Original Article

Length-weight relationships and condition factors of Mormyridae species in the Niger River: implications for conservation and management

Souley S.M.N.[1,2,3]*, Harouna M.[3], Ado M.I.[3], Youssoufa I.[4]

[1] Department of Water, Pollution and Sanitation, Faculty of Agronomic and Ecological Sciences, University of Diffa, BP 78 Diffa, Niger
[2] Atlantic Technical University - ISECMAR, S. 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

ABSTRACT. The length-weight relationship and condition factor of the ten most abundant Mormyridae species in the Niger River at Niamey were examined from August to November 2023. The species assessed were *Mormyrus rume*, *Campylomormyrus tamandua*, *Pollimyrus isidori*, *Brienomyrus niger*, *Hyperopisus bebe, Mormyrus macrophthalmus*, *Mormyrops anguilloides*, *Brevimyrus niger*, *Mormyrops oudoti*, *Cyphomyrus Psittacus*, and *Marcusenius cyprinoides*. Analysis of their length-weight relationships revealed "b" values ranging from 2.08 to 2.87, suggesting negative allometric growth across all species. Condition factor (k) values varied from 1.22 ± 0.31 for *H. bebe* to 10.48 ± 2.83 for *M. cyprinoides*, with no significant differences in average condition factors among the species. These findings highlight the potential vulnerability of Mormyridae species to environmental changes and anthropogenic pressures, emphasizing the need for targeted conservation measures. The results underscore the importance of sustainable fisheries management practices to preserve biodiversity and ensure the long-term productivity of the Niger River ecosystem. The observed negative allometric growth patterns indicate that environmental conditions may be suboptimal for these species, potentially due to factors such as habitat degradation, water quality issues, or overfishing. Addressing these challenges through habitat restoration and regulatory measures could enhance the resilience of fish populations and support sustainable fisheries.

Keywords: Mormyridae, length-weight analysis, condition factor, the Niger River, sustainable fisheries management

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1. Introduction

The Mormyridae family (Teleostei: Osteoglossiformes), indigenous to Africa, flourishes in nearly all freshwater habitats throughout sub-Saharan Africa. These species are extensively found across the river systems of the Afro-tropical zone (Lowe-McConnel, 1972) Their environments vary widely, from bottom dwellers in murky, low-oxygen swamps to surface feeders in swift rapids (Hopkins, 1986). Despite these diverse habitats, they often inhabit waters laden with suspended particles (Moyle and Cech, 2000). They are characterized by small, terminal or elongated snout-like mouths, reduced eyes (adaptations to turbid habitats), and weak electric organ discharges for electrosensory communication (Hopkins, 1986; Nelson et al., 2016). Their unique electrogenic and electrosensory systems, critical for navigation and social behavior, necessitate targeted conservation strategies to address habitat degradation and anthropogenic threats (Hopkins, 1986). Understanding their biological processes is essential for effective management and conservation.

A crucial tool in studying fish populations is the length-weight relationship (*LWR*), which is fundamental in biology, physiology, ecology, and fisheries management (Bolognini et al., 2013). The *LWR* is used to evaluate the condition and health of fish populations within aquatic ecosystems, providing vital information for managing fishery resources (Bagenal and Tesch, 1978; Hossain et al., 2006). It allows researchers to

*Corresponding author.
E-mail address: souleymanemamannourisouley1995@gmail.com (S.M.N. Souley)

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estimate a fish's weight based on its length, which is critical for assessing fishery yields (Froese, 2006; Froese et al., 2014). The condition factor, another important metric, indicates the fatness or overall health of fish and is used to compare the physiological well-being of populations across different environments and seasons (Le Cren, 1951; Lizama and Ambrósia, 2002). This metric also serves as an indicator of ecosystem disturbances, influenced by both biotic and abiotic factors (Baby et al., 2011).

Despite the importance of *LWR* and condition factors in ecological and fisheries research, there are few studies on these relationships in the Niger River, particularly in the Niamey region where human activities significantly impact the environment. The lack of comprehensive research on fish populations in this area hampers effective conservation efforts. To address this gap, more detailed studies on the diversity, biology, and ecology of fish in the Niger River are needed (Lalèyè, 2006). This study aims to bridge this knowledge gap by analysing the *LWR* of the ten most common Mormyridae species in the Niger River, providing essential data to support better management and conservation of the aquatic ecosystem.

2. Materials and Methods

Study location and selection of stations. The research was conducted in Niamey town, located in South-West Niger, at coordinates 13°30'49" N and 2°6'35.3" E. With assistance from the National Fisheries and Aquaculture Directorate, three stations were chosen: 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 local fishermen's catches, ease of collaboration with local fishermen and fishmongers, and sufficient distance between stations to ensure representative sector coverage.

Fish collection. Each station was visited twice a month between 7 a.m. and 10 a.m. to inspect the catches. Mormyridae samples were gathered from 34 fishermen and 9 fishmongers. The fishing gear, their characteristics, catches, and the numerical abundance of Mormyridae were documented. Various types of fishing gear (including shape, size, mesh size, and techniques) were examined to ensure the collection of specimens of all sizes (Lalèyè, 1995).

In total, 382 individuals of *M. rume*, 192 *M. cyprinoides*, 165 of *C. tamandua*, 144 of *P. isidori*, 142 of *B. niger*, 99 of *H. bebe*, 54 of *M. macrophthalmus*, 51 of *M. anguilloides*, 23 of *B. niger*, 13 of *M. oudoti*, and 10 of *C. psittacus* were sampled.

After identification, the following morphometric characteristics of the species were measured:

- Total length (*TL*): Distance from the mouth to the end of the caudal fin.
- Standard length (*SL*): Distance from the mouth to the base of the tail fin.
- Total weight (*W*) of each fish.

Data. Fish length-weight relationships typically exhibit an allometric growth pattern (Palomares et al., 1996). These relationships are represented by regression equations of the form ($W = aTL^b$), where (*W*) is the total weight of the fish in grams, (*TL*) is the total length in centimetres, (*a*) is the initial growth coeffi-

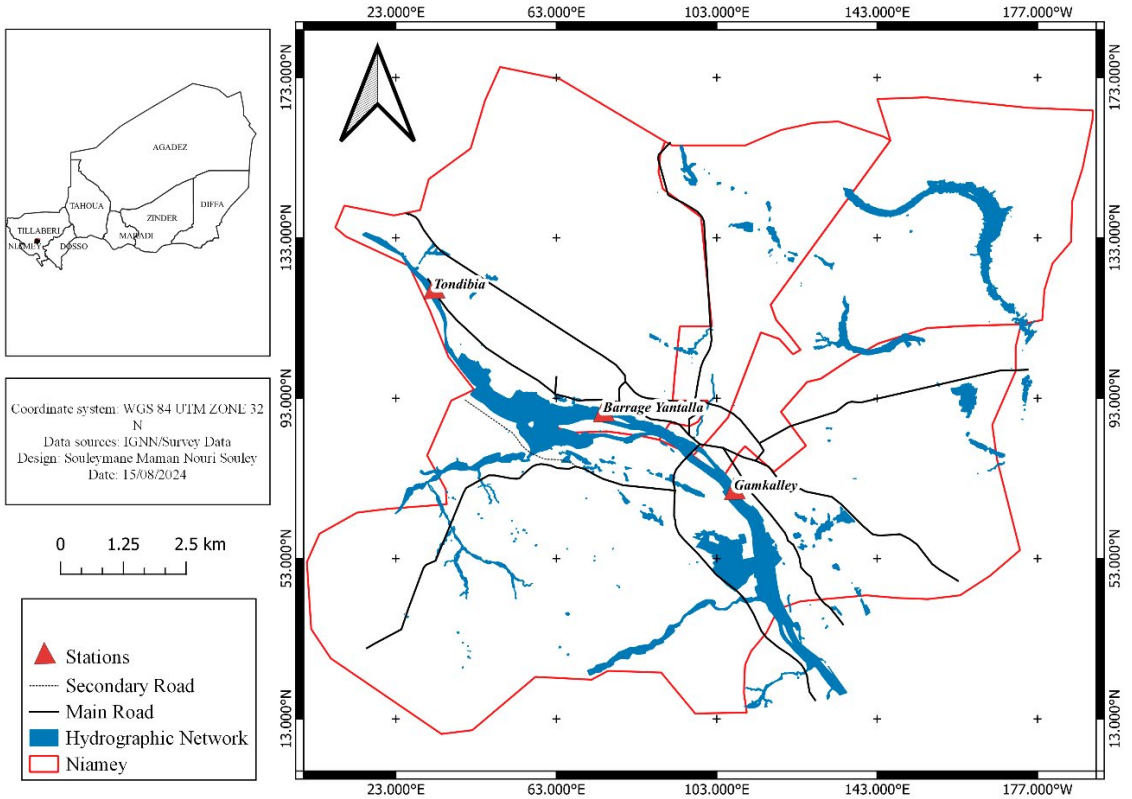

Fig.1. Study area.

cient, and (*b*) is the slope of the regression line. When (*b*) equals 3, the growth is isometric, but deviations from this value ($b \neq 3$) indicate allometric growth. Specifically, positive allometric growth occurs when ($b > 3$), and negative allometric growth occurs when ($b < 3$) (Shingleton, 2010). The 95% confidence intervals for (*b*) were calculated using Statview software (SAS Institute INC, 1992-1998).

To assess the condition factor of fish in the Niger River, the individual condition factor for each specimen was calculated using the equation ($K = 100\frac{W}{TL^b}$) (Bagenal and Tesch, 1978), where (*W*) is the fish's weight in grams and (*TL*) is the total length in centimeters. This study included only species with at least 10 specimens, as recommended by previous research (Lalèyè, 2006; Konan et al., 2007; Tah et al., 2012; Lederoun et al., 2012).

3. Results

3.1. Morphometric variables

During the survey, 14 species of the Mormyridae family were recorded. Table 1 details the morphometric variables of the Mormyridae species collected during the study. A total of 1279 individuals from 15 different species were measured. The number of individuals per species ranged from a single specimen (*Marcusenius senegalensis* and *Petrocephalus bovei*) to 382 specimens (*Mormyrus rume*). The total length of the fish varied from 6.7 cm (*Pollimyrus isidori*) to 118.5 cm (*Marcusenius cyprinoides*), while the standard length ranged from 5 cm (*Pollimyrus isidori*) to 61 cm (*Mormyrus rume*). The total weight of the specimens ranged from 3 g (*Brevimyrus niger* and *Pollimyrus. isidori*) to 5001 g (*Mormyrops anguilloides*).

3.2. Weight-length relationships of certain Mormyridae species

Figure 2 illustrates the length-weight relationships for Mormyridae species with sample sizes ≥10 individuals. The regression equations between total length and total weight, along with the coefficient of determination (R^2), are also shown. All relationships were highly significant ($p < 0.001$), with R^2 values ranging from 0.59 for *M. cyprinoides* to 0.97 for *M. rume*. The intercept values ('a'), representing the scaling coefficient of *LWRs*, ranged from 0.009 (*P. isidori*) to 0.09 (*M. cyprinoides*), with a mean of 0.031 ± 0.021. Lower values (*P. isidori*) suggest lighter body mass per unit length compared to species with higher a (*M. cyprinoides)*, which may correlate with differences in body shape, density, or ecological niche.

The slope values ('*b*') ranged from 2.08 (*M. macrophthalmus*) to 2.87 (*P. isidori*), averaging 2.86 with a standard deviation of 0.25. For all species, the '*b*' values were statistically less than 3 ($b < 3$), indicating negative allometric growth. These results align with typical patterns observed in teleost fishes, where mass often increases slower than the cube of length due to metabolic or ecological constraints.

The condition factor (*K*) values averaged 3.63 with a standard deviation of 0.71, ranging from 0.99 for *P. isidori* to 10.48 for *M. cyprinoides*. Three species (27.27%) had *K* values between 0.5 and 1.3, while

Table 1. Morphometric variables of Mormyridae species from the River Niger

Species	N, ind.	*TL*, cm			*SL*, cm			*W*, g		
		Max	Avg	Min	Max	Avg	Min	Max	Avg	Min
Mormyrus rume (Valenciennes, 1847)	382	68	26.08	12	61	23.04	10.5	1691	154.08	12
Marcusenius cyprinoides (Linnaeus, 1758)	192	118.5	23.97	12.5	57	20.68	11	1500	118.09	15
Campylomormyrus tamandua (Günther, 1864)	165	55	28.99	12	47	25.14	9	1800	182.08	11
Pollimyrus isidori (Valenciennes, 1847)	144	27	9.44	6.7	24	8.10	5	122	9.69	3
Brienomyrus niger (Günther, 1866)	142	11	8.91	7	9	7.34	6	14	8.20	4
Hyperopisus bebe (Lacepède, 1803)	99	48	32.83	13	43	29.47	11	700	240.96	24
Mormyrus macrophthalmus (Günther, 1866)	54	31	22.81	13	25	19.21	11	164	67.31	20
Mormyrops anguilloides (Linnaeus, 1758)	51	63.5	30.42	16.5	57	27.58	15	5001	304.86	20
Brevimyrus niger (Steindachner, 1870)	23	28	14.80	7	23	12.24	6	128	38.52	3
Mormyrops oudoti (Daget, 1954)	13	33	22.7	11	30	20.82	10	185	82.08	13
Cyphomyrus psittacus (Boulenger, 1897)	10	14	12.65	11	12	10.65	9.5	29	22.1	14

the remaining nine species (72.73%) had values significantly higher than 1.5. The highest *K* value was observed in *M. cyprinoides* (10.48 ± 2.83).

Table 2 provides a detailed summary of the species-specific *LWR* parameters, including the number of individuals per species (N), regression statistics (a, b, R^2), the type of growth type, and the condition factor (*K*). This table offers a clear and concise overview, making it easier to understand the key aspects of the research and the health status of the fish populations studied.

4. Discussion

The length-weight relationship in fish is a crucial metric for assessing various biological factors such as fat reserves, overall health, and reproductive maturity. Generally, fish that are heavier for a given length are considered to be in better condition (Nwani et al., 2008). The parameter (*b*), which ranges between 2 and 4 (Hile, 1936), is used to evaluate the predominance of length or weight. A fish with perfect dimensional balance would have an isometric (*b*) value of 3 (Thomas et

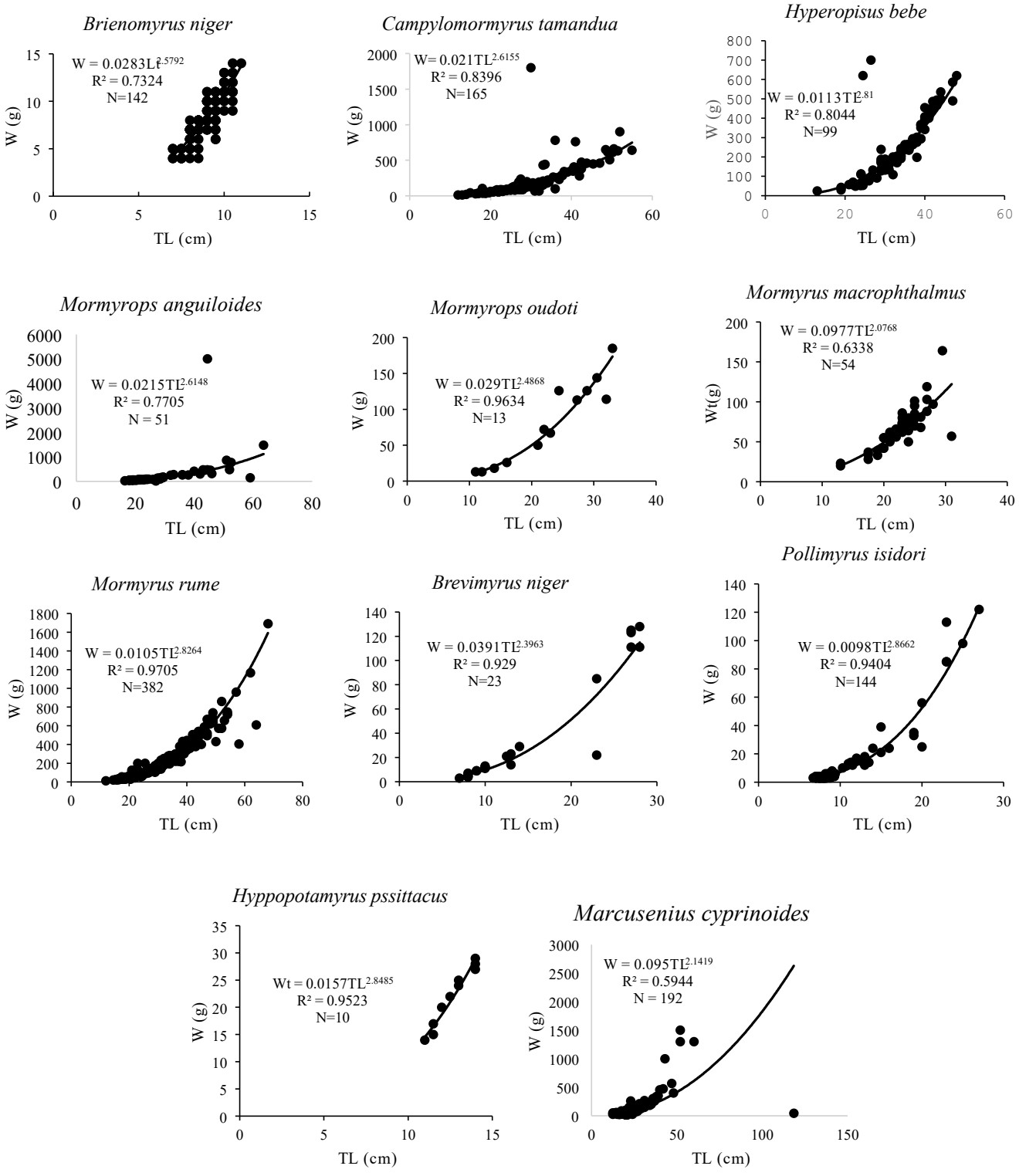

Fig.2. Weight-length relationship of some species of Mormyridae from the River Niger.

Table 2. Length-weight relationship parameters and growth types of Mormyridae fish in the Niger River

Species	N	R^2	a	b (CI à 95%)	K	Type of growth
Mormyrus rume	382	0.97	0.01	2.83(2.78-2.88)	1.05 ± 0.12	Negative allometry
Marcusenius cyprinoides	192	0.59	0.09	2.14(1.89-2.39)	10.48 ± 2.83	Negative allometry
Campylomormyrus tamandua	165	0.84	0.02	2.61(2.44-2.80)	2.33 ± 0.60	Negative allometry
Pollimyrus isidori	144	0.94	0.009	2.87(2.75-2.99)	0.99 ± 0.16	Negative allometry
Brienomyrus niger	142	0.73	0.03	2.57(2.31-2.84)	2.92 ± 0.32	Negative allometry
Hyperopisus bebe	99	0.80	0.01	2.81(2.53-3.09)	1.22 ± 0.31	Negative allometry
Mormyrus macrophthalmus	54	0.79	0.09	2.08(1.77-2.38)	9.81 ± 1.19	Negative allometry
Mormyrops anguiloides	51	0.77	0.02	2.61(2.21-3.02)	2.59 ± 1.001	Negative allometry
Brevimyrus niger	23	0.92	0.03	2.40(2.09-2.70)	4.04 ± 0.82	Negative allometry
Mormyrops oudoti	13	0.96	0.03	2.49(2.16-2.80)	2.92 ± 0.38	Negative allometry
Cyphomyrus pssittacus	10	0.95	0.01	2.85(2.33-2.37)	1.57 ± 0.07	Negative allometry

al., 2003). In this study, the correlation coefficients (R^2) between total length and total weight (W) were positive and very high for all species (0.84 ± 0.09), indicating that the fish grew in both length and weight. The (b) values obtained in this research ranged from 2.08 to 2.87, with an average of 2.57 ± 0.21, which aligns with values reported in other studies, such as Largler et al. (1977) at 2.998, King (1996) at 2.912, Anibeze (2000) at 2.153, Stergiou and Moutopoulos (2001) at 2.989, Ezenwaji and Inyang (1998) at 2.970, and Nwani et al. (2008) at 2.905. The average (b) value of 2.57 suggests a pattern of positive allometric growth. According to Carlander (1969), the (b) exponent should typically be between 2.5 and 3.5. The (b) values of 2.4 for *B. niger*, *M. macrophthalmus*, and *M. cyprinoides* indicate strong negative allometric growth, with very high condition factors (K) (4.04, 9.81, and 10.48, respectively).

Evaluating the condition factor (K) is essential for understanding the optimal environmental conditions, feeding habits, and stocking densities for fish (Tsadu and Adebisi, 1997). In this study, *H. bebe* had the highest condition factor (1.22 ± 0.31), followed by *C. pssittacus* and *C. tamandua*. These results differ from Nwani et al. (2008), who found *M. rume* to have the best condition in the Anambara River, Nigeria.

All species exhibited negative allometric growth, which could be attributed to the sampling period. As Paugy and Lévêque (2006) noted, most fish species in the Sudan-Sahelian regions reproduce during the flood season, leading to increased energy expenditure at the expense of weight growth. This phenomenon has also been observed by Hamani (2015) and Oumarou (2018) in the ichthyological communities of the Sôau River in southern Benin and the Mormyridae communities in the Niger River.

The condition factor (K) values for fish in the Niger River during the study period were generally low, indicating suboptimal living conditions. Zerbo (2004) reported that runoff water could affect the physico-chemical parameters of the water body, impacting the physiological conditions of the fish.

5. Conclusion

This study provides essential insights into the length-weight relationships and condition factors of 14 Mormyridae species in the Niger River near Niamey. As one of the pioneering studies on the biology of these species, it lays a crucial groundwork for future research. The results offer valuable data that can aid researchers and policymakers in formulating effective strategies for the management and conservation of Mormyridae populations in this area. This foundational information will be key in promoting sustainable fisheries practices and ensuring the long-term preservation of these species.

The findings highlight the importance of understanding the biological and ecological characteristics of Mormyridae, which are vital for maintaining the health and stability of aquatic ecosystems. By establishing baseline data on the length-weight relationships and condition factors, this study contributes to a deeper comprehension of the growth patterns and overall health of these fish. Such knowledge is indispensable for developing targeted conservation efforts and mitigating the impacts of environmental changes and human activities on these species.

Moreover, this research underscores the need for continuous monitoring and further studies to track the changes in Mormyridae populations over time.

Future research should focus on exploring the effects of seasonal variations, habitat conditions, and anthropogenic pressures on the growth and health of these fish. By building on the foundation laid by this study, subsequent research can provide more comprehensive insights and support the development of adaptive management strategies that ensure the sustainability of Mormyridae populations in the Niger River.

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Conflict of Interest

The authors affirm that they have no potential conflicts of interest concerning the publication of this manuscript.

References

Anibeze C.I.P., Inyang N.M. 2000. Oocyte structure, fecundity, and sex ratio of *Heterobranchus longifilis* (Valenciennes 1940) in the Idodo river basin, Nigeria, with comments on breeding biology. Journal of Aquatic Sciences 15: 59–61. DOI: 10.4314/jas.v15i1.19990

Baby F., Tharian J., Abraham K.M. et al. 2011. Length-weight relationship and condition factor of an endemic stone sucker, *Garra gotyla stenorhynchus* (Jerdon, 1849), from two opposite-flowing rivers in the southern Western Ghats. Journal of Threatened Taxa 3(6): 1851–1855. DOI: 10.11609/JoTT.o2535.1851-55

Bagenal T.B., Tesch A.T. 1978. Conditions and growth patterns in freshwater habitats. Blackwell Scientific Publications, Oxford, pp. 75–89.

Bolognini L., Domenichetti F., Grati F. et al. 2013. Weight-length relationships for 20 fish species in the Adriatic Sea. Turkish Journal of Fisheries and Aquatic Sciences 13: 555–560.

Carlander K.D. 1969. Handbook of freshwater fishery biology, Vol. 1. The Iowa State University Press, Ames, IA, pp. 752.

Ezenwaji H.M.G., Inyang N.M. 1998. Observations on the biology of *Clarias agboyiensis* Sydenham, 1980 (Osteichthyes: Clariidae) in the Anambra flood river system, Nigeria. Fisheries Research 36: 47–60.

Froese R. 2006. Cube law, condition factor, and weight-length relationships: history, meta-analysis, and recommendations. Journal of Applied Ichthyology 22: 241–253.

Froese R., Thorson J.T., Reyes R.B. 2014. A Bayesian approach for estimating length-weight relationships in fishes. Journal of Applied Ichthyology 30: 78–85.

Hamani H. 2015. Study of the exploitation of fish fauna in the Sô River, Benin (West Africa) [Mémoire de master, Faculté des Sciences Agronomiques, Université d'Abomey-Calavi, Bénin]. (in French)

Hile R. 1936. Age and growth of the cisco Leucichthys artedi (Le Sueur) in the lakes of northeastern highlands, Wisconsin. Bulletin of the United States Bureau of Fisheries 48: 211–317.

Hopkins C.D. 1986. Behavior of Mormyridae. In: Bullock T.H., Heiligenberg W. (Eds.), Electroreception.pp. 527–576.

Hossain M.Y., Ahmed Z.F., Leunda P.M. et al. 2006. Condition, length-weight, and length-length relationships of the Asian striped catfish *Mystus vittatus* (Bloch, 1794) (Siluriformes: Bagridae) in the Mathabhanga River, south-western Bangladesh. Journal of Applied Ichthyology 22: 304-307. DOI: 10.1111/j.1439-0426.2006.00803.x

King R.P. 1996. Length-weight relationship of Nigerian coastal water fishes. Naga ICLARM Quarterly 19(4): 53–58.

Konan K.F., Ouattara A., Ouattara M. et al. 2007. Weight-length relationships of 57 fish species from the coastal rivers in southeastern Ivory Coast. Ribarstvo 65(2): 49–60.

Lalèyè P. 1995. Comparative ecology of two species of *Chrysichthys* (Siluriformes, Claroteidae) from the lake Nokoué-Porto/Novo Lagoon Complex in Benin [Thèse de Doctorat, Université de Liège, Faculté des Sciences Agronomiques, Belgium]. (in French)

Lalèyè P.A. 2006. Length-weight and length-length relationships of fishes from the Ouémé River in Benin (West Africa). Journal of Applied Ichthyology 22(4): 330-333.

Largler K.F., Bardack J.E., Miller R.R. et al. 1977. Ichthyology (2nd ed.). New York: John Wiley and Sons.

Le Cren E.D. 1951. Length-weight relationship and seasonal cycle in gonadal weight and condition in perch (Perca fluviatilis). Journal of Animal Ecology 20: 201–219.

Lederoun D., Lalèyè P., Vreven E. et al. 2012. Length-weight and length-length relationships, and condition factors for 30 actinopterygian fish species from the Mono basin (Benin and Togo, West Africa). Cybium 40(4): 267–274.

Lizama M.A.P., Ambrósia A.M. 2002. Condition factor in nine species of Characidae family in the upper Paraná River floodplain. Brazilian Journal of Biology 62(1): 113–124. DOI: 10.1590/S1519-69842002000100014

Lowe-McConnel R.H. 1972. Freshwater fishes of the Volta and Kainji Lakes. Accra, Ghana: University Press.

Moyle P.B., Cech J.J. 2000. Fishes: An introduction to ichthyology (4th ed.) New Jersey: Prentice Hall.

Nelson J.S., Grande T.C., Wilson M.V.H. 2016. Fishes of the World. Hoboken: Wiley.

Nwani C., Ezenwaji H., Eyo J.E. et al. 2008. Length-weight relationships and condition factor of four Mormyrid species of the Anambra River. Animal Research International 3(1): 426–430. DOI: 10.4314/ari.v3i1.40764

Oumarou A. 2018. Diversity and exploitation of Mormyridae populations in the Niger River influenced by the Sand Control Program (PLCE) in Niger [Mémoire de master, Faculté des Sciences Agronomiques, Université d'Abomey-Calavi, Bénin]. (in French).

Palomares M.L.D., Entsua-Mensah M., Osei-Abunyewa A. 1996. Length-weight relationships of fishes from tributaries of the Volta River, Ghana: Part 2 and conclusion. NAGA, ICLARM Quarterly 19(1): 45–47.

Paugy D., Lévêque C. 2006. Les poissons des eaux continentales africaines: Diversité, écologie et utilisation par l'homme.

Shingleton A.W. 2010. Allometry: The study of biological scaling. Nature Education Knowledge 3(10): 2.

Stergiou K.I., Moutopoulos D.K. 2001. Review of length-weight relationships of fishes from Greek marine waters. NAGA, ICLARM Quarterly 24(1-2): 23–24.

Tah L., Bi Goore G., Da Costa K.S. 2012. Length-weight relationships for 36 freshwater fish species from two tropical reservoirs: Ayamé I and Buyo, Côte d'Ivoire. Revista de Biologia Tropical 60(4): 1847–1856.

Thomas J., Venu S., Kurup B.M. 2003. Length-weight relationship of some deep-sea fish inhabiting the continental slope beyond 250 m depth along the West coast of India. NAGA, WorldFish Center Quarterly 26(2): 17–21. URL: http://ideas.repec.org/b/wfi/wfbook/36166.html

Tsadu S.M., Adebisi A.A. 1997. Condition indices of pond-raised and wild populations of African catfish *Clarias gariepinus* (Burchell, 1822) (Pisces: Clariidae) on Plateau and Niger States. Nigeria Journal of Aquatic Science 12: 49-58.

Zerbo P. 2004. Contribution to the study of freshwater phytoplankton diversity: Case of Lounbila reservoir Burkina Faso [Mémoire de DEA, Université de Ouagadougou]. (in French)