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Ichthyological Note

Length–weight relationships of 19 fish species from two tropical artificial reservoirs (Manantali and Selingue) in Mali, West Africa

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Characters: 6,576 (from introduction to the end of discussion); **Figs: 1; Tabs: 1**

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Running title: Length–weight relationships of fish from two reservoirs in Mali

ABSTRACT

Length–weight relationships (LWRs) were estimated for 19 fish species sampled from two artificial reservoirs (Manantali and Selingue) in Mali: *Brycinus leuciscus*; *Brycinus macrolepidotus*; *Brycinus nurse*; *Chrysichthys auratus*; *Chrysichthys nigrodigitatus*; *Coptodon zillii*; *Distichodus brevipinnis*; *Distichodus rostratus*; *Hemichromis fasciatus*; *Hydrocynus forskahlii*; *Labeo coubie*; *Labeo senegalensis*; *Lates niloticus*; *Mormyrus rume*; *Sarotherodon galilaeus*; *Schilbe intermedius*; *Schilbe mystus*; *Synodontis schall*; *Synodontis sorex*. The fish were collected between June 2002 and October 2003 during three experimental fishing campaigns using gillnets deployed overnight. All fish were measured (total length) to the nearest mm and weighed to the nearest g (total weight). Coefficients of determination of the LWRs (r^2) were mostly high (> 0.9). The values of the allometry coefficient b ranged from 2.651 (*Chrysichthys auratus*) to 3.270 (*Brycinus leuciscus*). This study provides information about LWRs of two fish species which have been published but are not yet available in Fishbase (*Distichodus brevipinnis* and *Mormyrus rume*).

French title:

Relations taille-poids chez 19 espèces de poissons de deux réservoirs artificiels tropicaux (Manantali and Selingue) au Mali, en Afrique de l'Ouest

RESUME.

Les relations longueur-poids (LWR) ont été estimées pour 19 espèces de poissons échantillonnées dans deux lacs artificiels (Manantali et Sélingué) au Mali : *Brycinus leuciscus*; *Brycinus macrolepidotus*; *Brycinus nurse*; *Chrysichthys auratus*; *Chrysichthys nigrodigitatus*; *Coptodon zillii*; *Distichodus brevipinnis*; *Distichodus rostratus*; *Hemichromis fasciatus*; *Hydrocynus forskahlii*; *Labeo coubie*; *Labeo senegalensis*; *Lates niloticus*; *Mormyrus rume*; *Sarotherodon galilaeus*; *Schilbe intermedius*; *Schilbe mystus*; *Synodontis schall*; *Synodontis sorex*. Les poissons ont été collectés entre juin 2002 et octobre 2003 au cours de trois campagnes de pêche expérimentale utilisant des filets maillants déployés pendant la nuit. Tous les poissons ont été mesurés (longueur totale) au mm près et pesés au g près (poids total). Les coefficients de détermination (r^2) étaient pour la plupart élevés ($> 0,9$). Les valeurs du coefficient d'allométrie b étaient comprises entre 2,651 (*Chrysichthys auratus*)

et 3,270 (*Brycinus leuciscus*). Cette étude fournit des informations sur les relations longueur-poids de deux espèces de poissons qui ont été publiées mais ne sont pas encore renseignées dans Fishbase (*Distichodus brevipinnis* et *Mormyrus rume*).

Keywords: Length–weight relationship, freshwater fishes, artificial reservoir, Mali.

INTRODUCTION

A major constraint to science-based fish stock management in West Africa is the lack of reliable data on target stocks. This especially holds true for inland fisheries, such as those that operate in reservoirs (Abobi and Wolff, 2019).

Data provided from length–weight relationship of fish are useful for a number of purposes, such as biology, population dynamics and stock valuation. Such data are particularly valuable for data-poor stocks (Kantoussan et al. 2009, Andersen and Beyer 2015). Several studies have been carried out on length–weight relationships of freshwater species in West Africa (King 1996 on different freshwater bodies (both lotic and lentic system) in Nigeria; Ezenwaji 2004 and Nwani 2006 on Anambra river southeastern in Nigeria; Inyang and Ezenwaji 2004 on six-armed, medium-sized Agulu lake in Nigeria; Ecoutin et al. 2005 on the lower, middle and upper part of the Gambia estuary in The Gambia; Lalèyè 2006 on Oueme River in Benin; Konan et al. 2007 on five rivers (Bia, Soumié, Eholié, Ehania and Noé) in South-Easter of Ivory Coast, Odedeyi et al., 2007 on Ose River in Nigeria; Imam et al. 2010 on Wasai Reservoir in Kano in Nigeria; Ikongbeh et al. 2012 on Lake Akata, Benue state in Nigeria ; Niyonkuru and Lalèyè 2012 on Lakes Nokoué and Ahémé in Bénin ; Abobi and Ekau 2013 on the lower reaches of White Volta River (Yapei) in Ghana ; Alhasan et al. 2014 on Bontanga Reservoir in Ghana; Koffi et al. 2014 on the Taabo Electric Dam in Ivory Coast) but none examined the fish in Malian reservoirs.

The main objective of this study is to provide length–weight relationships of the major freshwater fish species inhabiting the Manantali and Selingue reservoirs in Mali.

MATERIALS AND METHODS

The two studied sites are artificial reservoirs. Selingue reservoir, created in 1980, is 80 km in length, with a width between 3 and 8 km, a maximum depth of 23.8 m, average depth of 5.4 m and an area of 409 km² (Anne et al. 1994, van der Knaap 1994). Manantali reservoir, which was filled in 1987, is 80 km long, with a width varying from 6 to 8 km, a maximum surface area of 457 km², maximum depth of 55 m, and mean depth of 23.8 m (Anne et al. 1994; van der Knaap 1994).

Fishes were collected between June 2002 and October 2003 during three experimental fishing campaigns: i) a first campaign, during low water period, was conducted from 10 to 14 June

2002 on Selingue reservoir and from 19 to 22 June 2002 on Manantali reservoir; ii) a second campaign, also during the low water period, was conducted from 9 to 16 April 2003 on Manantali reservoir and from 22 to 29 April on Selingue reservoir; iii) a last campaign was conducted at the end of the rainy season, from 1 to 6 October 2003 on Manantali reservoir and from 10 to 15 October on Selingue reservoir. For the campaign in June 2002, fish were captured using vertical gillnets with mesh size of 10, 12.5, 15, 17.5, 20, 25, 30, 35, 40, 50, 60, 70 and 80 mm, while the two other campaigns used monofilament gillnet panels with mesh sizes of 10, 15, 22.5, 45, and 80 mm knot to knot. Each panel of a given mesh size was 25 m length and 3 m high (Coll et al. 2007; Laë et al. 2004; Simier et al. 2019).

Total lengths of individual fish were measured to the nearest mm and total fresh weight to the nearest g. Parameters of the weight–length relationships were estimated by the least-squares method applied to log-transformed data for males and females together as:

$$\log(W) = \log(a) + b \log(L),$$

where W = total fresh weight (g), L = total length (cm), a = intercept, and b = slope of the linear regression.

Among the catches, only species represented by at least 10 individuals were included in the analyses. The 95% confidence intervals of a and b were calculated using the `confint` function of the `stats` package in R (R Core Team 2020).

RESULTS

Six species from five different families accounting for 958 individuals and 18 species from 8 different families accounting for 1428 individuals were selected for the LWR analysis respectively in Manantali and Selingue reservoirs. For each species, sample size, minimum and maximum length, minimum and maximum weight, a and b values with their 95% confidence intervals and the coefficient of determination (r^2) are given in Table 1. The number of individuals by species varied from 21 to 646 for Manantali reservoir and from 10 to 406 for Selingue reservoir. Coefficients of determination (r^2) ranged from 0.902 (*Schilbe intermedius*) to 0.999 (*Mormyrus rume*) and b values ranged between 2.651 (*Chrysichthys auratus*) and 3.270 (*Brycinus leuciscus*). *Distichodus brevipinnis* and *Mormyrus rume* have been studied in Anambra River and Ose River (Nigeria), and in Bontanga Reservoir (Ghana).

DISCUSSION

With determination coefficient (r^2) values which ranges from 0.90 to 0.99, the relationships between the total length and body weight are highly significant. Several studies on length–weight relationships of freshwater fishes have shown similar results in West African reservoirs (King 1996, Imam et al. 2010, Ikongbeh et al. 2012, Lederoun et al. 2018), estuaries (Ecoutin et al. 2005, Ndiaye et al. 2015), rivers (Entsua-Mensah et al. 1995, Ezenwaji 2004, Lalèyè 2006, Abobi and Ekau 2013, Lederoun et al. 2016), and lagoons (Fafioye and Oluajo 2005, Abohweyere and Williams, 2008, Kumolu-Johnson and Ndimele 2010). However, prior to our study, length–weight relationships for *Distichodus brevipinnis* and *Mormyrus rume* have been published for Anambra River, Nigeria (Ezenwaji 2004, Nwani 2006), Ose River, Nigeria (Odedeyi et al. 2007) and Bontanga Reservoir, Ghana (Alhasan et al. 2014), but are not yet available in Fishbase (Froese and Pauly 2020).

According to Carlander (1969), b values may range from 2.5 to 3.5. The results of this study confirmed this since the b values obtained ranged between 2.651 (*Chrysichthys auratus*) and 3.270 (*Brycinus leuciscus*). The high value of b close to 3 for *Hydrocynus forskahlii* (3.011), *Lates niloticus* (3.018), *Synodontis schall* (3.101) in Manantali and *Brycinus leuciscus* (3.270), *Brycinus nurse* (3.204), *Hemichromis fasciatus* (3.144), *Distichodus rostratus* (3.146), *Synodontis schall* (3.120), *Mormyrus rume* (3.175), *Schilbe intermedius* (3.269), *Schilbe mystus* (3.195) in Selingue reservoirs can be explained by food availability and good quality of environment (Le Cren 1951, Cushing and Horwood 1994, Arslan et al. 2004, Rahman et al. 2008).

These results, like many other fish length–weight relationship studies in West Africa, may be useful for future research, as well as for the management of freshwater species of Malian reservoirs.

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Table 1. Length–weight relationship (LWR) of the fish species of the Manantali and Selingue artificial reservoirs in Mali.

Reservoir	Family	Species	n	Total length (cm)	Weight (g)	Relationship parameters		
				Min-Max	Min-Max	a	b	r ²
Manantali	Alestidae	<i>Brycinus nurse</i> (Rüppell, 1832)	94	11.2-25.4	16-186	0.014 (0.012-0.017)	2.918 (2.864-2.973)	0.992
		<i>Hydrocynus forskahlii</i> (Cuvier, 1819)	646	9.4-45.2	5-598	0.006 (0.005-0.006)	3.011 (2.991-3.031)	0.993
	Cichlidae	<i>Coptodon zillii</i> (Gervais, 1848)	21	8.3-22.8	11-221	0.019 (0.011-0.035)	2.954 (2.728-3.180)	0.975
	Claroteidae	<i>Chrysichthys auratus</i> (Geoffroy Saint-Hilaire, 1809)	143	8.1-19.5	5-62	0.009 (0.008-0.011)	2.960 (2.894-3.027)	0.982
	Latidae	<i>Lates niloticus</i> (Linnaeus, 1758)	27	7.5-39.0	4-697	0.009 (0.008-0.012)	3.018 (2.957-3.079)	0.998
	Mochokidae	<i>Synodontis schall</i> (Bloch & Schneider, 1801)	27	12.5-40.0	17-584	0.006 (0.005-0.008)	3.101 (3.014-3.188)	0.995
Selingue	Alestidae	<i>Brycinus leuciscus</i> (Günther, 1867)	406	6.6-13.3	3-30	0.007 (0.006-0.009)	3.270 (3.170-3.370)	0.912
		<i>Brycinus macrolepidotus</i> Valenciennes, 1850	30	7.6-27.1	5-171	0.012 (0.008-0.018)	2.878 (2.727-3.029)	0.982
		<i>Brycinus nurse</i> (Rüppell, 1832)	134	7.5-20.8	3-102	0.007 (0.006-0.008)	3.204 (3.128-3.280)	0.981
		<i>Hydrocynus forskahlii</i> (Cuvier, 1819)	55	10.6-37.5	8-297	0.008 (0.007-0.009)	2.906 (2.861-2.951)	0.997
	Cichlidae	<i>Coptodon zillii</i> (Gervais, 1848)	17	5.7-20.4	3-150	0.017 (0.012-0.025)	2.995 (2.833-3.156)	0.991
		<i>Hemichromis fasciatus</i> Peters, 1857	113	6.2-17.0	4-86	0.010 (0.008-0.013)	3.144 (3.041-3.248)	0.970
		<i>Sarotherodon galilaeus</i> (Linnaeus, 1758)	76	8.3-20.9	10-191	0.022 (0.014-0.035)	2.953 (2.767-3.140)	0.931
	Claroteidae	<i>Chrysichthys auratus</i> (Geoffroy Saint-Hilaire, 1809)	53	6.4-20.5	3-56	0.018 (0.012-0.025)	2.651 (2.503-2.799)	0.962
		<i>Chrysichthys nigrodigitatus</i> (Lacepède, 1803)	33	5.0-30.7	1-173	0.008 (0.006-0.011)	2.840 (2.743-2.938)	0.991
	Cyprinidae	<i>Labeo coubie</i> Rüppell, 1832	85	8.2-30.9	6-288	0.012 (0.009-0.015)	2.911 (2.802-3.019)	0.972
		<i>Labeo senegalensis</i> Valenciennes, 1842	56	8.7-25.8	5-126	0.010 (0.008-0.012)	2.921 (2.853-2.989)	0.993
	Distichodontidae	<i>Distichodus brevipinnis</i> Günther, 1864	40	7.7-37.6	4-459	0.011 (0.009-0.014)	2.929 (2.827-3.031)	0.989
		<i>Distichodus rostratus</i> Günther, 1864	18	7.6-12.3	4-19	0.007 (0.003-0.017)	3.146 (2.752-3.540)	0.947
	Mochokidae	<i>Synodontis schall</i> (Bloch & Schneider, 1801)	10	11.0-26.4	10-166	0.007 (0.003- 0.016)	3.120 (2.797-3.442)	0.984
		<i>Synodontis sorex</i> Günther, 1864	26	6.7-12.5	2-11	0.008 (0.005-0.015)	2.802 (2.538-3.066)	0.952
	Mormyridae	<i>Mormyrus rume</i> Valenciennes, 1847	11	14.3-66.2	16-1815	0.003 (0.003-0.004)	3.165 (3.083-3.248)	0.999
Schilbeidae	<i>Schilbe intermedius</i> Rüppell, 1832	17	8.0-17.0	2-32	0.003 (0.001-0.013)	3.269 (2.675-3.863)	0.902	
	<i>Schilbe mystus</i> (Linnaeus, 1758)	248	6.0-29.6	1-163	0.003 (0.003-0.004)	3.195 (3.124-3.266)	0.969	

n, sample size; Max, maximum; Min, minimum; a and b, parameters of LWR; CL, confidence limits; r², coefficient of determination.

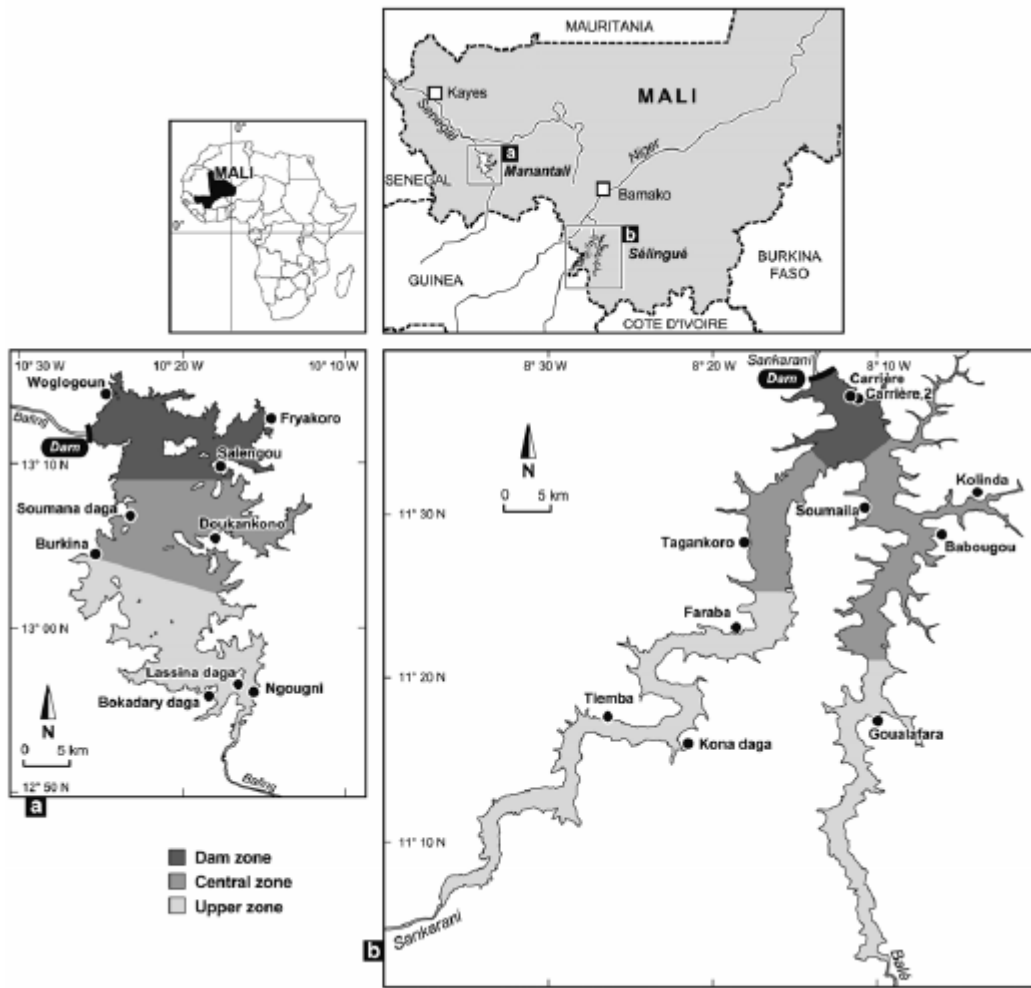


Figure 1. Situation map (top) and detailed map (bottom) of the two Malian lakes studied: (a) Manantali, (b) Sélingué.