Weight-length relationship and relative condition factor of *Micropterus salmoides* (Lacépède, 1802), *Cyprinus carpio* (Linneaus, 1758) and *Oreochromis niloticus* (Linnaeus, 1758) caught in the Al-Massira Dam Lake

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Abstract. The current study describes the length-weight relationships and relative condition factors (Kr) of three species during the period (September 2020- January 2021). For this purpose, 137 fish were sampled. The "size-weight"relationships thus established for each species are: *Largemouth Bass*: $Tw = 0.0055 Tl^{3.2816}$, *Cyprinus carpio*: $Tw = 0.0148\ Tl^{2.9417}$ and *Oreochromis niloticus*: $Tw = 0.0304\ Tl^{2.8386}$. These results showed positive allometry for the first species (*Micropterus salmoides*) and a negative one for the two other species. The relative condition factor (Kr) is higher than one, which shows that these species are in good conditions at the Al-Massira dam.

Keywords: Length-weight relationships, Relative condition factor, Al-Massira.

1 Introduction

A length-weight relationship is an essential tool in biology, physiology, ecology and stock assessment of fishes [1]. Indeed, this relationship is a widely used approach in fisheries management, as it provides information on the status of fish stocks in an aquatic ecosystem [2,3]. In addition, the length-weight relationship is often used by researchers and nature managers to predict the weight of a fish, knowing its length, when assessing fisheries yields [4,5].

According to [6], size-weight relationship parameters provide information about fish habitat and are otherwise tools for comparison among various populations of the same species living in similar or different ecosystems [7,8,9].

The condition factor provides information on the overweight status of a fish [10]. It is an instrument often used to compare the global physiological state of populations during a seasonal cycle or between basins with similar or different ecological conditions [11,12]. Despite the ecological and socio-economic interest of these species, studies dealing with their growth and other biological and ecological characteristics are absent in Morocco.

The objective of the present study is to investigate the length-weight relationship and condition factor of black bass, common carp and tilapia in Al-Massira Dam.

2 Materials and methods

2.1. Area study

The Al-Massira Reservoir, which was impounded in February 1979, is considered the centrepiece of the Oum Rabia watershed development plan. It is located in the province of Settat, 120 km southeast of Casablanca. The coordinates are 32°28'32" North and 7°32'15" West. The water resources of the Oum Rabia watershed are on the one hand of surface origin coming from three large wadis, and on the other hand, of groundwater coming from the water tables.

The climate at the reservoir level is continental, marked by a large thermal amplitude and high insolation [13]. Two factors are acting in opposite directions, precipitation and temperature condition the semi-arid climate of this region. Seasonal variations in the volume of water in the Al Massira Reservoir are sometimes significant; they are due to frequent and long-lasting drought episodes and result from:

- Liquid contributions from the Oum Rabia wadi,
- And restitutions (in particular extractions of the National Office of Electricity) and evaporation [13].

2.2. Data collection

Three species from Al-Massira Dam were selected for this study: *Micropterus salmoides*, *Cyprinus carpio* and *Oreochromis niloticus*. The sampling was carried out over 5 months between September 2020 and January 2021.

Measurements were made on a sample of 137 fish. Length measurements were made using an ichthyometer

caudal fin for total length (Tl). The total weight (Tw) of the fish was measured using an electronic scale with 0.1 g precision.

2.3. Relative growth or total weight-total length relationship

Relative growth provides information on the overweight of fish [14] and is necessary for estimating fish biomass and the analysis of ontogenetic changes [15], and various aspects of population dynamics.

In fisheries science, this growth is used to estimate weight from size [16], weight from age [17], and to express the linear growth equation in weight growth [18]. This relationship is also used for biological and biometric studies, i.e. the study of fish conditions. This relationship also allows inter-area, inter-annual and inter-lake comparisons [19], the weight-length relationship is of power type [11]:

$$Tw = a\ Tl^{\,b} \qquad (1)$$

With: Tw= total weight (g). Tl= total length (cm). a= constant. b= relative growth coefficient of weight and length.

On the other hand, the values of a and b generally give information on the weight variations of an individual to its size. They can be compared between two or more populations living under similar or different ecological conditions.

The value of coefficient b is compared statistically to b_0= 3. Three cases can be distinguished:
- If b=3, the weight increases proportionally to the length, there is an isometry.
- If b>3, the allometry is majoring, the fish gets bigger faster than its growth.
- If b<3, the allometry is minorizing, the fish grows faster than it gets bigger [20,21,22].

2.4. Relative condition factor (Kr)

Relative condition factor (Kr) is defined for each fish by the ratio between its observed mass and its calculated theoretical mass:

$$Kr = W / a\ L^{\,b} \qquad (2)$$

For each fish, the Kr value places it to the length-weight curve established for the sample [11].

- If Kr > 1, the fish has a mass superior to the average mass of individuals of its size.
- If Kr <1, its mass is smaller than the average mass.

3 Results

3.1. Height-weight relationship

individuals of black bass, common carp and tilapia, the mathematical
relations linking the total length to the total weight of the individuals were determined. In the black bass population, the minimum weight encountered is 62.3 g for a minimum size of 17.5 cm. The maximum total weight is 574 g for a size of 34 cm. The total lengths of the specimens vary from 14.5 cm to 43 cm in common carp with weights that vary between 48.8 g and 914 g. In tilapia, the total lengths vary between 10.5 cm and 43 cm, with total weights varying between 36 g and 1500 g.

Table 1 shows, for the three species, the number of specimens collected, the minimum and maximum size values, the estimated a and b parameters as well as the correlation coefficient for total weights. Correlations between length and weight of specimens are very high, with correlation coefficients of 0.9844, 0.9833 and 0.9898. The allometry coefficient of black bass is 3.2816 (b> 3), indicating major allometry between the weight and size of this species. Thus, the black bass presents a weight growth superior to its size growth.

We find slight minorizing allometry for the other two species, namely common carp and tilapia, indicating a slower weight growth to size.

Figures (A, B, C) represent respectively the results of the variations of the relationship linking total weight and total length for the three species: black bass, common carp and tilapia.

The regression equations for the size-weight relationship for the three species are represented in Table 2. Thus, the size-weight relationship is written:

- For black bass: $Tw = 0.0055\ Tl^{\,3.2816}$
- For common carp: $Tw = 0.0148\ Tl^{\,2.9417}$
- For tilapia: $Tw = 0.0340\ Tl^{\,2.3687}$

As for the relative condition factors (Kr), the results are superior to 1 for the three species: black bass, common carp and tilapia, indicate that the three species present a somatic overweight and therefore show good growth.

Table 3 presents the values of the relative condition factor for the three species.

4 Discussion

The study of the size-weight relationship in the three populations: black bass, common carp and tilapia in Al-Massira Dam, showed a good correlation between the total weight and total size for the three species since the correlation coefficient is close to 1. The positive and high values of the correlation coefficients obtained (R^2 = 0.9844, 0.9833, and 0.9898) for all the species in this study, suggest that the growth in size induces an increase in weight in the fish in the Al-Massira Dam Lake.

The value of the allometric coefficient of black bass obtained in this study (b = 3.2816 > 3), suggests that this species has a majoring allometric type growth. Thus, the black bass shows a weight growth higher than its size growth; so, he gets bigger faster than he grows. These results are similar to those found by [25] in a Reservoir in southern Brazil, [26] in Cain Lake in the USA,
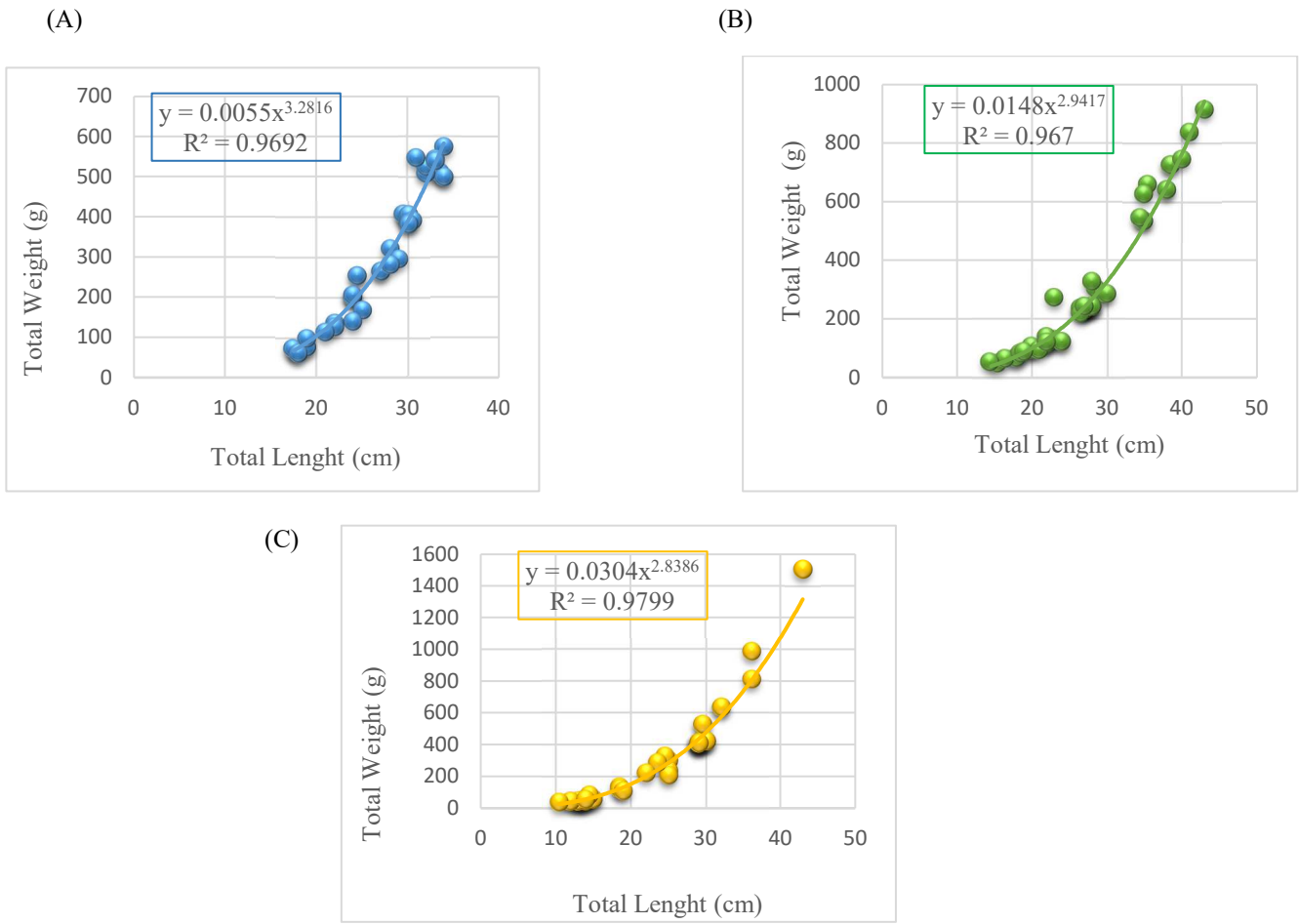
(A)

(B)

(C)

Fig.1. Size-weight relationship in black bass (A), common carp (B) and tilapia (C).

Table 1. Parameters of the weight-length relationship of the three species.

Species	N	Total length (cm)			Weight (g)			a	b	R^2	r
		Min	Max	Mean	Min	Max	Mean				
Micropterus salmoides	46	17.5	34	27.45	62.3	574	300.02	0.0055	3.2816	0.9692	0.9844
Cyprinus carpio	51	14.5	43	27.46	48.8	914	300.32	0.0148	2.9417	0.967	0.9833
Oreochromis niloticus	40	10.5	43	22.23	36	1500	350.55	0.0304	2.8386	0.9799	0.9898

N = Number of fish samples, a = constant, b = exponent, R^2 = determination coefficient, r = regression coefficient, max= maximum, min= minimum.

Table 2. Regression equations and growth type in the three species.

Species	B	Growth Pattern	Equation de regression
Micropterus salmoides	3.2816	A+	Tw = 0.0055 Tl $^{3.2816}$
Cyprinus carpio	2.9417	A-	Tw = 0.0148 Tl $^{2.9417}$
Oreochromis niloticus	2.8386	A-	Tw = 0.0304 Tl $^{2.8386}$

A- = negative allometry, A+ = positive allometry.

Table 3. Relative condition factor (Kr) in the three species.

Species	Relative condition factor (Kr)		
	Min	Max	Mean
Micropterus salmoides	0.757	1.278	1.005
Cyprinus carpio	0.717	1.806	1.078
Oreochromis niloticus	0.729	1.495	1.008

Table 4. Comparison of the parameters of the size-weight relationship of the three species with the results of other authors

Species	Authors and Year	Study region	A	B	R^2
Micropterus salmoides	Schulz and Leal (2005)	Brazil (Reservoir in southern Brazil)	—2.32	3.28	0.992
	Inman and al (2015)	USA (Cain Lake)	-4.9409	3.1349	
	Taylor and Weyl (2017)	South Africa (Wriggleswade)		3.033	0.989
	Taylor and Weyl (2017)	South Africa (Mankazana)		3.296	
	Keyombe et al. (2020)	Kenya (Lake Naivasha)	0.0082	3.1459	0.9748
	Present study	Morocco (Al-Massira Dam)	0.0055	3.2816	0.9692
Cyprinus carpio	Carlander (1969)	Japan (Shioda Plain)	0.0060	3.210	
	Kirankaya and Ekmekçi (2004)	Turkey (Gelingülü Dam Lake)	0.022	3.023	0.956
	Tarkan and al, (2006)	Turkey (Lake Iznik)	0.0250	2.830	
	Karatas and al. (2007)	Turkey (Almus Dam Lake)	0.005	3.319	0.944
	Moradinasab and al. (2012)	Iran (Caspian Sea)	0.0314	2.8449	0.93
	Present study	Morocco (Al-Massira Dam)	0.0148	2.9417	0.967
Oreochromis niloticus	Gómez-Márquez and al. (2008)	Mexico (Lake Coatetelco)	0.1207	2.469	0.8114
	Waithaka and al, (2020)	Kenya (Lake Naivasha)	0.031	2.86	0.92
	Shija (2020)	Ethiopia (Lake Chamo)	0.0102	3.1779	0.972
	Yem and al. (2020)	Nigeria (Wase Dam)	0.10	1.52	0.81
	Mohamed and Salman (2021)	Iraq (Garmat Ali River)	0.012	3.109	0.969
	Present study	Morocco (Al-Massira Dam)	0.0304	2.8386	0.9799

[27] in Lake Mankazana in South Africa and [28] in Lake Naivasha in Kenya. Only the results obtained by [27] at Lake Wriggleswade in South Africa are different.

For common carp, the value of b is less than 3 (b= 2.9417) and shows that the growth of common carp has a negative allometric type characterized by growth in length more than growth in weight. Negative allometry was highlighted for the same species by [29] in Turkey (Lake Iznik) and [30] in Iran (Caspian Sea). On the other hand, [31] revealed that the allometric coefficient of common carp indicates positive allometric growth in Korea. [32] observed such growth for the same species in Turkey (Almus Dam Lake). While, [33] found isometric growth in the same species in Gelingülü Dam Lake in Turkey (Table 4).

The value of the tilapia allometric coefficient also suggests a negative allometric growth (b= 2.8386 < 3). [34] found a similar result in Lake Coatetelco , the same results were suggested by [35] in Lake Naivasha and [36] in Wase Dam. However, [37] obtained in Lake Chamo, a major growth of this species. The same result was obtained by [38] in Garmat Ali River.

According to the previous results, a variation of the allometry coefficient (b) is observed for the three species.

These variations can be linked to several factors. Indeed, the literature mentions that the allometry coefficient can be influenced by sex, growth phase, stomach contents, level of gonad development [39] and environmental conditions [40] (Table 4).

The values of the relative condition factors (Kr) of all the studied species are higher than 1, which suggests that these species were in good conditions in their biotope (Al-Massira Dam).

5 Conclusion

The present study, which provides information on the length-weight and condition coefficients of three of the most abundant fish species in the Al-Massira Dam, is one of the few studies dealing with the biology of Moroccan freshwater fish. It mainly provides an important data base for researchers and nature managers in elaborating management and conservation measures for the fish populations of the Al-Massira Dam. The condition coefficient is always higher than 1, which indicates the well-being of the fish within their biotope.

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