E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 76.37
(GIF) Impact Factor: 0.549
IJFAS 2023; 11(5): 99-105

www.fisheriesjournal.com
Received: 05-06-2023
Accepted: 06-07-2023

Jibrin B
Department of Agricultural Technology, Federal Polytechnic, P.M.B 05 Bali, Taraba State, Nigeria

Shu'aibu N
Army Barrack Road, Old Teachers' Quarters Nyibango, House No. 11, Jimeta North Yola, Adamawa State, Nigeria

Corresponding Author:
Jibrin B
Department of Agricultural Technology, Federal Polytechnic, P.M.B 05 Bali, Taraba State, Nigeria

Assessments of some morphometric parameters of *Mormyrus rume* (Valenciennes, 1846) from Lake Geriyo, Adamawa, Nigeria

Jibrin B and Shu'aibu N

DOI: https://doi.org/10.22271/fish.2023.v11.i5b.2854

Abstract
The length-weight relationship (LWRs), length-length relationship (LLRs), length-fork relationship (LFRs) and condition factors of elephant snout fish (*Mormyrus rume*) from Lake Geriyo was studied from October, 2022 to March, 2023. A total of one hundred and thirty four (134) samples of fish species were sampled monthly from artisanal fishers' catches at exactly 6:00am at the lake's landing site. The specimens comprises of 69 and 65 male and female respectively. The major fishing methods employed by fisher folks for collecting the specimens were cast netting and set netting. The results from this study indicated a negative allometric growth pattern for LWRs, LLRs and LFRs with highest exponent, b value of 1.157 for the females, and 1.090 in LLRs and 0.965 in LFRs all for the males. All LWRs, LLRs and LFRs were significant ($p< 0.05$) with most R^2 values > 0.8 whereas the mean condition factor, K, for all sexes was ranged from 0.75 to 0.88 which indicated that the fish species exhibited compromised well-being within the examined lake. Therefore, this present research was crucial in addressing the information void and supplying data for the effective management and conservation of the studied species within the lake system and also suggested the need for additional investigation to compare the periods of the year characterized by wet and dry seasons.

Keywords: Allometric, condition, factor, *Mormyrus rume*, length, weight, fork

1. Introduction
Mormyrus rume, commonly called the Elephant snout fish, can be found extensively in inland tropical waters, with a notable presence in several African countries, including Niger River basin, Congo River basin, and Lake Tanganyika among others (Bawaa *et al*., 2019; Danba *et al*., 2020) [14, 17]. Researchers have reported it abundance in inland waters of Nigeria (Adeosun *et al*., 2011; Ataguba *et al*., 2014; Bake *et al*., 2016; Bawaa *et al*. 2019 and Danba *et al*., 2020) [5, 11, 12, 14, 17]. In addition, Abubakar *et al*., (2020) [4] documented that out of all the species studied, the family mormyridae had the highest number of species in Balanga Dam, Gombe State, Nigeria.
Mormyrus rume is a genus of fish in the Mormyridae family and is by far the largest family in the order of Osteoglossiformes with around 200 species. Morphologically, *Mormyrus rume* exhibits several notable characteristics. According to Alhassan *et al*., (2014) [7], Elephant snout fish can grows to lengths of approximately 1.5 meters and also demonstrates successful adaptation in natural water bodies, making it a promising candidate for aquaculture purposes. In addition, is a fish species that is active during the night and typically found near the bottom of the water column that sustains its diet by consuming invertebrates, detritus, and plant fragments, documented by Omotosho (1993) [35]. According to Kayode *et al*., (2019) [24] Mormyrid fishes have been identified as having considerable commercial and economic significance in the artisanal fisheries of the Niger River in Benin. They are found in fast moving (lotic) freshwaters of tropical Africa (Fletcher and Crawford, 2001) [20] while Fawole (2002) [19]; Lauren and Jason (2021) [26]; and Samuel *et al*., (2022) [42] reported they are typically found in shallow, slow moving (lentic) water habitats and are spawn more or less throughout the year reported by Scott (1974) [43] and confirmed by Fawole (2002) [19]. Notwithstanding, Stephen and Folashade (2020) [49] documented that among other fish species,

Mormyrus rume is the most exploited one in Ikere-Gorge, Iseyin Oyo State. Typically, organisms tend to grow in both length and weight as they progress through their development stages. Understanding the correlation between the size and weight of commercially caught fish is crucial for evaluating and controlling fish populations and is considered a valuable resource in fisheries management (Abdullahi *et al.,* 2016) [2]. The successful management of capture and culture fishery requires the use of biometric data in the field and convert them into appropriate indicators (Leonard *et al.,* 2012) [30]. The length-weight relationship is a widely accepted approach that provides reliable biological data and holds significant significance in evaluating fishery assessments. (Somyi 2017) [47] reported that the length weight relationship has constitutes a mathematical connection between the two variables, length and weight, aiding in the assessment of variations in weight from the anticipated values for specified length categories. Also, according to Nazek *et al.,* (2018) [32], the significance of length-weight relationships (LWRs) and relative condition factor in fishery assessment studies lies in their ability to offer insights into the growth patterns of fish, their overall health, and adaptation in a marine environment. The Condition factor provides information about the physical state of the animal in the environment (Leandro and Francisco, 2005) [29]. Moreover, in the field of Fisheries, the condition factor is employed to evaluate and compare the overall well-being, fatness, "condition" of fish (Seher and Suleyman, 2012) [44]. This measurement is founded on the assumption that fish of the same length but with greater weight are in better physiological health (Seher and Suleyman, 2012; Andem *et al.,* 2013; Shahnawaz *et al.,* 2014; Wally *et al.,* 2015; and Balai *et al.,* 2017) [44, 8, 45, 52, 13]. Additionally, the condition factor serves as a valuable indicator for monitoring factors such as feeding intensity, age, and growth rates in fish and also, the status of the aquatic ecosystem in which fish reside can be evaluated by using it as a gauge, as it is significantly affected by both the living (Biotic) and non-living (abiotic) environmental factors (Seher and Suleyman 2012) [44]. Condition factor decrease with increase length and decreases as the fish increases in size (Wally *et al.*, 2015; Elsayed and Ahmed 2020) [52, 18].

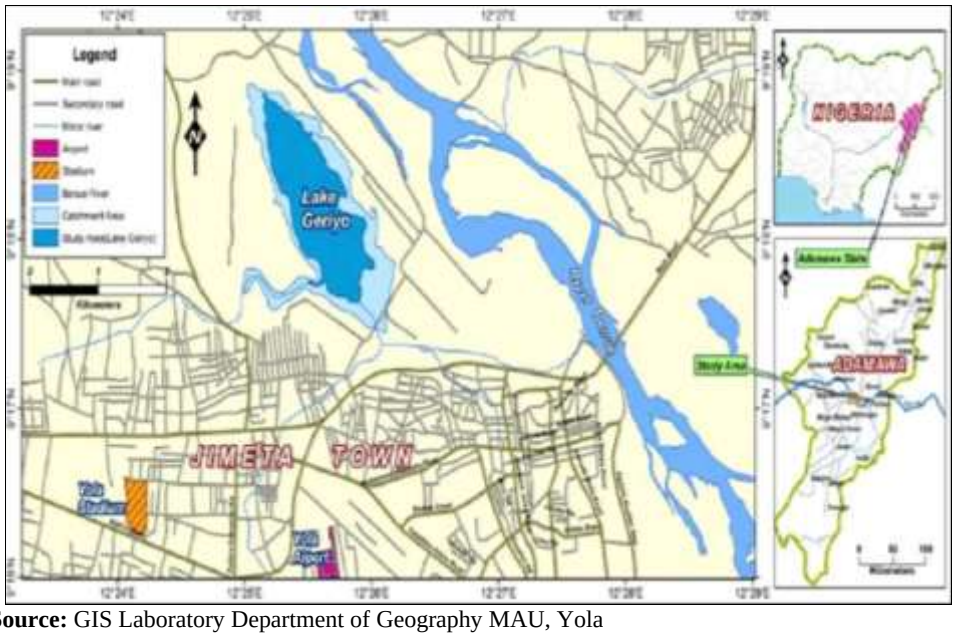
Knowledge of the morphometric parameters of fishes is essential in order to obtain a maximum fish yield using the minimum effort without depleting adversely the stock. This will also provide some basis for comparative study and for the proper management of fishes in culture for maximum yield (Onimisi and Shittu, 2015) [36]. According to the report of Fawole (2002) [19], there is dearth of information regarding the biological aspects of Mormyrid fishes in Nigeria. In this research work, some aspects of the fish biology such as length-weight relationships, length-length relationships, length-fork relationships and condition factor of *M. rume* from Lake Geriyo were investigated hence no work has been conducted on morphometric of this fish species in the Lake, thus required more study. The aim of this research was to offer data that can be utilized as additional inputs for the future management and conservation of this fish species in the Lake.

Materials and Methods

Study Area

The study was conducted in Lake Geriyo, Yola North Local Government Area of Adamawa State. Lake Geriyo is positioned at coordinates 09º 18' 11"N and 12º 25' 36"E (Figure 1) and occupies natural depression close to the upper Benue River in the north-eastern part of Nigeria (UBRBDA, 1985) [51].

Based on the information provided by the leader of the local fisher folk, Lake Geriyo was naturally formed when the River Benue became blocked due to significant silt accumulation approximately 60 years ago. This blockage created a small gully, which eventually filled with water from rainfall and the flooding of the River Benue. The Lake is relatively shallow, with an average depth of around 2 meters. During the rainy season from May to September, the River Benue causes the lake to become flooded. The aquatic vegetation in the Lake consists of various types of floating weeds, including water hyacinth, typha grass, water lilies, and wild guinea corn. These plants tend to drift across the surface of the Lake due to prevailing winds. The primary commercially important fish species in the Lake are Clarias and Tilapia (UBRBDA, 1985) [51] as cited by Shinggu *et al.* (2015) [45].



Source: GIS Laboratory Department of Geography MAU, Yola

Fig 1: Map of Study Area

Sample collection
A total of one hundred and thirty four (134) samples (Image 1) were collected from artisanal fisher folk at Lake Geriyo's landing site at exactly 6:00am. Sampling was carried out monthly from the period of October, 2022 to March, 2023. The specimens were identified using the identification keys provided by Olaosebikan and Raji (2013) [34]. The samples were stored in cooler containing ice and transported to the laboratory for further analysis. The major fishing gears employed were cast net and set net.

Image 1: Specimen *(M. rume)*

Sample Sex determination
The structural differences in sexual characteristics of *Mormyrus rume* were determined by studying the external and internal reproductive organs. The females of the species were larger than males and had a pinkish to greyish colour whereas males exhibited a silvery, translucent to whitish colour. In mature individuals, the presence of eggs in female was clearly observed within their ovaries, while males exhibited typically smooth, whitish testes located along the dorsal surface of the body. The sexual organs of immature specimen were observed as elongated, slender structures positioned along the dorsal surface of the body cavity. However, the male shows a ventral body wall that had a concave formation directed towards the dorsal side, involving the dorsal edge of their anal fin. On the other hand, female shows a relatively straight dorsal margin, contrasting with the male's characteristics as described by Peter *et al.,* (2004) [39].

Morphometric Measurements
The specimen's total length was determined by placing it on a measuring board with its right side down and its head pointing to the left. The measuring board had a wooden base with a central scale and a headpiece (Nose block) against which the specimen's snout was lightly pressed. The specimen's body and tail were aligned in a straight line along the centre, and the measurement was read to the nearest 0.1cm from the scale. Thus, parameters measured were:

- **The total length (TL):** The length from the position of mandibular symphysis (tip of the lower jaw) to the tips of the longest caudal fin rays,
- **The fork length (FL):** The length from the position of the mandibular symphysis to the cartilaginous tip of the shortest, or median, caudal fin rays (fork of tail), while
- **The standard length (SL):** The length from the position of the mandibular symphysis to the tip of the hypural bone (uro style/keel or fleshy peduncle/last vertebrate).

However, each specimen was weighed separately in grams (g). The excess water on the fish was eliminated by draining it with a paper towel. Then, the specimen was placed on the Digital Electronic Weighing Balance (Adam AFP 4100L), and its weight was recorded to the nearest 0.1g.

Length-weight relationships
The association between length and weight was established using the equation:

$W = {}_a L^b$ (Le-Cren, 1951; Pauly, 1983) [28, 39]

Where
"W" represents the weight of the specimen in grams (g)
"L" denotes the total length of the specimen in centimetres (cm)
"a" represents the coefficient associated with body form and
"b" represents the exponential expressing the relationship between length and weight.
Moreover, to estimate the parameters "a" and "b", the logarithm transformation of the equation was applied as:

$\text{Log } W = \log a + b \text{ Log } L$

(Wang *et al.,* 2012; Kahraman *et al.,* 2014) [13, 23].
Notwithstanding, total length (TL) and fork length (FL), fork length (FL) and standard length (SL), as well as standard length (SL) and total length (TL) relationship (LLRs) were determined by linear regression (Hossain *et al.,* 2006a) [22]. Also, the degree of association between them was estimated by computing the correlation coefficient (r^2) through the linear regression analysis:

$R = r^2$

Condition Factor
The condition factor (k) of each individual specimen was estimated by applying the formulae described by Worthington and Richardo (1930) [55]:

$K = (W\ 100/L^3)$

Where
K = condition factor,
W = weight of the fish in (g),
L = total length of fish in (cm)
This estimation was formed based on the relationship between the length and weight of the specimens, and the calculations was carried out for each month.

Data Analysis
The data on morphometric measurements were underwent a logarithmic transformation prior to linear regression analyses. Correlations among the morphometric parameters were computed. All of these analyses were performed at a significance level of 0.05 ($\alpha = 0.05$).

Results and Discussion
In Nigeria, there is limited knowledge on the biological aspect of Mormyrid species (Fawole, 2002) [19]. In this study, the results on morphometric characteristics of *Mormyrus rume* were grouped into three (3) according to the sex; male, female and combined sexes. The regression analyses showed the values of intercepts (a), slopes (b), coefficient of determinations (R^2) and condition factor as depicted in table 1. The b- values ranged from 0.233-1.157 and coefficient of determinations were all strong (R^2 >0.5) except for fork-length relationship in the female (0.061) that was weak but R^2

were all significantly different ($p<0.05$). The 'k' values for male, female and combined sexes were 0.75, 0.82 and 0.88 respectively. Whereas the results in table 2, indicated strong positive correlations among all the morphometric characteristics ranged from r = 0.826 - 0.961 with significant differences ($p< 0.05$).

Table 1: Relationships with total length and different body lengths of *Mormyrus rume* from Lake Geriyo between October, 2022 to March, 2023 (n=134)

Parameter	Sex	N	*a*	*b*	R^2	*K*
LWR	Male	69	0.554	0.858	0.858	0.75
	Female	65	0.289	1.157	0.826	0.82
	Pooled	134	0.439	0.999	0.831	0.88
LLR	Male	69	-0.220	1.090	0.847	
	Female	65	0.225	0.696	0.818	
	Pooled	134	0.049	0.839	0.805	
LFR	Male	69	-0.022	0.965	0.832	
	Female	65	0.924	0.233	0.061	
	Pooled	134	0.098	0.857	0.879	

N= number of species; *a*= intercept; *b*= slope; R^2 = coefficient of determination; *K*= condition factor.

Table 2: Correlation matrix of some morphometric parameters (pooled, male and female sexes) of *Mormyrus rume* from Lake Geriyo between October, 2022 to March, 2023 (n=134)

	TW	TL	SL	FL	SW
TW	1				
TL	0.950*	1			
SL	0.901*	0.862*	1		
FL	0.961*	0.949*	0.906*	1	
SW	0.941*	0.886*	0.826*	0.919*	1

TW= total weight; TL= total length; SL= standard length; FL= fork length; SW= stomach weight.

Length-weight Relationship (LWR)

In fisheries assessment, a relationship with total length and different body lengths provides useful information on the growth pattern of a particular stock in its environment. From this study, the regression coefficient of the length and weight relationship of *M. rume* indicates negative allometric growth pattern 'b'<3 (b= 0.858, 1.157 and 0.999) in both male and female fish, and the combined sexes respectively. This suggests that fish grow longer in length than in weight thus, indicating compromised well-being within the investigated lake. This result is in line with that of Ogunola *et al*. (2018) [33] that reported fish becomes slender (lighter) as its length increases. For LWRs, the female individuals exhibited significantly higher exponents (1.157) than the male specimens (0.858), and both displayed significantly smaller exponents than the cubic growth pattern. Similar ontogenic variations in the cubic law have been observed in other fish species (Froese, 2006) [21]. This elevated 'b' value of LWR of the female (1.157) agreed with the Ricker (1975) who stated that female Mormyrids usually grow in larger size than male. However, the increase in 'b' value of any individual cannot be due to a single factor but various factors (Abobi, 2015) [3]. The factors could be either intrinsic or extrinsic, or both and favoured by the changes of the growth parameters (length and weight) of the fish. Adeyemi *et al*. (2009) [6] observed that changes in fish growth are a prevalent occurrence in tropical and subtropical waters, primarily due to shifts in the environment, spawning patterns, and alterations in the composition of food resources.

Length-length relationship (LLRs) and length-fork relationship (LFRs)

The regression coefficient for LLRs and LFRs of different sexes of *M. rume* in this study has also suggested non-isometric growth pattern 'b'<3 (b= 1.090, 0.696, 0.839) and (b= 0.965, 0.233, 0.857). This result has corroborated that of Lawson and Jimoh (2010) [27] who reported a negative allometric growth pattern in *M. cephalus* from Lagos lagoon and Asuquo *et al.* (2015) [10] on the *M. cephalus* from Cross River estuary. However, whatever the species considered, the allometric coefficient (b) is less than 3, thus indicating a negative allometric growth trend. As a result, fish tend to experience greater increases in length compared to their weight. Furthermore, Arslan *et al.* (2004) [9] elucidate these deviations by noting that (b) is influenced by both biological and environmental factors, particularly the availability of food and the characteristics of the habitat. Similarly, Wooten (1998) [54] suggests that disparities in b values can be attributed to a combination of factors, encompassing the number of specimens analysed, regional and seasonal effects, habitat conditions, level of stomach fullness, reproductive maturity, gender, fish health, preservation methods, and variations in the observed length ranges of the captured specimens. Even though, there are no other existing reports on the LLR and LFR of the *M. rume* from the lake but in this study, we observed 'b' value for LLR and LFR of the male (1.090 and 0.965) is greater than that of female (0.696 and 0.233). This b values also indicates negative allometric relationship between the two morphometric parameters and still suggests that fish grow slimmer as their length increases, thus the caudal fin does not increase proportionately with the species' length. Instead, it grows with relatively smaller increments. Therefore, this study revealed the status of species in the lake and characterized patterns of growth. This is in agreement with Froese, (2006) [21]; Kharat *et al*. (2008) [25], they emphasized that Length-length Relationship (LLRs) of fishes can serve as indicators of the species' status in an environment and reveal distinctive growth patterns. Montcho *et al*., (2009) [31] also reported the value of the regression coefficient b gives information on the type of fish growth. In addition, the relationships between lengths are crucial within fisheries management, especially for conducting growth comparisons (Hossain *et al*., 2006a) [22].

Condition factor (K)

The condition factor serves as an estimate of the overall health status of fish (Oribhabor *et al*. 2011) [37]. This estimate is based on the hypothesis that fish with greater weight (at a given length) are in better health compared to lighter ones (Abdul *et al.* 2016) [2]. A condition factor of 1.0 or higher indicates good fish health, while a value less than 1.0 suggests poorer health (Abobi 2015) [3]. In this study, the condition factors of the studied specimens were found to be 0.75 for males, 0.82 for females and 0.88 for combined sexes. This displayed a compromised state of well-being, probably due to improper conservation methods or inadequate prey within the lake. According to several researchers (Stergiou and Moutopoulos 2001, Chikou 2006) [50, 16] the condition factor, denoted as K varies based on species, location, and season. This variation stems not only from seasonal or environmental influences on general nutritional conditions, but also from different stages of gonad maturation. Moreover, in studies of population dynamics, higher K values typically correspond to favourable environmental conditions, while lower values

suggest less favourable environmental conditions (Blackwell *et al.*, 2000) [15]. Similarly, Radkhan and Eagderi (2015) [40] documented that lower condition values suggest less favourable environmental conditions. The growth conditions for Lake Geriyo appeared to be more unfavourable for *M. rume.*

Correlations among some morphometric/growth parameters

In Table 2, a strong positive correlation was observed ($P < 0.05$; $R^2 > 0.8$), suggesting a high degree of correlation among various body lengths and they were compared to existing literature. In the Soomro *et al.* (2007) [48] study, the length-length relationships of *E. vacha* were documented as TL = 0.923 SL + 1.017 (R^2 = 0.971), SL = 1.036 FL + 0.934 (R^2 = 0.986), and FL = 1.012 TL + 0.940 (R^2 = 0.977) for both sexes from the Indus River in Pakistan. These findings were differed from our current study, possibly due to variations in ecological conditions or physiological differences among the animals (Le Cren 1951) [28]. However, it's worth mentioning that the length ranges and sampling periods in the Soomro *et al.* (2007) [48] study were not the same as those in our present research. In this study, fish grow longer in length than in weight. This finding is in discordance with the work documented by Ogunola *et al.* (2018) [33] that reported *Hepsetus odoe* had isometric growth pattern in the Lake Eleiyele, Ibadan, Nigeria.

Conclusion

To the best of our knowledge, no previous references dealing with LLR and LFR for *M. rume* were available in the Lake Geriyo. In conclusion, *M. rume* growths in weights were not proportional to the cube of their length. Length-length parameters were found linear and significant except in the female. In the case of Condition factors (K), values showed negative influence with K values less than 1 (K < 1). This study provided some information on morphometric parameters and condition factor that can be useful for fishery biologists and conservation species to impose adequate regulations for sustainable fishery management and conservation in the Lake Geriyo. It was recommended to carry out this research for a period of 12 months, in order to be able to conclude on the morphometric measurements and K values.

Acknowledgements

The authors wishes to express their gratitude to TETFUND and the Research and Publication Committee, Federal Polytechnic Bali, particularly, Mal. UMAR Hafiz, Department of Library and Information Sciense for a critical guide to research proposal; to Dr. S.B. Jidauna, and Dr. Y.N. Emamanuel, Department of Fisheries, MAU Yola for suggestions and guidance in the course of this research; to the local fishermen for their cooperation in collecting samples. Also, all the materials used published and unpublished for the purpose of this publication are duly acknowledged.

References

1. Abdul WO, Omoniyi IT, Adekoya EO, Adeosun FI, Odulate OO, Idowu AA, *et al.* Length-weight relationship and Condition factor of some commercial fish species in Ogun State coastal estuary, Nigeria. Ife Journal of Agriculture, 2016, 28(1). DOI:10.13140/RG.2.2.13139.07200.
2. Abdullahi AIN, Carlos GL, Andrew JK. Spatio-Temporal variation in Length-weight Relationships and Condition of the Ribbonfish *Trichiurus lepturus* (Linnaeus, 1758): Implications for Fisheries Management. PLos ONE. 2016;11(8):e0161989. Doi:10.1371/journal.phone.0161989.
3. Abobi SM. Weight-length models and relative condition factors of nine (9) freshwater fish species from the Yapei stretch of the White Volta, Ghana. Elixir Applied Zoology. 2015;79:30427-31.
4. Abubakar UM, Nazeef S, Mohammed TB. Ichthyofaunal Assemblage of Balanga Dam, Gombe State, Nigeria. Bima Journal of Science and Technology. (2536-6041). 2020;4(01):1-7
5. Adeosun F, Omoniyi Akegbejo-Samsons Y, Olujimi O. The fishes of the Ikere Gorge drainage system in Ikere, Oyo State, Nigeria: Taxonomy and distribution. Asiatic Journal of Biotechnology Research. 2011;2:374-383.
6. Adeyemi SO, Bankole NO, Adikwu IA, Akombu PM. Age, growth and mortality of some commercially important fish species of the Gbedikere Lake, Kogi State, Nigeria. International Journal of Lakes and Rivers. 2009;2(1):45–51.
7. Alhassan E, Abobi S, Mensah S, Boti F. The spawning pattern, length-weight relationship and condition factor of Elephant fish, *Mormyrus rume* from the Bontanga reservoir, Ghana. International Journal of Fisheries and Aquatic Studies. 2014;2:109-114.
8. Andem BA, Idung JU, Eni GE, George UU. Length-weight relationship and Fulton's Condition factor of Brackish river prawn (*Macrobrachium macrobrachion* Herklots, 1851) from great Kwara river, Obufa Esuk beach, Cross River state, Nigeria. European Journal of Experimental Biology. 2013;3(3):722-730.
9. Arslan M, Yidirim A, Bekta S. Length-weight relationships of Brown Trout, *Salmo trutta* L., Inhabiting Kan Stream, Coruh Basin, North-eastern Turkey. Turkish Journal of Fisheries and Aquatic Sciences. 2004;4:45-48.
10. Asuquo PE, Eyo VO, Ikechukwu CC. Feeding ecology, length-weight relationship and factor of *Mugil cephalus* (Pisces: Mugilidae, Linnaeus, 1758) from Cross River Estuary, Nigeria. European Academic Research. 2015;11(12):15276-15294.
11. Ataguba GA, Tachia MU, Aminu G. Fish species diversity and abundance of Gubi Dam, Bauchi State of Nigeria. Asian Journal of Conservation Biology. 2014;3:60-67
12. Bake GG, Kolo AW, Kpotun A, Sadiku SOE. Relationship between basic morphometric measurements and cross carcass variation in the body parts of trunk fish (*Mormyrus rume*) from Agaie- Lapai dam, Niger state, Nigeria. Journal of Science, Technology, Mathematics and Education (JOSTMED), 2016, 11(3).
13. Balai VK, Sharma LL, Ujjania NC. Length-weight relationships and Condition factors of Indian major carps in Jaisamand Lake (India). International Journal of Fisheries and Aquatic Studies. 2017;5(1):01-04.
14. Bawaa DY, Nurul-Amin SM, Aziz bin Arshad, Yusoff FM, Argungu LA. Fish Species Composition and Morphological Descriptions of Five Dominant Families from Inland Waters of Kebbi State-Nigeria. Asian Journal of Fisheries and Aquatic Research. 2019;3(1):1-8, 2019; Article no.AJFAR.47271
15. Blackwell BG, Brown ML, Willis DW. Relative Weight

(Wr) Status and Current Use in Fisheries Assessment and Management. Reviews in Fisheries Science. 2000;8:1-44.
16. Chikou A. Etude de la démographie et de l'exploitation halieutique de six espèces de poissons-chats (Teleostei, Siluriformes) dans le delta de l'Ouémé au Bénin. Thèse de Doctorat, Université de Liège, Liège; c2006. p. 459.
17. Danba EP, Ja'afaru A, Abubakar KA, Zira JD, Kefas M, Barau BW. Fish biodiversity and abundance in River Taraba, Taraba State, Nigeria. Ethiopian Journal of Environmental Studies and Management. 2020;13(5):535-544 doi: https://ejesm.org/doi/v13i5.2
18. Elsaye FEF, Ahmed MA. Length-weight, Condition factor and Reproductive aspects of the Cobia, *Rachycentron canadum* (Linnaeus, 1766) in the Arabian gulf off the United Arab Emirates. Egyptian Journal of Aquatic Biology and Fisheries. 2020;24(3):85-95.
19. Fawole OO. Morphometry and diet of Mormyrirus rume in the Lekki Lagoon, Nigeria. Revista de Biologia Tropical. 2002;50(2):689-694.
20. Fetcher LR, Crawford JD. Acoustic detection by sound-producing fishes (Momyridae): The role of gas filled tympanic bladders. J Exp. Biol. 2001;204:175-183.
21. Froese R. Cube law, condiion factor and weight–length relationships: history, meta-analysis and recommendations. Journal of Applied Ichthyology. 2006;22:241-253; http://dx.doi.org/10.1111/j.1439-0426.2006.00805.x
22. Hossain MY, Ahmed ZF, Leunda PM, Islam AKMR, Jasmine S, Oscoz J, *et al*. length-weight, and length-length relationships of some small indigenous fish species from the Mathabhanga River, Southwestern Bangladesh. Journal of Applied Ichthyology. 2006a;22:301-303.
23. Kahraman AE, Göktürk D, Aydin E. Lengthweight relationships of five fish species from the Sakarya River, Turkey. Annual Research and Review in Biology. 2014;4(15):2476-2483.
24. Kayode NA, Alphonse A, Hamdou A, Sisi RI, Stanislas PS. Biodiversity and community structure of Mormyridae (Pisces: Teleostei: Osteoglossiformes) from Niger River in Northern Benin: Threats, Conservation and Valorisation perspectives. International Journal of Sciences. 2019;8(5):106-116.
25. Kharat SS, Khillare YK, Dahanukar N. Allometric Scaling in Growth and Reproducion of a Freshwater loach *Nemacheilus mooreh* (Sykes, 1839). Electronic Journal of Ichthyology. 2008;4(1): 8-17.
26. Lauren AK, Jason RG. Sperm competition, sexual selection and the diverse reproductive biology of Osteoglossiformes. Journal of Fish Biology. 2021;99(3):740-754.
27. Lawson EO, Jimoh AA. Aspects of the biology of grey mullet (*Mugil cephalus*) in Lagos lagoon, Nigeria. AACL Bioflux. 2010;3(3):181-193.
28. Le Cren ED. The length-weight relationships and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). Journal Animal Ecology. 1951;20:201-219.
29. Leandro MG, Francisco MSB. This condition factor of fishes from two rivers basins in Sao Paulo state, Southeast of Brazil. Acta Scientiarum: Biological Sciences, 2005, 73-78.
30. Leonard T, Goore BG, Kouassi SDC. Length-weight relationships for 36 freshwater fish species from two tropical reservoirs: Ayume'I and Bayu, Cote d'voir. Revista de biologia tropical. 2012;60(4):1847-1856.
31. Montcho AS, Laleye P, Linsenmair KE. Length-length, length-weight relationships and condition factor of Nile perch, *Lates niloticus* (Linnaeus, 1762) in the Pendjari River, West Africa. International Journal of Biological and Chemical Sciences. 2009;3(3):466-474.
32. Nazek J, Ghassan Y, Carol S, Mohammed HED. Length-weight relationships and Relative condition factor of fish inhabiting the Marine area of the Eastern Mediterranean city, Tripoli-Lebanon. The Egyptian Journal of Aquatic Research. 2018;44(4):299-305.
33. Ogunola OS, Onada OA, Falaye AE. Preliminary evaluation of some aspects of the ecology (growth pattern, condition factor and reproductive biology) of African pike, *Hepsetus odoe* (Bloch 1794), in Lake Eleiyele, Ibadan, Nigeria. Fisheries and Aquatic Sciences. 2018;21:12 https://doi.org/10.1186/s41240-018-0087-y.
34. Olaosebikan BD, Raji A. Field Guide to Nigerian Freshwater Fishes (Revised Edition). National Institute of Freshwater Fisheries Research (NIFFR), New Bussa, Nigeria; c2013. p. 29-38.
35. Omotosho JS. Analysis of fish species composition of Oyun min-dam, University of Ilorin, Nigeria. J. W. Afr. Sci. Assoc. 1993;36:37-48.
36. Onimisi MM, Shittu OA. Some Aspects of the Biology of African Electric Fish *Mormyrus rume* Valenciennes, 1846 (Osteoglossiformes; Mormyridae) in Lower River Niger at Idah, Kogi State, Central Nigeria. International Journal of Innovative Research and Development. 2015;4(8):45-48.
37. Oribhabor BJ, Ogbeigbu AE, Udo MT. The length-weight relationship of brackish water/marine fish species assemblage in Niger Delta mangrove creek, Nigeria. Current Research Journal of Biological Science. 2011;3(6):616-21.
38. Pauly D. Some Simple Methods for the assessment of tropical fish stock. FAO Fish Tech. 1983;234:52.
39. Peter M, Christian S, Frank K. Permanent and Seasonal Expressions of Sexual Dimorphisms in a Weakly Electric Fish, *Mormyrus rume* proboscirostris Boulenger 1898 (Mormyridae, Teleostei). Environmental Biology of Fishes; c2004. DOI: 10.1023/B:EBFI.0000029359.45235.7b.
40. Radkhah A, Eagderi S. Length-weight and length-length relationships and condition factor of six cyprinid fish species from Zarrineh River (Urmia Lake basin, Iran). Iranian Journal of Ichthyology. 2015;2(1):61-64.
41. Ricker WE. Computation and interpretation of biological statistics of fish populations. Bulletin Fish. Research. Bd. Can. 1975;191:209-210.
42. Samuel DN, Arnold RBN, Bassirou H, Jean PB, Leah B, Antoine P, *et al*. Inventory of the Ichthyofauna of the Mpem and Djim National Park (Centre, Cameroon) provides Baseline Data for a Conservation project. Diversity. 2022;14(12):1029.
43. Scott DBC. The reproductive cycle of *Mormyrus kannume* (forks) in Lake Victoria, Uganda. Journal of Fish Biology. 1974;6:447-454.
44. Seher D, Suleyman C. Condition factors of Seven Cyprinid fish species from Camligoze Dam Lake on Central Anatolia, Turkey. African Journal of Agricultural Research. 2012;7(31):4460-4464.

45. Shahnawaz A, Ashoktaru B, Prem K, Jyoti S, Rohit K, Haldar RS. Study of Length-weight relationship and Condition factor for the Golden mahseer, Tor puttiora from Himalayan rivers from India. Journal of Environmental Biology. 2014;35(1):225-228.
46. Shinggu DY, Maitera ON, Barminas JT. Level Of Organochlorine Pesticide Residue in Fish, Water and Sediments in Biu Dam/Reservoir, Borno State, Nigeria. International Research Journal of Pure and Applied Chemistry. 2015;5(2):150-159.
47. Somyi K. Estimation of length weight relationship in fishes. Fishery Resources Assessment Division. ICAR-Central Marine Fisheries Research Institute, CMFRI; Kochi; c2017.
48. Soomro AN, Baloch WA, Jafri SIH, Suzuki H. Studies on length-weight and length-length relationships of a catfish *Eutropiichthys vacha* Hamilton (Schilbeidae: Siluriformes) from Indus river, Sindh, Pakistan. Caspian Journal of Environmental Science. 2007;5:143-145.
49. Stephen OA, Folashade FOF. Population dynamics of *Mormyrus rume* (Valenciennes, 1847; Osteoglossiformes; Mormyridae) of Ikere-Gorge, Iseyin, Oyo State, Nigeria. Global Journal of Agricultural Sciences. 2020;19(1):51-57.
50. Stergiou KI, Moutopoulos KD. A review of lengthweight relationships of fishes from Greek marine waters. Naga ICLARM Q. 2001;24(1 and 2):23-39.
51. Upper Benue River Basin Development Authority (UBRBDA). Feasibility study of Lake Geriyo; c1985.
52. Wally N, Khady D, Ousseynou S, Papa N, Jacques P, Marbec UMR, *et al*. The length-weight relationship and condition factor of White grouper (*Epinephelus aeneus*, Geoffroy Saint Hilaire, 1817) at the South-west Coast of Senegal, West Africa. International Journal of Advanced Research. 2015;3(3):145-153.
53. Wang T, Wang HS, Sun GW, Huang D, Shen JH. Length-weight and length–length relationships for some Yangtze River fishes in Tian-e-zhou Oxbow, China. Journal of Applied Ichthyology. 2012;28(4):660-662.
54. Wooton RJ. Ecology of teleost fishes. Kluwer Academic Publishers, Dordrecht, Nedherlands; c1998.
55. Worthinton GH, Richardo CK. Scientific results of the Cambridge expedition to the East African lakes No. 15: the fish of Lake Rudolf and Lake Baningo. Journal of Lim. Soc. Zool. 1930;267:353-389.