JURNAL PERIKANAN
UNIVERSITAS GADJAH MADA
Terakreditasi Ristekdikti No: 158/E/KPT/2021

ISSN: 2502-5066 (Online)
ISSN: 0853-6384 (Print)
Vol. 25 (1), 51-56
DOI 10.22146/jfs.77207

Length-Weight Relationship and Condition Factors of *Sarotherodon galilaeus* (Linnaeus, 1758) from Nguru-Gashua Wetlands, Northeast Nigeria

Ashley-Dejo Samuel Segun*[1], Idi-Ogede Musa Abubakar[2], Mohammed Sabo[3], Musa Alhaji Musa[3] & Ogah Samuel Ijabo[3]

[1]Department of Forestry Wildlife and Fisheries, Olabisi Onabanjo University, Ago-Iwoye, Ogun State, Nigeria
[2]Department of Fisheries and Aquaculture, University of Ilorin, Kwara State, Nigeria
[3]Department of Fisheries and Aquaculture, Federal University Gashua, Yobe State, Nigeria
*Corresponding Author, email: ashleydejosamuel@gmail.com

Submitted: 03 August 2022; **Revised:** 24 October 2022; **Accepted :** 03 June 2023

ABSTRACT This study examined the length-weight relation and condition factor of *Sarotherodon galilaeus* (Linnaeus, 1758) from Nguru-Gashua Wetlands, Northeast, Nigeria. A total of 375 specimens were purchased from local fishermen at the designated landing sites for six months. Results of morphometric characteristics showed that the body weight of male *S. galilaeus* ranged from 127-770 g (601.7±28.01) and females ranged from 272-704 g (711.3±38.12). Meristic features show that spinous anal fin rays were constant in both sexes while soft dorsal fin rays, pectoral fin rays, soft anal fin rays and spinous dorsal fin rays had the same range for both sexes. The sex ratio (1:2.18) observed in this study tends to favour male species but contrasts with the general assumption of a sex ratio of 1:1. Mean coefficient of determination was 0.89±0.07 and 0.87±0.07 for male and female *S. galilaeus* respectively indicating that length-weight relationship model is very reliable. This implies that the change in weight of the sampled fish was caused by 88.52% and 86.68% change in length of male and female *S. galilaeus* respectively. It was further revealed that both sexes (b = 2.86±0.18 and 2.88±0.35) had negative allometric growth patterns. The wetland's environmental conditions were within a tolerable range for cichlids.

Keywords: Growth pattern; meristic features; morphometric characteristics; sex ratio

INTRODUCTION

Fish from inland waters is a demanding, treasured, and essential source of protein to man, contributing considerably to the gross domestic product (GDP) of the country (Bolarinwa, 2015). It is a low-cost source of nutritious protein high fillet quality and good taste (Ashley-Dejo *et al*., 2022). To manage this resource, suitable knowledge of the fish population structure is vital which includes biological parameters (Birkeland & Dayton, 2005). In biology, the study of the structure and form of organisms is very significant and of great importance in population studies because it is beneficial in differentiating taxonomically and creating evolutionary interactions (Oladimeji & Olaosebikan, 2017). Morphometric and meristic parameters are vital tools for assessing the discreteness of the same (Oladimeji & Olaosebikan, 2017).

To identify the growth form of fish, the length-weight relationship (LWR) is an essential fishery management device that can be used (Ajagbe *et al*., 2016). Alex *et al*. (2012) opined that understanding some measurable features such as the LWR is essential in studying fish biology. There are different types of growth that fish can reach such as positive allometric growth, negative allometric growth, or isometric growth. Isometric growth denotes an increase in the growth of an organism but there is no variation in body shape. Negative allometric growth indicates that as fish increases in weight, the fish becomes slim while positive allometric growth shows that as the length of the fish increases, it becomes moderately bolder or deeper-bodied (Nehemia *et al*., 2012). The length-weight factor which is stated as the 'coefficient of condition' shows the grade of fish wellbeing in their environment. This factor measures numerous biological and ecological factors such as gonad development, degree of fitness, and environmental appropriateness concerning the feeding condition (Alex *et al*., 2012). For a fish to attain an enhanced state, the condition factor must be higher. Fish condition factors can be affected by several factors such as sex, feed availability, stress, other water quality parameters, and season (Khallaf *et al*., 2003).

S. galilaeus which is known as mango tilapia and from the Cichlids family is one of the commercially significant fish. In Africa, *S. galilaeus* distribution ranges from Cote d'Ivoire and Nigeria in the west to the Democratic Republic of Congo in central Africa and Morocco and Egypt in the North (Dadebo *et al*., 2014; Ahmad *et al*., 2015). In the Northern part of Nigeria, *S. galilaeus* is one of the freshwater fishes which form the greater part of food protein (Hetch, 2010; Azubuike, 2016).

Therefore, assessment of this fish is vital. Information collected will be beneficial to formulate an approach for the sustainability, conservation and management of the water body. Hence, this study becomes vital due to larger households that rely on Nguru-Gashua wetlands for their source of livelihood and the only worldwide acknowledged ecological site. Even though the species has been well researched, very little is known about the ecology of *S. galilaeus* populations in Nguru-Gashua wetlands, North East, Yobe State, Nigeria.

MATERIALS AND METHODS

Study area

The study area for this research is Nguru-Gashua wetlands, which is a broad area of floodplain wetlands situated in

the northeast area of Yobe State, Nigeria. According to Ramsar (1994), the Nguru-Gashua wetlands are the first wetland in Nigeria to be named a Ramsar site. The Marma channel complex and Nguru Lake are a partition of the Hadeji-Nguru wetlands which are located at Latitude 10°22'N and Longitude 12°46'E. The wetland catchment area covers about 3.500 km^2 and consists of two rivers namely, the Jama'are and the Hadejia which move and run into Lake Chad. The wetlands are extraordinarily acknowledged for the regeneration and renewal of subversive water in the Komadugu-Yobe Basin. It is an inexpensive and biological environment that is rich in the biodiversity of abundant fauna and flora.

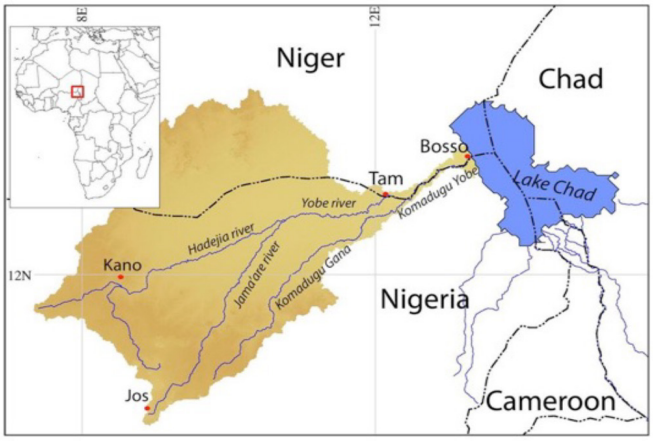

Figure 1. Map of the study area.

Sample collection

A total of 375 specimens of *S. galilaeus* were purchased from local fishermen fishing at the selected landing sites for a duration of six months (June - November 2020) covering both dry and wet seasons. The fishermen within Nguru-Gashua wetlands use diverse fishing gears which include gill nets, cast nets, seine nets, and traps. Sampling was carried out early morning between 06:00 am to 10:00 am (GMT +1) two times a month. Purchased *S. galilaeus* were kept in an ice chest and transported immediately to the laboratory of the Department of Fisheries and Aquaculture, Federal University, Gashua, Yobe State, for measurement and proper identification using the field guide of Nigerian freshwater fisheries by Olaosebikan & Raji (2004).

Morphometric characteristics were measured in centimetres (cm) using a digital Vernier calliper and measuring board. The body weight of each fish sample was measured with an electronic chemical balance of 0.1 g precision. All the measurements were done according to Olaosebikan & Raji (2004). The meristic count was done according to Turan *et al*. (2011) within 24 hours of sample collection.

The specimens were sorted based on their external genital papilla according to Maar et al. (1966). Female *S. galilaeus* has three orifices ventrally (anus, transverse genital opening, and urinary opening) while the male has only two (anus and urinogenital aperture on the small papilla).

Length-weight relationship

The LWR was estimated using the length-weight equation given by (Panase & Mengumphan, 2015) as follows:

$$W = aL^b$$

Where: W = bodyweight of fish (g), L = total length of fish (cm), a = scaling constant determined empirically and b = growth coefficient/pattern. If b=3 the growth is referred to as isometric and if b≠3 is referred to as allometric it can either be positive (b > 3) or negative (b < 3) (Imam et al., 2010; Famoofo & Abdul, 2020). The point at which the regression line intercepts along the y-axis and the slope of the regression line is known as "a and b" respectively. The above equation was logarithmically transformed to make a linear straight-line equation (Abdul *et al*., 2016) to obtain $\text{Log}_{10} W = \text{Log}_{10} a + b \text{Log}_{10} L$

Condition factor

The condition factor which is generally referred to as the well-being of fish was determined using the formula described by Le Cren (Famoofo & Abdul, 2020). It is an important index for evaluating feeding intensity, age, and rowth rates, also used in assessing the status of an aquatic ecosystem where fish lives but is widely influenced by both the biotic and abiotic environmental variables.

$$K = \frac{W \times L}{L^3}$$

Where: k = condition factor, W = body weight of fish (g), L = total length of fish (cm).

Data analysis

Data collected were processed using Microsoft Office Excel software 2013 basically for estimating the intercept and slope. The data were further subjected to basic descriptive statistics which include minimum and maximum value, means, and standard deviation. The statistical analyses were done using Statistical Package for Social Sciences (SPSS) version 23.

RESULTS AND DISCUSSION

Morphometric characteristics and meristic features of S. galilaeus

Results of morphometric characteristics and meristic features of *S. galilaeus* (male and female) from Nguru-Gashua wetlands showed that the bodyweight of male *S. galilaeus* ranged from 127-770 g (601.7±28.01) and females ranged from 272-704 g (711.3±38.12). The mean total length was (29.63±0.61 and 27.28±0.88), standard length (25.17±4.11 and 25.51±0.38), body depth (10.84±0.16 and 12.17±0.49) eye diameter (3.94 ±0.15 and 2.49±0.50), head length (5.48±0.19 and 6.16 ±0.11) for male and female respectively. Results for other morphometric characteristics are present in Table 1.

Table 2 shows the meristic features of the sampled fish. Spinous anal fin rays were found to be in constant in both sexes, soft dorsal-fin rays and pectoral fin rays ranged between 11-13 likewise soft anal-fin rays and spinous dorsal fin rays ranged between 10-12 and 12-18 respectively in both sexes.

Monthly sex ratio, length-weight relationship, and condition factors of S. galilaeus.

Monthly sex ratio, length-weight parameters and condition factors of *S. galilaeus* in Nguru-Gashua wetlands estimated from 375 fish samples for six (6) months showed that

Table 1. Morphometric characteristics of *S. galilaeus* from Nguru-Gashua wetlands.

Morphometric characteristics	Male		Female	
Sex	Range	Mean±SE	Range	Mean±SE
Body weight (g)	127-770	601.7±28.01	272-704	711.3±38.12
Total length (cm)	11-15	29.63±0.61	22-42	27.28±0.88
Standard length (cm)	10-31	25.17±4.11	19-31	25.51±0.38
Body depth (cm)	4.3-16.4	10.84±0.16	4.9-15.3	12.17±0.49
Eye diameter (cm)	0.8-6.3	3.94±0.15	1.1-4.3	2.49±0.50
Head length (cm)	1.1-7.9	5.48±0.19	5.4-7.8	6.16±0.11
Head width (cm)	1.6-7.9	5.18±0.29	3.5-8.7	6.73±0.31
Caudal peduncle length (cm)	1.3-4.9	3.11±0.22	1.1-5.1	3.83±0.23
Caudal peduncle depth (cm)	1.0-8.1	5.07±0.23	2.4-6.2	4.69±0.47
Pre dorsal length (cm)	4.8-11.7	8.78±0.41	5.9-11.8	7.93±0.58
Length of dorsal base (cm)	3.2-15.8	10.84±0.74	6.4-13.1	11.16±0.78
Length of anal base (cm)	2.5-7.3	5.11±0.18	2.4-7.7	5.60±0.19
Height of dorsal fin (cm)	2.8-7.9	5.73±0.15	4.5-8.1	6.57±0.86
Height of anal fin (cm)	2.7-8.9	4.61±0.18	3.2-7.7	5.12±0.36
Length of pectoral fin (cm)	2.1-10.8	6.74±0.45	3.4-8.9	6.91±0.57

Table 2. Meristic counts of *S. galilaeus* from Nguru-Gashua wetlands.

Meristic counts	Male		Female	
Sex	Range	Mean±SE	Range	Mean±SE
Soft anal fin rays	10-12	10.82±0.19	10-12	10.82±0.19
Soft dorsal fin rays	11-13	12.3±0.03	11-13	12.3±0.03
Scale along the lateral line	21-34	26.8±0.53	20-31	27.27±0.41
Scale above lateral line	103-128	117.64±0.88	97-136	121.8±3.19
Scale below lateral line	111-216	183.76±3.45	103-221	198.1±2.19
Scale around caudal peduncle	29-47	35.9±0.49	28-51	36.9±1.71
Spinous anal fin rays	3	3.0±0.00	3	3.0±0.00
Spinous dorsal fin rays	12-18	16.63±0.05	12-18	16.63±0.05
Pectoral fin rays	11-13	12.0±0.10	11-13	12.0±0.10
Gill rakers on the first arch	19-27	23.23±0.32	21-27	24.16±0.31

257 (68.5%) and 118 (31.5%) were male and female *S. galilaeus* respectively, with a mean sex ratio of 1:2.18 which was contrary to the prior expectation of sex ratio of 1:1. The mean coefficient of determination (r^2) was 0.89 ±0.07 and 0.87±0.07 for male and female *S. galilaeus* respectively. This implies that the change in weight of the sampled fish was caused by 88.52% and 86.68% change in length of male and female *S. galilaeus*. It was further revealed that both sexes (b = 2.86±0.18 and 2.88±0.35) had a negative allometric growth pattern. The mean condition factor *S. galilaeus* from Nguru-Gashua wetlands ranged between 2.31 to 2.91 with a mean value of 2.55±0.20 and 2.09 to 2.67 with a mean value of 2.36±0.25 and for male and female *S. galilaeus* respectively. The lowest condition factor was recorded in October for both sexes while the highest was recorded in June and July for male and female *S. galilaeus* respectively. The result from this study shows that morphometric features of *S. galilaeus* were within the range reported by Ebenezer (2010) from Weija reservoir Ghana. The result from morphometric characteristics was also found to be similar to the study of Egbal *et al*. (2017) who studied the LWR and condition factors of five freshwater fish in Roseires Reservoir, Sudan. The finding was also similar to the study of Abdul *et al*. (2011) who reported an average weight of 696.93 g from Ogun estuary, Nigeria. The mean head length and body depth reported in this study were higher compared to those reported by Ebenezer (2010). The discrepancy observed in the morphometric characteristics could be likened to environmental variations such as water temperature, stress, food availability, spawning ground, and sex. The sex ratio observed in this study tends to favour male species but contrary to the study of Fawole & Arawomo (2010) who reported a sex ratio of 1:1 (male: female) in their study in Opa reservoir in Osun State, Nigeria. Abdul *et al* (2011) reported a sex ratio of

Table 3. Monthly sex ratio, length-weight relationship, and condition factors of *S. galilaeus* from Nguru-Gashua wetlands.

Parameters/ Month		June	July	August	September	October	November	Mean±SD
Sex ration	Male	1	1	1	1	1	1	1.00±0.0
	Female	1.78	2.39	2.65	2.20	1.65	2.19	2.14±0.37
A	Male	0.022	0.071	0.051	0.132	0.018	0.033	0.05±0.04
	Female	0.027	0.079	0.067	0.031	0.017	0.031	0.04±0.02
B	Male	3.015	2.762	2.582	2.817	3.081	2.911	2.86±0.18
	Female	3.011	2.521	2.972	2.421	3.384	2.945	2.88±0.35
r^2	Male	0.912	0.931	0.897	0.817	0.793	0.961	0.89±0.07
	Female	0.791	0.904	0.917	0.848	0.793	0.948	0.87±0.07
K	Male	2.91	2.49	2.49	2.61	2.31	2.31	2.55±0.20
	Female	2.48	2.67	2.56	2.23	2.09	2.11	2.36±0.25

1:1.6 (male: female) in the Ogun State estuary. This implies that male fish are favoured in the study area compared to female fish. Also, the study disagrees with the general assumption of a sex ratio of 1:1.

Several authors have postulated that the LWR is important data when estimating fish biomass, it has been accepted internationally as a vital tool by fish biologists, physiologists, ecologists, population dynamics, and stock assessment (Abdul *et al*., 2016). It is also used in evaluating stock well-being and growth patterns Eyo & Awom (2016) but faced with some limitations which include; pollution, population variability, sampling season, estimation methods, food availability, feeding intensity, size of fish, age of fish, sex, maturity stage, muscular development and quantity of reserved (Ujjania *et al*., 2012; Abdullahiand 2013; Miller et al., 2015; Gupta & Banerjee, 2015; Al Nahdi et al., 2016; Famoofo & Abdul, 2020). In LWR, the value of regression coefficient (b) determines the growth pattern exhibited by fish species which could be allometric (positive b > 3 or negative b < 3) or isometric (b = 3) growth pattern (Nash *et al*., 2006; Eyo *et al*., 2015; Eyo & Awom 2016). The b-value for this study indicates a negative allometric growth pattern for both sexes. This implies that the rate at which body length increases is not proportional to the rate of increase in body weight i.e. the fish grow faster in length than in weight. The result of this study was similar to the findings of Abdul *et al*. (2016) who reported a negative allometric growth pattern for *S. galilaeus* in Ogun State coaster estuaries with b value of 2.898±0.144. A negative growth pattern was also reported by several authors in Nigeria water bodies for Tilapia species (Dan-Kishiya, 2013; Nehemia et al., 2012; Ajagbe et al., 2016). Also, Barnes (2007) reported a similar result in her study on *S. galilaeus* in Ghana but contrary to the findings of Majid *et al*. (2018) who reported isometric growth pattern (b = 3) for Tilapia species from Southern Iraq from three culture medium cage, pond and wild fish respectively.

The condition factor describes the fish's health and well-being as regards its environment (Reynold, 1968). It gives overall information about the biological condition of fish concerning its environment (Gupta & Banerjee, 2015), growth pattern, and rate of feeding (Ighwela *et al*., 2011). The higher the "k" values, the heavier the fish. Thus, the "k" value is directly proportional to the body weight of the fish. But the disparity in the "k" is likened to the environmental condition (Ratnakala *et al*., 2013; Sarkar *et al*., 2013), water temperature fluctuation (Bolarinwa & Popoola, 2013), breeding season (Abujam & Biswas, 2016), habitat and feeding habit (Nandikeswari *et al*., 2014), spawning season and gonadal development (Henderson, 2005; Obasohan *et al*., 2012). Condition factor is generally influenced by food availability, feeding pattern/regime, and gonad development (Irom *et al*., 2017). Abowei & Hart (2009) and Lizama *et al*. (2002) opined that gonads development negatively affects the condition factor as a result of energy transfer to gonads development. It was obsessed that male *S. galilaeus* has a better condition factor than its female counterpart. This finding corroborates the hypothesis of Bagenal & Tesch (1978) who stated that heavier fish of a given length have better condition factors.

CONCLUSION

Morphometric characteristics and metric features of S. galilaeus from Nguru-Gashua wetlands were very similar to the findings of other authors from African water bodies. Also, male and female *S. galilaeus* have similar characteristics. The sex ratio violates the general assumption of the 1:1 hypothesis, which shows a negative allometric growth pattern but the condition factor of the male was slightly higher than that of the female. The wetlands' environmental conditions were within a tolerable range for cichlids. The fishery of *S. galilaeus* from Nguru-Gashua wetlands has enhanced the livelihood of the inhabitant of Northeast Nigeria. However, other fish species within the wetlands should be fully assessed for sustainability and robust decision-making and policy formulation.

REFERENCES

Abdul, W.O & I.T. Omoniyi. 2011. Recruitment pattern, probability of capture and predicted yields of *Tilapia zillii* in Ogun Estuary, Nigeria. Journal of Agricultural Science and Environment. 11 (2): 90-102. https://journal.unaab.edu.ng/index.php/JAgSE/article/view/1334

Abdul, W.O., I.T. Omoniyi, E.O. Adekoya, F.I. Adeosun, D.O. Odulate, A.A. Idowu, A.E. Olajide & O.S. Olowe. 2016.

Length-Weight relationship and condition factor of some commercial fish species in Ogun State coastal estuary, Nigeria. Ife J. Agriculture, 28: 1-10. https://ija.oauife.edu.ng/index.php/ija/article/view/20

Abdullahi, J.M & A.M. Ahmad. 2013. Survey of phytoplankton in Wudi River, Kano State, Nigeria. Aqu. Biol. Res. 1: 10-16. https://doi.org/10.12966/ABR.08.02.2013

Abowei, F.N & A.I. Hart. 2009. Some morphometric parameters of ten finfish species from Nun River, Niger Delta, Nigeria. Res. J. of Bio. Sci. 4 (3): 282-288. https://www.cabdirect.org/cabdirect/abstract/20093100914

Abujam, S.K.S & S.P. Biswas. 2016. Length-weight relationship of spiny eel *Macrognathus pancalus* (Hamilton-Buchanan) from Upper Assam, India. Journal of Aquaculture Engineering and Fisheries Research. 2 (2): 50-60. https://doi.org/10.3153/JAEFR16007

Ahmad, M.K., H.A. Baba, M.A. Haruna, A.H. Bichi, S. Abubakar & E.P. Danba. 2015. Some aspects of the biology of *Tilapia zilli* in Kanye Dam, Kabo Local Government, Kano State, Nigeria. International Journal of Agriculture, Forestry and Fisheries. 3 (2): 32-36. http://www.openscienceonline.com/journal/archive2?journalId=706&paperId=1232

Ajagbe, S.O., D.O. Odulate, A.A. Idowu, R.O. Ajagbe, D.O. Alao & A.O. Adekunle. 2016. Length-weight relationship and condition factor of redbelly tilapia (*Tilapia zillii*) caught with gillnets in Asejire Lake, Oyo State, Nigeria. Intl. J. of Fish. And Aqua. Stud. 4 (1): 448-452. https://www.fisheriesjournal.com/archives/?year=2016&vol=4&issue=1&part=F&ArticleId=661

Al Nahdi, A., K. de Garcia, C. Leaniz & A.J. King. 2016. Spatio-temporal variation in length-weight relationships and condition of the ribbonfish *Trichiurus lepturus* (Linnaeus, 1758): implications for fisheries management. PLoS One. 11: 8-12. https://doi.org/10.1371/journal.pone.0161989

Alex, N., D.M. Justin & R. Cyrus. 2012. Length-Weight relationship and condition factor of tilapia species grown in marine and freshwater ponds. Agriculture and Biology Journal of North America. 3 (3): 117-124. https://doi.org/10.5251/ABJNA.2012.3.3.117.124

Ashley-Dejo, S.S., I.S. Ogah & U. Usman. 2022. Length-Weight relationship and condition factor of *Tillapia zilli* in River Yobe, Northeast, Nigeria. Jurnal Perikanan Universitas Gadjah Mada. 24 (1): 55-61. https://doi.org.10.22146/jfs.69814

Azubuike, A. 2016. Studies on the Food and Feeding Habits, Condition Factors of *Tilapia zilli* in Tiga Dam, Kano State, Nigeria. Journal of Biotechnological Research. 1 (2): 53-63. https://doi.org/10.20448/805.1.2.53.63

Bagenal,T.B & F.W. Tesch. 1978. Methods for Assessment of Fish Production in Freshwaters (Ed. T.B. Bagenal) 3rd edition. IBP Handbook, Blackwell, Oxford, 93-130.

Barnes, F. 2007. Observations on some environmental factors and growth characteristics of the Nile tilapia (*Oreochromis niloticus* L.) in fish ponds in Sunyani district, Ghana. M.Phil Thesis, University of Cape Coast, Ghana. 111.

Birkeland, C & P.K. Dayton. 2005. The importance of fishery management of leaving the big ones. Trends in Ecology and Evolution. 20 (7): 356-358. https://doi.org/10.1016/j.tree.2005.03.015

Bolarinwa, J.B & Q. Popoola. 2013. Length-weight relationships of some economic fishes of Ibeshe Waterside, Lagos Lagoon, Nigeria. J. Aquac. Res. Development. 5: 1-8. https://doi.org/10.4172/2155-9546.1000203

Bolarinwa, J.B. 2015. Length-weight relationship and condition factor of Tilapia zilli and Chrysichthys nigodigitatus in Epe Lagoon, Nigeria. Sci and Eng Persp. 10: 21-8.

Dadebo, E., N. Kebtineh, S. Sorsa & K. Balkew. 2014. Food and feeding habits of the red-belly Tilapia (Tilapia zilli, Gervais, 1848) (Pisces: Cichlidae) in lake Ziway, Ethiopia. Agriculture, Forestry and Fisheries. 3 (1): 17-23. http://dx.doi.org/10.11648/j.aff.20140301.14

Dan-Kishiya, A.S. 2013. Length-weight relationship and condition factor of five fish species from a tropical water supply reservoir in Abuja, Nigeria. Amer. J. of Res. Com. 1 (9): 175-187.

Ebenezer, D.E. 2010. Aspect of the biology of the nile tilapia (*Oreochromis niloticus*) in Weija reservoir Ghana. MSc. Thesis, University of Cape Coast Ghana. 135pp.

Egbal, O.A., E.A. Mohammed, A.A. Afra & M.K.R. Esam. 2017. Length-weight relationships and condition factors of five freshwater fish species in Roseires Reservoir, Sudan. European Journal of Physical and Agricultural Sciences. 5 (2): 26-33. http://www.idpublications.org/ejpas-vol-5-no-2-2017/

Eyo, J. 2003. Congeneric discrimination of morphometric characters among members of the pisces genus: Clarias (Clariidae) in Anambra River, Nigeria. The Zoologist. 2: 1-17.

Eyo, V.O & I.E. Awom. 2016. Length-weight relationship, length frequency distribution and condition factor of the shiny nose Polydactylus Corporation; quadrafilis (Cuvier, 1829) from the Cross-River Estuary, Nigeria. Int. J. Sci. Res. Sci. Eng. Technol. 2: 373-378.

Eyo, V.O., M.M. Akpan & I.S. Udoh. 2015. Some aspects of the biology of the female blue crab Callinectes amnicola from the Cross-River estuary, Nigeria. Journal of Coastal Life Medicine. 3: 387–394.

Famoofo, O.O & W.O. Abdul. 2020. Biometry, condition factors and length-weight relationships of sixteen fish species in Iwopin fresh-water ecotype of Lekki Lagoon, Ogun State, Southwest Nigeria. Heliyon. 6 (1): 1-8. https://doi.org/10.1016/j.heliyon.2019.e02957

Fawole, O.O & G.A.O. Arawomo. 2000. Fecundity of *Sarotherodon galilaeus* (Pisces: Cichlidae) in the Opa Reservoir Ile- Ife, Nigeria. Revista de Biolgia Tropical, 48 (1):201-204. https://www.scielo.sa.cr/scielo.php script=sci_arttext&pid=S0034-77442000000100023

Gupta, S & S. Banerjee. 2015. Length-weight relationship of *Mystus tengara* (Ham.-Buch., 1822), a freshwater catfish of the Indian subcontinent. Int. J. Aquatic Biol. 3: 114-118. https://doi.org/10.22034/ijab.v3i2.55

Henderson, P.A. 2005. The growth of tropical fishes. In: Val, A.L., Vera, M.F., Randall, D.J. (Eds.), The Physiology of Tropical Fishes, 21. Academic Press, USA, pp. 85–99.

Hetch, T. 2010. Consideration of African Aquaculture. Journal of World Aquaculture M. 31: 12-19.

Ighwela, K.A., A. Bin-Ahmed & A.B. Abol-Munaf. 2011.

Condition factor as an indicator of growth and feeding intensity of nile tilapia fingerlings (*Oreochromis niloticus*) feed on different levels of maltose. American-Eurasian J. Agric. Environ. Sci. 11: 559-563.

Irom, O., B.O. Offem & R.I. Keremah. 2017. Length-weight relationship, condition factor and gut content of *Chrysichthys Furcatus* Gunther, 1864 (Bagridae) from Cross River at Ahaha. Fisheries Aquac. J. 8 (4): 1-8. https://doi.org/10.4172/2150-3508.1000228

Khallaf, E., M. Galal & M. Athuman. 2003. The Biology of *Oreochromis niloticus* in a polluted canal. Ecotoxicology. 12: 405-416. https://doi.org/10.1023/A:1026156222685

Lizama, M., A.P. Delos & A.M. Ambrosio. 2002. Condition factor in nine species of fish of the Characidae family in the upper Parana River flood plain, Brazil. Brazilian J. Bio., 62: 113-124.

Maar, A., M.A.E. Mortimer & Van der Linger I. 1966. Fish culture in centre East Africa. FAO Publication, 158pp.

Majid, M., A.Y. Taher, S. Al-Dubakel & J. Muhamed. 2018. Comparison of length-weight relationship and condition factor of redbelly tilapia *Coptodon zillii* (Gervais, 1848) from three different locations in Basra, Southern Iraq. Marsh Bulletin. 13 (2): 87-99. https://www.iasj.net/iasj/article/171910

Miller, S.J., V. Genechten, T. Daniel & E. Charles. 2015. Length-weight relationships and an evaluation of fish–size and seasonal effects on relative condition (Kn) of fishes from the Wekiva River, Florida. Florida Academy of Sciences, Inc. 78: 1-19. https://www.jstor.org/stable/24321839

Nandikeswari, R., M. Sambasivam & V. Anandan. 2014. Length-weight relationship of *Terapon jarbua* (Forsskal, 1775) from Pondicherry Waters. Int. J. Biol. Vet. Agric. Food Eng. 8: 278-282. https://doi.org/10.5281/zenodo.1091772

Nash, R.D., A.H. Valencia & A.J. Geffen. 2006. The origin of Fulton's condition factor setting the record straight. Fisheries. 31: 236-238.

Nehemia, A., J.D. Maganira & C. Rumisha. 2012. Length-weight relationship and condition factor of tilapia species grown in marine and freshwater ponds. Agriculture and Biology Journal of North America. 3 (3):117-124. http://dx.doi.org/10.5251/abjna.2012.3.3.117.124

Obasohan, E.E., J.A. Imasuen & C.E. Isidahome. 2012. Preliminary studies of the length-weight relationships and condition factor of five species from Ibiekuma stream, Ekpoma, Edo state, Nigeria. J. Agricu. Res. Dev. 2: 061-069.

Oladimeji, T.E & T.O. Olaosebikan. 2017. Morphological variability of *Tilapia zillii* (Gervais, 1848) from Selected Reservoirs in Southwestern, Nigeria. Ife Journal of Science, 19 (1): 15-25. https://dx.doi.org/10.4314/ijs.v19i1.3

Olaosebikan, B.D & A. Raji. 2004. Field guide to Nigerian freshwater fishes. 2nd Edition, Federal College of Freshwater Fisheries Technology, New Bussa. 111p.

Panase, P & K. Mengumphan. 2015. Growth performance, length-weight relationship and condition factor of backcross and recciprocal hybrid catfish research in net cages. International Journal of Zoological Research. 11 (2) :57-64. https://dx.doi.org/10.3923/ijzr.2015.57.64

Ramsar, C. 1994. Convention on Wetlands of International Importance Especially as Waterfowl Habitat, United Nations Educational, Scientific and Cultural Organization (UNESCO): Paris, France.

Ratnakala, M., M.P. Kumar & K.S. Ramulu. 2013. The length-weight relationship and condition factor of Lates Calcalifer in West Godavari and Krishna Districts of Andhra Pradesh. International Journal of Scientific and Technology Research, 2(7): 190-193. https://www.ijstr.org/research-paper-publishing.php?month=july2013

Reynold, T.D. 1968. The biology of the clupeids in the New Volta. In: Man-made Lakes. The Accra Symposium. Ghana University Press, Accra 251pp.

Sarkar, U.K., G.E. Khan, A. Dabas, A.K. Pathak, J.I. Mir, S.C. Rebello, A. Pal & S.P. Singh. 2013. Length-weight relationship and condition factor of selected freshwater fish species found in River Ganga, Gomti and Rapti, India. Journal of Environmental Biology. 34: 951-956. https://pubmed.ncbi.nlm.nih.gov/24558811/

Turan, C. 2004. Stock identification of Mediterranean horse mackerel (*Trachurus mediterraneus*) using morphometric and meristic characters, ICES Journal of Mainer Science. 61: 774-781. https://doi.org/10.1016/j.icesjms.2004.05.001

Turan, C., M. Gurlet, D. Ergudin, D. Yaghoglu & D. Ozturk. 2011. Systematic status of species (Mugilidae) in the Mediterranean Sea. Turk. J. of Fish. and Aqua. Sci., 11: 315 – 312.

Ujjania, N.C., M.P.S. Kohli & L.L. Sharma. 2012. Length-weight relationship and condition factors of Indian major carp (*C. catla*, *L. rohita* and *C. mrigala*) in Mahi Bajaj Sagar, India. Res. J. Biol., 2: 30–36. http://dx.doi.org/10.21077/ijf.2017.64.special-issue.76263.-27

How to cite this article Ashley-Dejo, S.S., I-O.M. Abubakar, M. Sabo, M.A. Musa & O.S. Ijabo. 2023. Length-weight relationship and condition factors of *Sarotherodon galilaeus* (Linnaeus, 1758) from Nguru-Gashua Wetlands, Northeast Nigeria. Jurnal Perikanan Universitas Gadjah Mada. 25 (1): 51-56. DOI https://doi.org/10.22146/jfs.77207