Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 28(5): 2019 – 2028 (2024)
www.ejabf.journals.ekb.eg

Exploitation Parameters for the *Mormyrus rume* (Valenciennes, 1846) Population (Mormyridae fish) in the River Niger in Niamey (Niger, West Africa)

Souleymane Maman Nouri Souley[1, 2, 3*], Harouna Mahaman[3], Ado Moussa Ibrahim[3], Youssoufa Issiaka[4]

[1]Department of Water, Pollution and Sanitation, Faculty of Agronomic and Ecological Sciences, University of Diffa, BP 78 Diffa, Niger
[2]Universidade Técnica do Atlântico (UTA) - ISECMAR Ribeira de Julião - C.P. 163 Mindelo, São Vicente, Cabo Verde
[3]Directorate of Fisheries and Aquaculture; General Directorate of Water and Forests. Niamey –Niger
[4]Department of Rural Engineering, Water and Forestry, Faculty of Agronomy and Environmental Sciences, Dan Dicko Dankoulodo University, Maradi, Niger
[*]**Corresponding author: souleymanemamannourisouley1995@gmail.com**

ARTICLE INFO
Article History:
Received: Aug. 14, 2024
Accepted: Oct. 25, 2024
Online: Oct. 30. 2024

Keywords:
Exploitation,
Mormyrus rume,
Niger River,
Niamey,
Sustainable management

ABSTRACT

Mormyrus rume in the River Niger in Niamey is one of the most abundant species in the catch, and for rational management of this species, scientific information is more than necessary. This study assessed the exploitation parameters for this species. The data used to conduct this study were collected from August to November 2022. The generation of these parameters was made possible using StatView and FiSAT II software, with a mean annual temperature of 26°C. The initial catch length (Lc), natural mortality (M), fishing mortality (F), and total mortality were 18.74, 0.95, 0.39, and 1.34 per year, respectively. The current exploitation rate was 29% with a maximum of 40%. These initial results concerning the species under study in this part of the Niger River would serve as a basis for future studies in the context of sustainable and rational exploitation of *Mormyrus rume*.

INTRODUCTION

Understanding the parameters of fish population dynamics is essential for developing sustainable management strategies **(Laleye, 1991)**. This requires, among other things, the study of relative abundance in catches, as well as the analysis of the age and growth of species **(Philippart, 1977)**. In Niger, particularly in Niamey, there is very little specific research on the populations of Mormyridae, especially *Mormyrus rume*. The fishing sector suffers from a lack of scientific and statistical data. This study aimed to promote the rational and sustainable exploitation of the *Mormyrus rume* population in the Niger River in Niamey. Specifically, it intended to analyze the exploitation parameters of this population.

MATERIALS AND METHODS

Study location and choice of study stations

The study area was Niamey, a town in southwestern Niger, located at latitude 13°30'49"N and longitude 2°6'35.3"E. Three sampling stations were selected with assistance from the National Fisheries and Aquaculture Directorate: Tondibia (13°33'52.0"N, 2°00'33.8"E) and Barrage Yantalla (13°31'9"N, 2°4'18"E) (Fig. 1). The selection criteria included accessibility during the sampling period, the presence of Mormyridae species in fishermen's catches, ease of collaboration with local fishermen and fishmongers, and sufficient distance between stations to ensure representative coverage of the area.

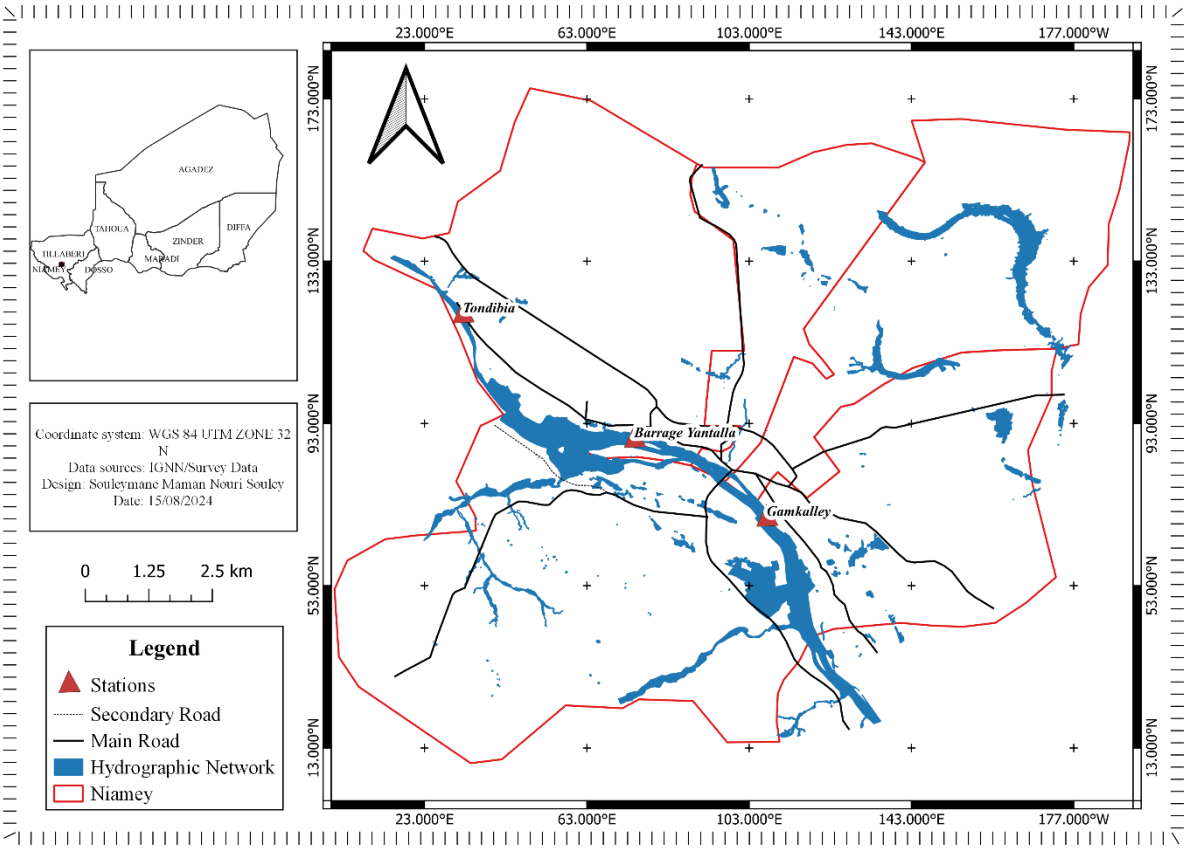

Fig. 1. Study area

Fish sampling

Each station was visited twice a month between 7 a.m. and 10 a.m. to check catches. Mormyridae samples were collected from 34 fishermen and 9 fishmongers. The fishing gears, their characteristics catches, and numerical abundance of Mormyridae were surveyed. Various fishing gears (shape, size, mesh size, and techniques) were examined to maximize the chances of harvesting specimens of all sizes **(Lalèyè, 1995)**. Sampled fish were identified according to the identification key of **Paugy *et al.* (2003)**. The following morphometric parameters were measured: total length (Lt), standard length

(Ls) and weight. The total and standard lengths were measured to the nearest millimeter using an ichthyometer. Total length is defined as the distance from the anterior end to the caudal end, while standard length refers to the distance to the point where the caudal peduncle can be folded back.

Growth, mortality and exploitation rate parameters

FISAT II (Electronic Length Frequency Analysis/ FAO ICLARM Stock Assessment Toll II) software was used to determine these parameters. A key requirement for using this software is to have frequency distributions of at least 100 observations, which should also be compressed into 10 to 20 length classes.

Growth parameters

The metrics have been incorporated into the FiSAT II software to determine the growth parameters, i.e. growth rate (K), performance index (Φ') and symptotic size. These parameters are estimated using the model of **von Bertalanffy (1957)** via the ELEFAN I programme using the distribution of total fish length frequencies according to the expression:

$$Lt = L\infty(1expo^{k(t-to)})$$

Where, Lt = length at age t; L∞ = asymptotic length or maximum average length of the population assuming that the fish continue to grow indefinitely; K = growth coefficient and to = age at zero length, i.e. the abscissa of the point where the curve intersects the age axis.

The growth performance index was determined using the equation of **Munro and Pauly (1983)**:

$$\Phi' = logK + 2logL\infty$$

Mortality and exploitation rate parameters

Total mortality (Z) was assessed by the "length-converted catch curve" method using the formula Ln (N/dtj). Ni represents the number of individuals in size class i, and dt is the time taken for the fish to grow into size class i. This formula, developed and described by **Pauly (1983, 1984)** and **Pauly *et al.* (1995)**, was implemented in the FiSAT II software. Natural mortality (M) was derived from the empirical relationship of **Pauly (1980)**: Log10M = - 0.0066 - 0.279xLog10

$$Log_{10}M = -o.0066 - 0.279xLog_{10}L\infty + 0.6543xLog_{10}K + 0.4634Log_{10}T$$

Where:

M: represents natural mortality; L∞: the asymptotic length;

K: the growth coefficient;

T: mean annual habitat temperature (°C).

Once Z and M are obtained, fishing mortality (F) is evaluated using the relationship: F=Z-M.

The exploitation rate (E) was obtained from E = F/Z = F /(F + M). It lies between 0 and 1. Optimum exploitation was defined as E = 0.5. Overfishing occured if E> 0.5. Recruitment (the process by which an age group of fish becomes part of the exploitable stock for the first time) was also determined.

RESULTS

In the Niamey segment of the Niger River, *Mormyrus rume* exhibits a size range from 12 to 68cm, averaging 26.08cm in length. The von Bertalanffy growth model illustrates the growth trajectory for this species. The calculated growth parameters were as follows: the asymptotic length (L∞), representing the hypothetical maximum length if growth continued indefinitely, was 59.85cm. The growth coefficient (K), which indicates the rate at which the fish approaches its maximum size, was 0.54 per year. The growth performance index (Ø') was 3.30, and the estimated lifespan of the species was 5.55 years. The length at first capture (L50), defined as the point where 50% of the fish are susceptible to fishing gear, was 18.74cm (Figs. 5, 6). The first maturity length (Lmax) was 68cm, and the optimal length (Lopt)—the length at which the ratio of optimal length to asymptotic length (Lopt/L∞) is maximized—was 0.62.

The recruitment cycle of *Mormyrus rume* in this part of the river (Fig. 7) shows a single annual pattern from June to August, with a peak in August. The annual instantaneous total mortality rate (Z) was 1.34 per year, with natural mortality at 0.95 per year and fishing mortality at 0.39 per year. The exploitation rate, at a local water temperature of 26°C, was 0.29 (Fig. 4). The ratios of natural mortality to the von Bertalanffy growth function coefficient (M/K) and total mortality to the growth coefficient (Z/K) were 1.86 and 3.48, respectively.

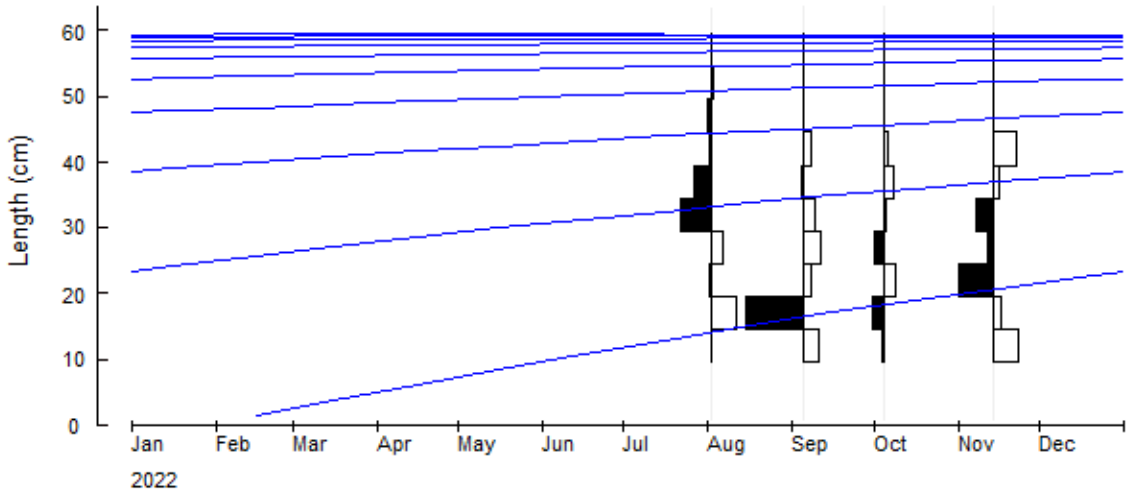

Fig. 2. Growth curve obtained from length frequency histograms (LT) of *Mormyrus rume*

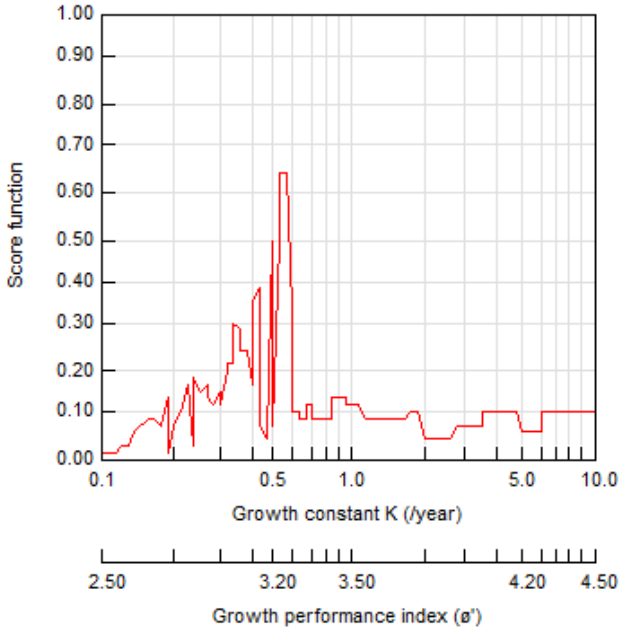

Fig. 3. Curves from the K-scan routine for determining the best value of asymptotic length and growth performance indices in *Mormyrus rume*

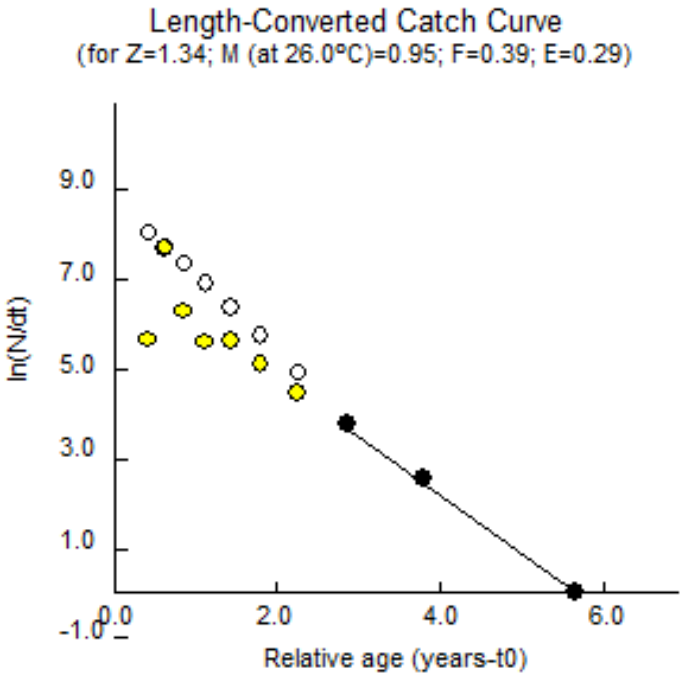

Fig. 4. Length-based capture curve with extrapolated data points, after conversion from lengths to ages

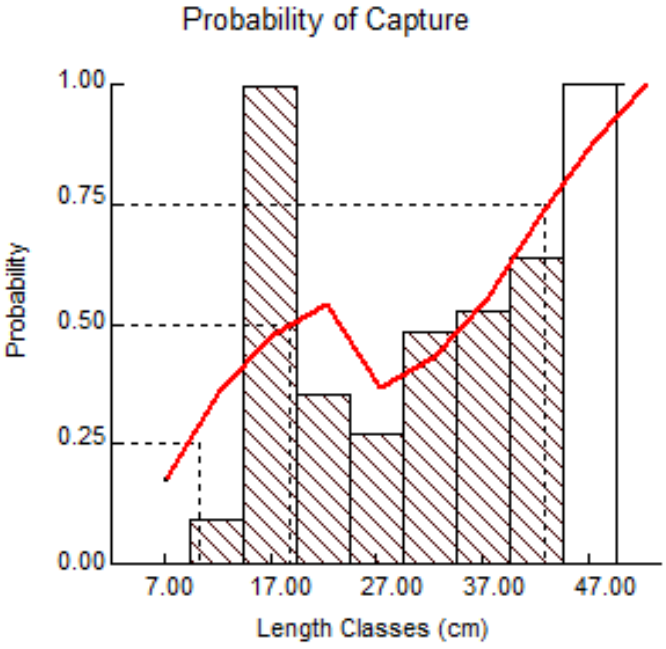

Fig. 5. Fish selectivity curve based on capture probabilities

It was niticed that *Mormyrus rume* has an exploitation rate (E) that exceeds the threshold at which the stock is reduced to 50% of its unexploited biomass (E50).

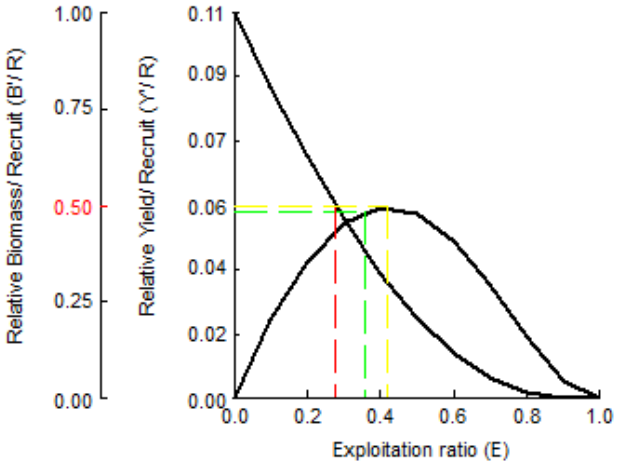

Fig. 6. Curves showing variation in relative yield per recruit (Y'/R) and relative biomass per recruit (B'/R) as a function of exploitation rate (E) by Ogive selection of *Mormyrus rume*

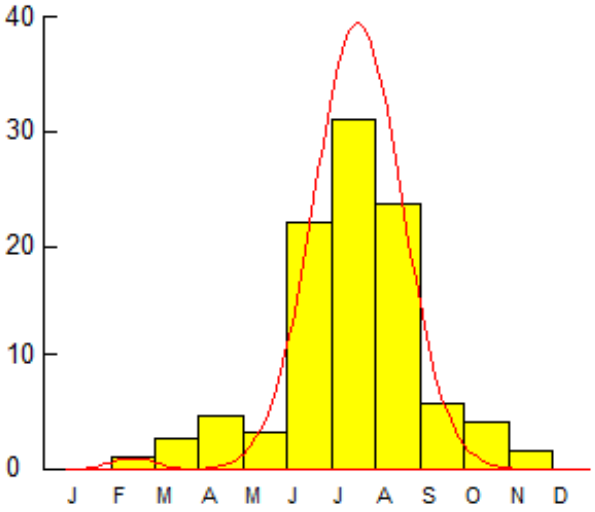

Fig. 7. *Mormyrus rume* recruitment curves

DISCUSSION

This study found that the maximum length (Lmax) of *Mormyrus rume* aligns with the 45cm reported by **Odedeyi *et al.* (2007)** for individuals in the River Ose, Southwestern Nigeria. Nevertheless, previous studies of **Olaosebikan and Raji (2004)** and **Ajagbe and Ojo-Fakuade (2020)** indicate that *Mormyrus rume* can potentially grow up to 100cm. **Offem *et al.* (2009)** documented a mean length of 25.2± 2.5cm for this species in the Cross River inland wetlands, Nigeria. The asymptotic length determined in this study is lower than the one reported by **Ajagbe and Ojo-Fakuade (2020)** for the same species in Ikere-Gorge, Iseyin, Oyo State, Nigeria. While, **Ragheb (2016)** recorded lengths of 80.63 and 53.11cm for *Mormyrus kannume* in the Damietta branch of the Nile, Egypt. Moroever, **Imam *et al.* (2012)** provided similar data for this species from the Nile.

The growth coefficient (K), which reflects how quickly fish approach their asymptotic length, was estimated using the K-scan method in ELEFAN I. According to **Pauly *et al.* (1984)**, K values for tropical fish generally range from 0.39 to 1.6 per year. This study calculated a K-value of 0.54, corresponding to a longevity of 5.55 years. In contrast, **Ajagbe and Ojo-Fakuade (2020)** reported a K-value of 0.62 and a longevity of 4.48 years for *Mormyrus rume* in Ikere-Gorge, Iseyin, Oyo State, Nigeria.

The ratio of optimum length to asymptotic length found in this study was 1.14, surpassing the ratios of 0.63 and 0.65 reported by **Froese and Binohlan (2000)** and **Ajagbe and Ojo-Fakuade (2020)**, respectively. In the Niger River, *Mormyrus rume* achieves sexual maturity at 68cm with a reproductive load of 1.12, which is significantly higher compared to the 52.57 and 0.52cm reported by **Ajagbe and Ojo-Fakuade (2020)** in Ikere-Gorge, Iseyin, Oyo State, Nigeria. This finding supports **Binohlan's (1998)** observation that fish reaching a maximum size of around 200cm mature at approximately 100cm. Conversely, **Imam *et al.* (2012)** reported that *Mormyrus kannume* in the Nile matures at 31. cm for females and 31.5cm for males, with reproductive loads of 0.754 and 0.748, respectively. These differences are likely due to various environmental and biological factors, as well as regional fishing practices.

The study also found that the length at first capture for *Mormyrus rume* is notably smaller than the length at maturity, which is consistent with the findings of **Ajagbe and Ojo-Fakuade (2020)**. This suggests that *Mormyrus rume* in the Niger River may be heavily fished before reaching reproductive maturity. The mortality parameters observed are lower than those reported by **Ajagbe and Ojo-Fakuade (2020)** for the same species in Nigeria but remain within the acceptable range for tropical fish as outlined by **Pauly *et al.* (1984)**. Increased fishing pressure in the Niger River is leading to higher fishing mortality, surpassing the impact of diseases, predators, and other factors. The ratio of

total mortality to the growth coefficient (Z/K = 2.48) and the exploitation rate (E = 0.29) suggest that *Mormyrus rume* in the Niger River is currently less exploited compared to the findings of **Ajagbe and Ojo-Fakuade (2020)**.

CONCLUSION

With an exploitation rate of 0.29 and a maximum allowable rate of 0.40, along with a capture size of 18.74cm, the fishery is currently operating within safe limits. However, it must continue to be monitored to prevent overexploitation.

For sustainable and coordinated management of this species, it is essential to develop and implement an integrated management plan. This should include compliance with current fishing regulations, enforcement of local management conventions that prohibit fishing during certain periods, and raising awareness among fishermen and fish vendors about the dangers of overexploitation.

REFERENCES

Ajagbe, S.O. and Ojo-fakuade, F.F. (2020). Population dynamics of Mormyrus rume (Valenciennes, 1847; Osteoglossiformes; Mormyridae) of Ikere-Gorge, Iseyin, Oyo State, Nigeria. Global Journal of Agricultural Sciences, 19(1), 51-57.
https://dx.doi.org/10.4314/gjass.v19i1.7

Froese, R. and Binohlan, C. (2000). Empirical relationships to estimate asymptotic length, length at first maturity and length at maximum yield per recruit in fishes, with a simple method to evaluate length frequency data. Journal of fish biology, 56(4), 758-773.

Mekkawy, I.A. and Hassan, A.A. (2012). Reproductive characteristics of the elephant-snout fish Mormyrus kannume Forsskål, 1775 from the Nile, Egypt. Journal of Biological Sciences, 12(1), 15-24.
http://doi.og/10.3923/jbs.2012.15.24

Lalèyè, P.A. (1995). Ecologie comparée de deux espèces de Chrysichthys, poissons siluri-formes (Claroteidae) du complexe lagunaire lac Nokoué-lagune de Porto-Novo au Bénin. Tropicultura, Vol 13, Iss 4, Pp 153-154

Odedeyi, D.O.; Fagbenro, O.; Bello-Olusoji, O. and Adebayo, O. (2007). Length-weight relationship and condition factor of the elephant fish, mormyrus rume (Valenciennes, 1846) in river ose, southwestern Nigeria. Animal Research International, 4(1), 617-620.
http://dx.doi.org/10.4314/ariv4il.40803

Offem, B.O.; Samsons, Y.A. and Omoniyi, I.T. (2009). Length-weight relationship, condition factor and sex ratio of forty-six important fishes in a tropical flood river. Research Journal of fisheries and Hydrobiology, 4(2), 65-72.

Olaosebikan, B.A. and Raji, A. (2004). field guide to Nigerian freshwater. Fishes Federal. Fisheries technology New Bussa. Second edition 111pp.

Paugy, D.; Lévêque, C. and Teugels, G.G. (2003). Faune des Poissons d'Eaux Douces et Saumâtres de l'Afrique de l'Ouest (Tome 1). IRD: Paris.

Pauly, D. (1980). On the interrelationships between natural mortality, growth parameters, and mean environmental temperature in 175 fish stocks. ICES journal of Marine Science, 39(2), 175-192.

Pauly, D. (1983). Some simple methods for the assessment of tropical fish stocks (No. 234). Food & Agriculture Org.

Pauly, D. and Munro, J.L. (1984). Once more on the comparison of growth in fish and invertebrates. Fishbyte, *2*(1), 1-21.

Philippart, J.C. (1977). Contribution à l'hydrobiologie de l'Ourthe. Dynamique des populations et production de quatre espèces de poissons Cyprinidae:" *Barbus barbus*"(L.)," *Leuciscus cephalus*"(L.)," *Chondrostoma nasus*"(L.) et" *Leuciscus leuciscus*"(L.). Thèse de Doctorat en Sciences Zoologiques, Université de Liège, 225 pages.

Ragheb, E. (2016). Growth pattern and natural mortality of elephant fishes (Mormyrus kannume, Mormyridae) in the Damietta branch of Nile, Egypt. Egyptian journal of aquatic research, 42(2), 161-168.
https://doi.org/10.1016/j.ejar.2016.04.002