Length-weight relationship, condition factor, morphometric and meristic characteristics of *Ctenopoma kingsleyae* from Esa-Odo Reservoir, Nigeria.

Ekundare Olugbemi Victora[1] and Fagbuaro Omotayo[2]

[1]Department of Biological Sciences, Faculty of Sciences, University of Ilesa, Ilesa, Osun State, Nigeria.
[2]Department of Zoology and Environmental Biology, P.M.B. 5363, Faculty of Science, Ekiti State University, Ado-Ekiti, Ekiti State, Nigeria.

*Corresponding author: aquatres2010@gmail.com

https://orcid.org/0000-0001-8773-8910

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Abstract Anabantid, *Ctenopoma kingsleyae* is a commercially important fish being captured as a food and aquarium fish. Limited literature is available on the biology of the fish. Therefore, this study investigated the length-weight relationship, condition factor, morphometric and meristic characteristics of *C. kingsleyae* from Esa-Odo water Reservoir, Nigeria. Fish collected (n = 90) from fishermen were subjected to morphometric measurements to the nearest length (0.1cm) and weight (0.1g) and meristic counts were recorded in the laboratory. Results revealed the fin formula of *C. kingsleyae* was D_1xvii, D_2 9-11, A_1 ix, A_2 10-11, P 11-13, vi/5, TLr 25-27. The b value for males, females and combined sexes were 10.014, 12.7 and 12.81 respectively, indicating positive allometric growth for all the samples. The mean condition factors, 1.95±0.02, 2.03±0.02 and 2.00±0.01 were recorded for males, females and combined sexes respectively, implying that the fish are in good health condition. The correlation coefficient (R) of 0.8925, 0.9175 and 0.9507 were recorded for males, females and combined sexes respectively, revealing a positive relationship between the weight and total length of the fish. Positive correlations were observed between the total length and each of the other morphological characteristics of the fish ($p \leq 0.05$). Data generated from this study can form baseline information for the conservation, production and management of *C. kingsleyae* reservoirs in Nigeria.

Keywords: Allometric growth, Correlation Coefficient, *Ctenopoma kingsleyae*, Length-weight relationship

Introduction

Ctenopoma kingsleyae belonging to the Family Anabantidae has a relatively wide distribution in Africa. They are found in the basin Niger, Senegal and Volta. *C. kingsleyae* has also shown a wide distribution in Democratic Republic of Congo and some parts of Lower Guinea (Norris, 2003). Records have shown that it is available in the waters of Mauritania and Gambia (Dankwa et al., 2020). The species has a wide distribution but has not been threatened and it is listed as the least concerned (Dankwa et al., 2020). *C. kingsleyae* are benthopelagic species that thrive well at a pH range of 6.0 to 8.0 (Norris, 2003). It has an accessory breathing organ which helps in its survival in poorly oxygenated water (Dankwa et al., 2020). There are four genera of Anabantids, they are *Ctenopoma* and *Microctenopoma* found throughout sub–Saharian Africa, *Anabas* widely distributed in tropical Asia and *Sandelia* found in the Southern African regions (Norris et al., 1988; Norris and Douglas, 1991; Norris, 1995).

Members of the genus been extensively described morphologically having previously grouped the genus into *C. congicum*, *C. multispine* and *C. petherici* based on morphological and life history characteristics (Norris and Teugels, 1990; Norris and Douglas, 1991, 1992; Norris, 1992) but *C. kingsleyae* morphology remain undescribed.
Length-weight relationships of fish estimate fish growth rate by establishing a mathematical relationship between relative average weight and length and providing information on well-being of fish populations. The length-weight relationship is applicable in fish stock assessment, estimation of standing stock biomass and comparison of ontogeny of fish populations (Ayoade and Ikulala, 2007). *C. kingsleyae* is commercially important as aquarium fish and is being fished for food in different regions, an activity that can subsequently

result in overfishing (Dankwa et al., 2020). Dankwa et al., (2020) reported that there is no record of program with respect to its conservation and more research is needed in the biology of the species. In view of this short coming, this study embarked on the study of its length-weight relationship, morphology and meristic characteristics which are baseline information needed for conservation and its biology.

Materials and Methods

Fish Collection

Samples of male (Figure 1) and female (Figure 2) *C. kingsleyae* were collected from fishermen from Esa-Odo Reservoir, Osun State, Nigeria. A total of 90 fish specimens captured with a local trap (made of raffia palm) were collected and brought to the laboratory of the Department Biological Sciences, Faculty of Science, University of Ilesa, Ilesa, Nigeria where they were identified following the method described by Norris (2003).

Figure 1: Male *C. kingsleyae* from Esa-Odo Water Reservoir, Esa-Odo, Osun State, Nigeria.

Figure 2: Female *C. kingsleyae* from Esa-Odo Water Reservoir, Esa-Odo, Osun State, Nigeria.

Measurements of various morphological parameters were taken using a transparent ruler and measuring board to the nearest 0.1cm. Body weights were measured to the nearest 0.1g using an electronic digital weighing scale (ATOM) model number ATOM-A110C-Blue-600gm. The measurements of thirteen different morphological parameters were recorded (Table 1). Countable characteristics such as the number of spines, fin rays, scales above and below lateral lines and number of scales on lateral lines were recorded in a tabular form. The lateral line of *C. kingsleyae* is broken into two lines and as such, this study considered the anterior one as upper and the posterior one as lower lateral line. Fish were dissected and gonads were examined for sex determination.

The Condition Factor and the Length-weight relationships (LWR) of the fish (male, female and combined sexes) were estimated using the equation $W=aL^b$ where W=weight (g), L= total length (cm), a = regression constant or intercept, b= regression coefficient or slope. Logarithmic transformation was used to linearise the equation. Log W= log a + b log L was computed using Microsoft Excel to calculate "a" and "b" values. Means of total length and weight were used to calculate the condition factor $K=100W/L^3$ (males, females and combined sexes) where K= condition factor, W= mean body weight (g) and L= mean total length (cm) Pauly (1983). The relationships between total length and weight of fish (male, female and combined sexes) were evaluated using Microsoft Excel 2013.

Results

Morphometric and meristic characteristics of *C. kingsleyae* are presented in Table 1 and Table 2 respectively. Table 3 shows the range, mean and standard error of total length and weight of *C. kingsleyae* (males, females and combined sexes). Table 4 shows a, constant; b, slope; R^2, correlation coefficient; determination coefficient; R, growth and K; condition factor of male, female and combined sexes *C. kingsleyae*. The b value for male, female and combined sexes are 10.01, 12.7 and 12.81 respectively, they all showed positive allometric growth. The length-weight relationships of male, female and combined sexes showed significant relationships 0.89, 0.92 and 0.95 respectively. Table 5 represents the mean, standard error, R^2 correlation coefficient and regression equation between different morphometric characters of *Ctenopoma kingsleyae* and its total length.

Table 1: Morphometric characteristics of *C. kingsleyae* from Esa-Odo Water Reservoir, Esa-Odo, Osun State, Nigeria

No	Characteristics	Female Mean ± SE (cm)	Male Mean ± SE (cm)	Combined sexes Mean ± SE (cm)
1	Weight	62.97±1.13	48.43±0.91	56.51±1.07
2	Total length	14.55±0.08	13.52±0.08	14.10±0.08
3	Standard length	12.24±0.07	11.30±0.07	11.82±0.07
4	Body depth	4.63±0.04	4.22±0.03	4.45±0.03
5	Eye diameter	0.86±0.01	0.84±0.01	0.85±0.01
6	Snout length	0.9±0.01	0.86±0.01	0.88±0.01
7	Pre-dorsal length	4.44±0.04	4.08±0.03	4.28±0.03
8	Height of pectoral fin	2.84±0.03	2.62±0.04	2.74±0.02
9	Height of ventral fin	2.06±0.01	1.94±0.04	2.01±0.02
10	Caudal peduncle length	1.92±0.01	1.77±0.02	1.85±0.01
11	Head length	3.75±0.02	3.47±0.03	3.63±0.02
12	Length of dorsal base fin	7.71±0.06	6.98±0.06	7.39±0.06
13	Length of anal base fin	5.01±0.04	4.72±0.04	4.88±0.03

Table 2: Meristic characteristics of *C. kingsleyae* from Esa-Odo Water Reservoir, Esa-Odo, Osun State, Nigeria

No	**Character**	**Number**
1	Dorsal spine	xvii
2	Anal spines	ix
3	Dorsal fin rays	9-11
4	Anal fin rays	10-11
5	Pectoral fin rays	11-13
6	Ventral fin rays	5
7	Ventral fin spines	i
8	Scales on the upper lateral line	16
9	Scales on the lower lateral line	9-11
10	Total scales of lateral line	25-27
11	Scales above lateral line	3
12	Scales below lateral line	8

Table 3: Total length and weight of male, female and combined sexes of *C. kingsleyae collected* from Esa-Odo water reservoir

	Total length (cm)				**Weight (g)**		
Sex	**N**	**Min**	**Max**	**Mean ±SE**	**Min**	**Max**	**Mean ±SE**
Males	40	12.4	14.6	13.52±0.08	35.0	59.2	48.43±0.91
Females	50	13.0	15.6	14.55±0.08	41.17	74.67	62.97±1.13
Combined sexes	90	12.4	15.6	14.10±0.08	35.0	74.67	56.51±1.07

Table 4: Sample size, length-weight relationship Condition factor of *C. kingsleyae* collected from Esa-Odo Water Reservoir

							K
Sex	**N**	**a**	**b**	**R^2**	**r**	**Growth**	**Mean ± SE**
Males	40	-87.0	10.01	0.80	0.89	Positive	1.95±0.02
Females	50	-121.82	12.70	0.84	0.92	Positive	2.03±0.02
Combined sexes	90	-124.05	12.81	0.90	0.95	Positive	2.00±0.01

Table 5: Relationship between the total length and other morphometric characteristics of *C. kingsleyae* of the combined sexes

No	**Morphometric characteristic**	**Mean ± SE (cm)**	**R^2**	**Correlation Coefficient R**	**Regression equation**
1	Weight	56.51±1.07	0.90	0.95	Y=12.81x-124.05
2	Standard length	11.82±0.07	0.90	0.95	Y=0.8456x-0.0953
3	Body depth	4.45±0.03	0.65	0.81	Y=0.3381x-0.3178
4	Eye diameter	0.85±0.01	0.26	0.51	Y=0.0339x+0.3738
5	Snout length	0.88±0.01	0.50	0.70	Y=0.0479x+0.2076
6	Pre-dorsal length	4.28±0.03	0.64	0.80	Y=0.3509x-0.6669
7	Height of pectoral fin	2.74±0.02	0.38	0.62	Y=0.1945x-0.002
8	Height of ventral fin	2.01±0.02	0.40	0.63	Y=0.1454x-0.0413
9	Caudal peduncle length	1.85±0.01	0.62	0.79	Y=0.1347x-0.047
10	Head length	3.63±0.02	0.79	0.89	Y=0.2576x-0.0048
11	Length of dorsal base fin	7.39±0.06	0.72	0.85	Y=0.6157x-1.2932
12	Length of anal base fin	4.88±0.03	0.37	0.61	Y=0.2419x+1.4742

Discussion

The fin formula for *C. kingsleyae* in this study, is D_1xvii, D_2 9-11, A_1 ix, A_2 10-11, P 11-13, vi/5, TLr 25-27. This is different from the fin formula recorded for *Anabas testudineus* fish that belongs to the same family Anabantidae. Local (D_1 xv-xvii, D_2 7-9, A_1 ix-xi, A_2 10, P 13-16, vi/5, TLr 26-35) and Thai (D_1 xvii-xix, D_2 9-10, A_1 x-xi, A_2 9-10, P 13-15, vi/5, TLr 26-35) *A. testudineus* had different fin formula showing variations even within a species in anabantid fishes. The fin formula recorded in this study can contribute to taxonomic identification of *C. kingsleyae*. The morphological characters length-weight relationship in combined sexes *C. kingsleyae* in this study revealed coefficient of determination R^2= 0.90 which implies that a strong positive relationship exists between the weight and length. The results showed that as the weight of fish increases, the length increases. This agrees with Obasohan et al. (2012). Some of the morphometric character studies showed strong positive relationship with the total length: standard length (r^2=0.90), head length (r^2=0.79) and length of dorsal fin (r^2=0.72), poorly strong relationship: body depth (r^2=0.65), pre-dorsal length (r^2=0.64), caudal peduncle (r^2=0.62) and snout length (r^2=0.50) and weak relationship: length of anal base fin (r^2=0.37), height of ventral fin (r^2=0.4003), height of pectoral fin (r^2=0.38) and eye diameter (r^2=0.25). The weak relationship observed in length-eye diameter (r^2=0.26) might be due to slow growth change in the eye, this was reported by Hossain and Sultana (2014), they reported in Bele, (*Glossogobius giuris*) from Mithamoin haor least change in growth change in the eye as against the fish size. The poor total length-fin length relationship (length of anal base fin r^2=0.37), the height of ventral fin (r^2=0.40), the height of pectoral fin (r^2=0.38)) recorded in this study could be due to mechanical damage that fin ends are subjected to due to motility.

The length-weight relationship of combined sexes *C. kingsleyae* from Esa-Odo reservoir showed a b value= 12.81, which is a positive allometric growth, when the b value is greater than 3, the fish has positive allometric growth but when it is lesser than 3 allometric growth is negative (Ndome et al., 2012). Maurya et al., (2020) reported in another Anabantids an isometric growth b= 2.99 in *Anabas testudineus* in Rudrasagar Lake. They reported the combine effects of factors such as variation in seasons, sex of fish, state of fish health, feeding strength, gonadal maturation and river habitat might be reasons for differences in b value. The report of this study is contrary to what was studied by Ahmadi (2019) they reported another *A. testudineus* from Sungai Batang River, Indonesia grew negatively allometric (b<3). The condition factor K=2.00 was recorded in this study indicating that the fish population has good overall health status, physiological state and productivity (Richter, 2007). Bagenal and Tesch (1978) reported that when condition factor of fish is greater or equal to 1, it means the fish population is in good condition. There is a varied condition factor among members of Anabantid: *A. testudineus*, Kumary and Raj (2016) reported from Kuttanad of Kerala, India, K= 2.06 and 2.07 from Kausalyaganga of Orissa, India (Kumar et al., 2013). Olanrewaju et al., (2016) stated that environmental factors in the water body have significant role in determining physiological condition of the fish population thereby influencing the condition factor.

Conclusion

This study has described the fin formula of *C. kingsleyae* D_1xvii, D_2 9-11, A_1 ix, A_2 10-11, P 11-13, vi/5, TLr 25-27, length-weight relationship in combined sexes R^2= 0.90 showed strong positive relationship and b value= 12.81 indicating a positive allometric growth. These results can be useful as baseline information for the conservation, production and management of *C. kingsleyae* reservoirs in Nigeria.

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Conflict of interest

The authors declare that there are no conflicts of interest.

Author contributions

Conception of the study: Ekundare Olugbemi Victor. Design of the study: Ekundare, Olugbemi

Victor and Fagbuaro, Omotayo. Collection of experimental sample: Ekundare, Olugbemi Victor Acquisition of data and data analysis: Ekundare, Olugbemi Victor. Laboratory work: Ekundare, Olugbemi Victor. Drafting and critical revision of the article: Ekundare, Olugbemi Victor. Final approval of the version to publish: Ekundare, Olugbemi Victor

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