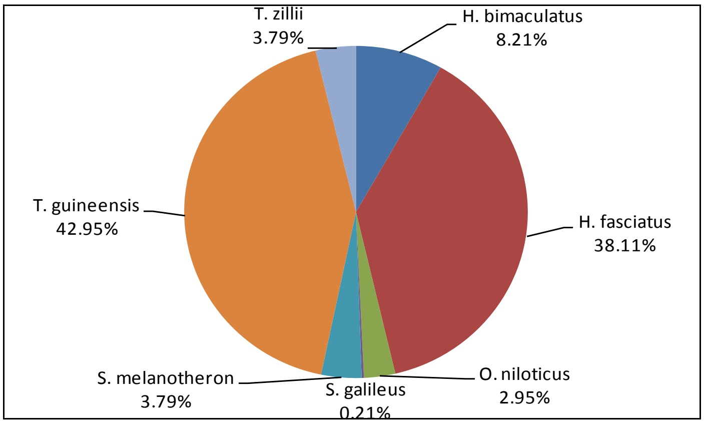

Fig 2b: Relative abundance of Cichlids from Weija Reservoir in terms of Number

Descriptive statistics of Cichlids from Weija Reservoir (Table 1) indicates that the highest mean weight of 49.41 g was recorded for *O. niloticus* followed by 28.84 g for *S. melanotheron* while the least mean weight was recorded for *H. bimaculatus* (8.26 g). The highest mean SL recorded was 93.5 mm for *O. niloticus* followed by 77.83 mm for *S. melanotheron* with the least of 57.1 recorded for *H. bimaculatus*. The heaviest species was *O. niloticus* (283.0 g) followed by *T. guineensis* (149.7 g). The species with the least weight were *H. bimaculatus* and *T. guineensis* (3.4 g) followed by *T. zillii* (4.7 g). The maximum standard length recorded was 195.0 mm for *O. niloticus* followed by 150.0 mm for *T. guineensis* and 140.0 mm for *S. melanotheron* and *H. fasciatus* (105.0 mm).

Table 1: Summary Descriptive Statistics of Cichlids from Weija Reservoir

Species	*H. bimaculatus*	*H. fasciatus*	*O. niloticus*	*S. galileus*	*S. melanotheron*	*T. guineensis*	*T. zillii*	Pooled
Mean SL	57.1	69.71	93.5		77.83	63.81	63.11	66.86
Min SL	47.0	55.0	50.0		50.0	44.0	48.0	44.0
Max SL	90.0	105.0	195.0		140.0	150.0	90.0	195.0
Mode SL	50.0	60.0	120.0		70.0	60.0		60.0
Mean Wt	8.26	13.11	49.41		28.84	15.50	11.43	15.33
Min Wt	3.4	5.5	5.1		5.4	3.4	4.6	3.4
Max Wt	20.9	47.2	283.0		111.4	149.7	33.6	283
Total Wt	322.3	2372.6	691.8	7.5	519.1	3160.9	205.7	7299.9
Number	48	172	14	1	18	204	18	475

All SL measurements in centimeters (cm); All Wt measurements in grammes (g)

Length-weight relationship

The range of estimated "b" values for males and females were 2.61 - 3.01 and 2.72 - 3.15 respectively (Table 2). Apart from male *H. fasciatus* which had a "b" value of 3 (b=3) as well as male *O. niloticus* and female *S. melanotheron* which had "b" values above 3 (*b*>3), the remaining species and sex had "b" values below 3 (*b*<3) (Table 2). The correlation coefficient 'r' values for males and females ranged from 0.982 to 0.999 and 0.971 to 0.997 respectively.

For combined sexes, the length-weight relationship equation for each species is shown in Fig. 6a – 6f. The estimated "b" values for combined sexes for each species ranged between 2.79 and 3.07 while the correlation coefficient 'r' values ranged from 0.938 to 0.996 (Figs 6a – 6f). Three (3) species namely *H. fasciatus*, *O. niloticus* and *T. zillii* had "b" values above 3 (*b*>3) while the remaining species had "b" values below 3 (*b*<3) (Figs 6a – 6f).

Table 2: Length-Weight Relationship of Males and Females of Cichlid Species from Weija Reservoir

Species	n	Length range (mm)	a	b	r
Male *H. bimaculatus*	9	50 – 85	0.025	2.61	0.982
Female *H. bimaculatus*	30	47 – 90	0.020	2.73	0.975
Male *H. fasciatus*	46	55 - 95	0.012	3.0	0.984
Female *H. fasciatus*	47	55 - 105	0.012	2.97	0.971
Male *O. niloticus*	5	64 - 195	0.012	3.01	0.998
Female *O. niloticus*	6	63 - 120	0.020	2.72	0.979
Male *S. melanotheron*	6	50 - 140	0.018	2.82	0.999
Female *S. melanotheron*	8	60 - 135	0.010	3.15	0.997
Male *T. guineensis*	61	48 - 150	0.018	2.83	0.991
Female *T. guineensis*	70	47 - 135	0.016	2.89	0.987
Male *T. zillii*	1				
Female *T. zillii*	14	48 – 90	0.016	2.87	0.99

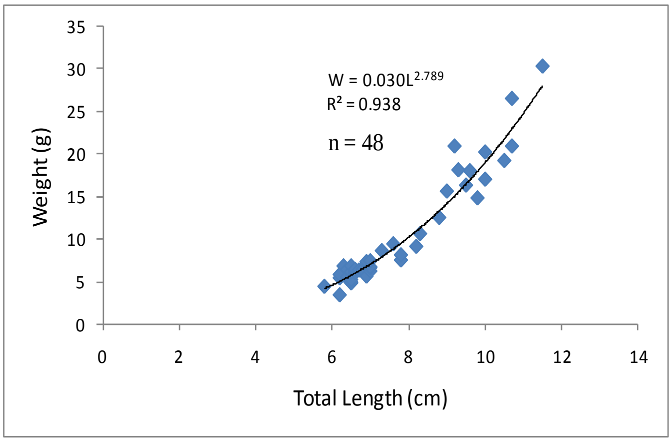

Fig 6a: Length-weight relationship for combined sexes of H. *bimaculatus* from Weija Reservoir

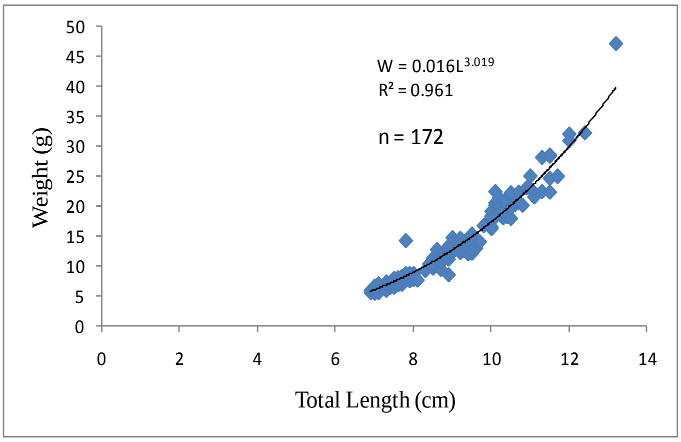

Fig 6b: Length-weight relationship for combined sexes of *H. fasciatus* from Weija Reservoir

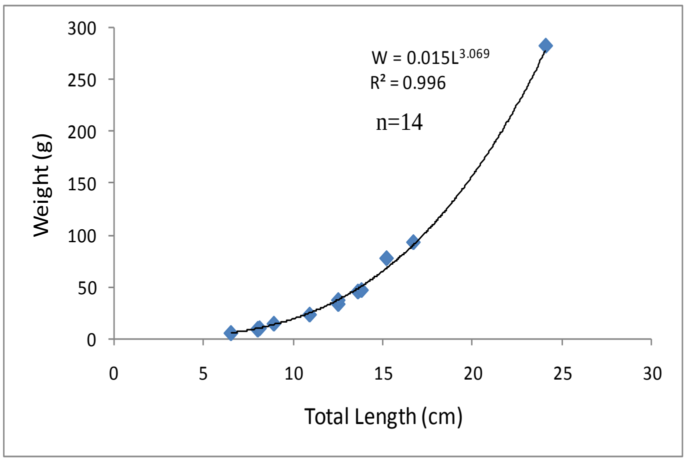

Fig 6c: Length-weight relationship for combined sexes of O. *niloticus* from Weija Reservoir

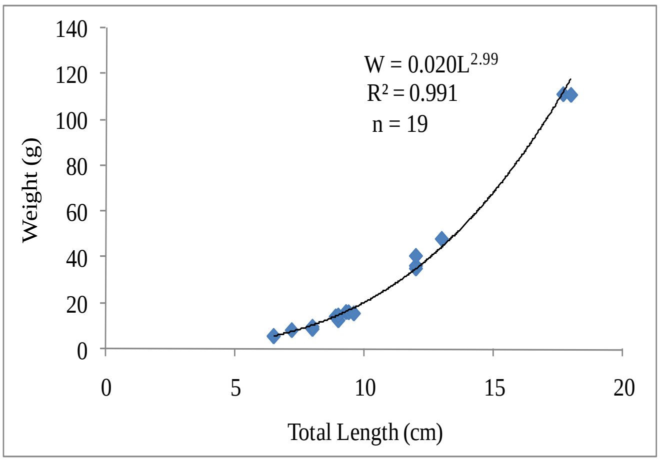

Fig 6d: Length-weight relationship for combined sexes of *S. melanotheron* from Weija Reservoir

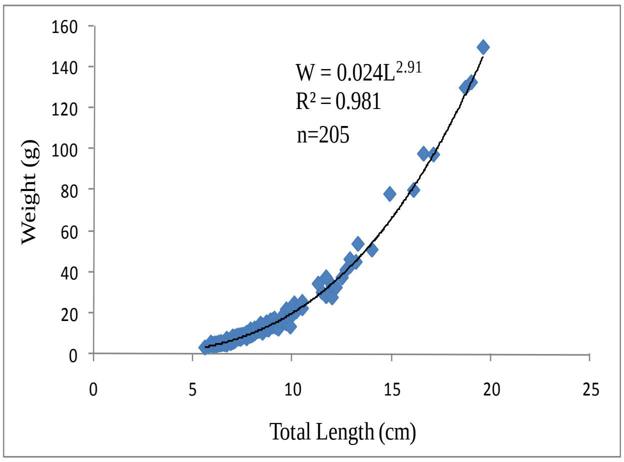

Fig 6e: Length-weight relationship for combined sexes of *T. guineensis* from Weija Reservoir

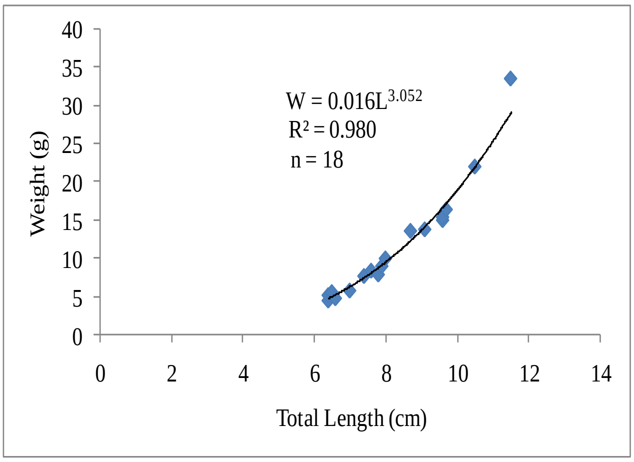

Fig 6f: Length-weight relationship for combined sexes of T. *zillii* from Weija Reservoir

Condition factor

The condition factor for males ranged from 1.704±0.14934 for *T. zillii* to 2.1025±0.1405 for *S. melanotheron*. For females, the condition factor ranged from 1.58794±0.14384 for *O. niloticus* to 2.1175±0.20849 for *T. guineensis* (Table 3). For three species namely *O. niloticus*, *S. melanotheron* and *T. guineensis* males had higher condition factor values than the mixed population while for *H. bimaculatus*, *H. fasciatus*, *S. melanotheron*, *T. guineensis* and *T. zillii* females had higher condition factor values than the mixed population. For *O. niloticus* and *S. melanotheron*, males had better condition factor values than females while for *H. bimaculatus*, *H. fasciatus*, *T. guineensis* and *T. zillii* females had better condition factor than males. In two species namely *S. melanotheron* and *T. guineensis* both males and females separately had better condition factor values than the mixed population.

Table 3: Condition Factor of Six Cichlid Species from Weija Reservoir

Species	Pooled	Male	Female
H. bimaculatus	2.0508±0.2781	1.9921±0.1666	2.10453±0.29246
H. fasciatus	1.7365±0.1717	1.7062±0.2366	1.77699±0.14878
O. niloticus	1.7798±0.2251	1.8683±0.1123	1.5879±0.14384
S. melanotheron	1.5713±0.1714	2.1025±0.1405	1.83937±0.10517
T. guineensis	2.08844±0.2101	2.0925±0.184	2.1175±0.20843
T. zillii	2.0072±0.2335	1.7044	2.04154±0.24024

Sex ratio

There were significantly more females than males for every species. The least monthly sex ratio of 1:1.2 was recorded for *O. niloticus* and the highest of 1:14 for *T. zillii*. Differences in monthly sex ratio were variable in significance for each species except *O. niloticus* and *T. zillii* where monthly differences were not significant. Again with the exception of *O. niloticus*, each species showed significant differences in sex ratio when pooled together.

Table 4a: Monthly sex ratio for *Hemichromis bimaculatus* from Weija Reservoir n=39

Month	Males	Females	Total	Ratio	χ^2 Calc.	χ^2 Critical	Remarks
March							
April		1	1	0.5	0.625		NS
May	1	2	3	1.5	0.625		NS
June	1	2	3	1.5	0.625		NS
July	1	6	7	3.5	39.0625		S
August	2	7	9	4.5	39.0625		S
September		6	6	3	81		S
October		1	1	0.5	0.625		NS
November	1	4	5	2.5	5.0625		NS
December	3	1	4	2	1		NS
Total	9	30	39	19.5	165.4375	15.51	S

NS = Not Significant S = Significant

Table 4b: Monthly sex ratio for *Hemichromis fasciatus* from Weija Reservoir n= 119

Month	Males	Females	Total	Ratio	χ^2 Calc.	χ^2 Critical	Remarks
March		6	6	3.0	81		S
April	9	2	11	5.5	150.063		S
May	3	10	13	6.5	150.063		S
June	4	8	12	6.0	16		S
July	6	8	14	7.0	1		NS
August							
September							
October	3	15	18	9.0	1296		S
November	8	11	19	9.5	5.0625		NS
December	12	14	26	13.0	1		NS
Total	45	74	119	59.5	1700.19	14.07	S

NS = Not Significant S = Significant

Table 4c: Monthly sex ratio for *Oreochromis niloticus* from Weija Reservoir n= 11

Month	Males	Females	Total	Ratio	χ^2 Calc.	χ^2 Critical	Remarks
March							
April	2	1	3	1.5	0.0625		NS
May							
June	1		1	0.5	0.0625		NS
July		1	1	0.5	0.0625		NS
August		1	1	0.5	0.0625		NS
September		2	2	1.0	1		NS
October	1	1	2	1.0	0.0625		NS
November	1		1	0.5	0.0625		NS
December							
Total	5	6	11	5.5	1.3125	12.59	NS

NS = Not Significant

Table 4d: Monthly sex ratio for *Sarotherodon melanotheron* from Weija Reservoir n=14

Month	**Males**	**Females**	**Total**	**Ratio**	**χ^2 Calc.**	**χ^2 Critical**	**Remarks**
March							
April	1	1	2	1.0	0		NS
May	1	2	3	1.5	0.0625		NS
June							
July							
August	1		1	0.5	0.0625		NS
September							
October		4	4	2	16		S
November		1	1	0.5	0.0625		NS
December	3		3	1.5	5.0625		NS
Total	6	8	14	7.0	21.25	9.49	S

NS = Not Significant S = Significant

Table 4e: Monthly sex ratio for *Tilapia guineensis* from Weija Reservoir n=131

Month	Males	Females	Total	Ratio	χ^2 Calc.	χ^2 Critical	Remarks
March	2	4	6	3	1		NS
April	23	13	36	18	625		S
May	9	10	19	9.5	0.0625		NS
June	3	5	8	4	1		NS
July	4	6	10	5	1		NS
August	8	12	20	10	16		NS
September	1	5	6	3	16		NS
October	1	5	6	3	150.063		S
November	2	3	5	2.5	0.0635		NS
December	6	2	8	4	16		NS
Total	61	70	131	65.5	826.188	16.92	S

NS = Not Significant S = Significant

Table 4f: Monthly sex ratio for *Tilapia zillii* from Weija Reservoir n=15

Month	Males	Females	Total	Ratio	χ^2 Calc.	χ^2 Critical	Remarks
March		3	3	1.5	5.0625		NS
April	1	4	5	2.5	5.0625		NS
May		3	3	1.5	5.0625		NS
June		1	1	0.5	0.0625		NS
July		1	1	0.5	0.0625		NS
August							NS
September							
October							
November							
December		1	1	0.5	0.0625		NS
Total	1	14	15	7.5	15.4375	12.59	S

NS = Not Significant S = Significant

Discussion

Relative abundance

The composition of the Cichlidae family in Weija Reservoir is similar to that of Kpong Headpond where eight Cichlid species belonging to four genera were reported by Quarcoopome *et al.* (2011) [34] and to Lake Ayame I where seven Cichlid species were reported by Gourene *et al*. (1999) [18]. *S. melanotheron* was, however, present in Weija Reservoir but not in Kpong Headpond while *C. guntheri* and *S. irvinei* were not reported in Weija Reservoir but were recorded in Kpong Headpond. The relative abundance of Cichlids from Weija Reservoir indicates that two genera and two species are important and together account for 93.06% and 83.27% of number and weight respectively. For species, *T. guineensis* was the most important (42.95% of number and 43.42% of weight) followed by *H. fasciatus* (38.11% of number and 32.59% of weight). The remaining species altogether constituted 23.99% of weight and 18.95% of number. With respect to genera, the most important were Tilapia (46.74% of number and 46.25% of weight) and Hemichromis (46.32% and 37.02% of number and weight respectively). The least abundant species in terms of number were *S. galileus, O. niloticus, S. melanotheron* and *T. zillii.* In terms of weight, *S. galileus, T. zillii, H. bimaculatus* and *S. melanotheron* were the least important.

O. niloticus and *S. melanotheron* exhibited preferable size characteristics namely highest mean standard length and weight, and when managed properly are capable of growing to large sizes which are the preferred commercial sizes.

Length-weight relationship

Tilapias are plastic animals because their growth and maximum obtainable size can be seriously influenced by the physical and biological composition of their environment (Olurin & Aderigbe, 2006) [30]. Fish can exhibit different growth patterns namely isometric growth (b=3), negative allometric growth (*b*<3) and positive allometric growth (b>3).

Male *H. fasciatus* exhibits isometric growth (b=3) where there is no change in body shape with increase in length. Male *O. niloticus* and female *S. melanotheron* show positive allometric growth (*b*>3) where fishes become fatter with increase in length indicative of good environmental factors such as dissolved oxygen, optimum temperature, availability and/or abundance of food. The remaining species and sexes showed negative allometric growth (*b*<3) where fishes become slender with increase in length indicative of not too good environmental factors. The correlation coefficient ‘r’ values indicate strong relationships between length and weight for combined sexes, males and females. Males generally had stronger relationship between length and weight than females as indicated by higher correlation values for males.

For combined sexes, *H. fasciatus*, *O. niloticus* and *T. zillii* showed positive allometric growth pattern (*b*>3) while *H. bimaculatus*, *S. melanotheron* and *T. guineensis* showed negative allometric growth pattern (*b*<3). Positive allometric growth pattern reported for *H. fasciatus* by Entsua-Mensah *et al.* (1995) [14] is similar to findings in this study while isometric growth pattern for *H. bimaculatus* and *S. galileus*. Offem *et al.* (2009) [29] identified *O. niloticus*, *T. guineensis*, *T. zillii* and *S. galileus* as exhibiting negative allometric growth patterns for combined sexes in Cross River Inland Wetland in Nigeria. Differences in growth patterns exhibited by the different species in different environments could be due to differences in sample sizes, seasons and related environmental factors such as food availability and optimum temperatures. Entsua-Mensah *et al.* (1995) [14] reported positive allometric growth patterns for combined sexes of Cichlids from the tributaries of the Volta River in the Brong Ahafo and Northern Regions namely *H. bimaculatus, H. fasciatus, S. galileus, T. zillii* with b values ranging between 3.02 and 3.20.

Condition factor

When condition factor values are higher it means that fishes have attained a better condition and are better adapted to the environment. Four species namely *H. bimaculatus*, *H. fasciatus*, *T. guineensis* and *T. zillii* recorded higher condition factor values for females than males and combined sexes indicating that females were in better condition and were better adapted to the Weija Reservoir environment than the males. On the other hand, for two species namely *O. niloticus* and *S. melanotheron* the males as well as the combined sexes had higher condition factor values indicating that the males were in better condition than the females and were also better suited to the environment. These observations on condition factors have been influenced by a number of factors including sex, sexual activity, environmental stress, and season among others. Anene (2005) [3] reported that male, female and combined sexes of *T. zillii* from freshwater had condition factor of 4.29, 4.31 and 4.30 respectively while the dry and wet season values were 4.21 and 4.37 respectively indicating better condition in the wet season. Imam *et al*. (2010) [20] recorded a range of 2.63 to 3.4 for *T. zillii* in the wet and dry season whereas Mahomoud *et al.* (2011) [25] reported for the same species mean condition factor values for TL between 8 and 21 for male and 7 to 16 for female ranging from 1.6603 to 2.0190 and 1.6354 to 2.1340 for males and females respectively.

Sex ratio

A total of 127 males and 200 females of Cichlids was recorded to give a ratio of 1 male to 1.59 female. This was significantly different from the expected 1:1 ratio ($p<0.05$). There were, however, no significant differences in temporal variation in sex ratio for *O. niloticus* and *T. zillii*. Though growth rate was not assessed in this study, the report by Vincentini & Araujo (2003) [42] suggest that significantly more females could be due to faster growth for females than males as well as abundant food availability which favours females.

Conclusion

The Weija Cichlid community was dominated by two genera namely Tilapia and Hemichromis which together accounted for over 90% and over 80% of number and weight respectively. Two species namely *H. fasciatus*, which constituted almost half of total number and *T. guineensis* constituting over one-third of total weight are the most important. *S. galileus* was the least important in terms of number and weight. With few exceptions, all species showed strong correlation between length and weight while males generally had stronger correlations than females. Estimated growth constant values were all within the range expected for tropical fishes. All species showed negative allometric growth pattern except male *H. fasciatus*, male *O. niloticus* and female *S. melanotheron*. Females were in better condition and therefore better adapted to the Weija environment than males for four species namely *H. bimaculatus*, *H. fasciatus*, *T. guineensis* and *T. zillii* while for *O. niloticus* and *S. melanotheron* males were in better condition than females indicating that the males were better suited to the environment than females. Monthly differences in sex ratio were variable for all species at 95% confidence interval except for *O. niloticus*. The differences in sex ratio for all species were significant except for *O. niloticus* which was not significant at 95% confidence interval. Though *S. melanotheron* and *O. niloticus* exhibited preferable size and weight characteristics, they were found in limited abundance.

Recommendation

Regular monitoring of the Cichlidae family is recommended as a means of identifying changes in the biological and related characteristics of the species so as to put in place intervention mechanisms. *S. melanotheron* and *O. niloticus* require management intervention to increase their relative abundance in view of their preferable length and weight characteristics..

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