Length-weight and length-length relationships and condition factors of 30 actinopterygian fish from the Mono basin (Benin and Togo, West Africa)

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ABSTRACT

Based on their catches, this study describes the length-weight relationships (LWRs), length-length relationships (LLRs), and condition factors (K) of the 30 most common actinopterygian fish found in the Mono basin. A total of 6,591 specimens were caught, using multiple gears and fishing methods, between February 2011 and May 2014. The allometric *b* coefficient of the LWRs ($BW = a \times TL^b$) ranged between 2.650 for *Polypterus senegalus* and 3.468 for *Awaous lateristriga* with an average of 2.993 ± 0.177. Thirteen species had an isometric growth, seven species a negative allometric growth, and for the remaining ten species, growth was positive allometric. Regarding the LLRs, the coefficient of determination r^2 was significant and ranged from 0.905 in *Petrocephalus bovei* to 0.999 in *Parachanna obscura* with an average of 0.973 ± 0.027. The condition factor ($K = BW/TL^b \times 100$) ranged from 0.406 ± 0.044 in *A. lateristriga* to 2.374 ± 0.805 in *Lates niloticus*, with an overall average of 1.145 ± 0.161.

The Mono basin constitutes one of the most important fishing areas in Benin and Togo. Fishing activities in the basin have significantly increased since the construction of the Nangbéto dam in 1987 and the artificial lake is currently regarded as the main fishing ground of the basin. Fishing pressure has increased the urgency to establish a regulatory framework for the sustainable management of these fish populations. This regulatory framework requires baseline information on the population dynamics of the target species. Data on the length and weight have often been analyzed to obtain this information (Le Cren, 1951; Froese, 2006). The lengthweight relationship has been widely used in stock assessment analyses to estimate biomass by size and management of fish populations (Le Cren, 1951; Petrakis and Stergiou, 1995). This empirical relationship provides information on growth patterns and can be used to predict the weight corresponding to a given length in yield evaluation (Le Cren, 1951; Garcia *et al*., 1989; Petrakis and Stergiou, 1995; Sparre and Venema, 1998; Blackwell *et al*., 2000; Haimovici and Velasco, 2000). It is also used in studying gonadal development, feeding rate, metamorphosis and maturity (Le Cren, 1951; Petrakis and Stergiou, 1995). When available, it can contribute significantly to the improvement of fisheries statistics. Similarly, the condition factor, closely related to the growth pattern of the species, has been used as an indicator of health in studies of fisheries biology on growth and feeding intensity (Froese, 2006). The condition factor provides information on the change in the physiological state of fish and can be used to compare mono-specific populations in similar or different conditions (Le Cren, 1951; Lizama and Ambrosia, 2002).

Despite the usefulness of length-weight relationship and condition factor in fishery science and the importance of the Mono basin for the fisheries of Benin and Togo, information on the growth and the condition of exploited fish species in the basin are non-existent. To fill this gap, this study focused on the weight-length relationships (LWRs), length-length relationships (LLRs) and condition factors (K) of the most common fish species in the catches and classified them based on the growth model. This could contribute to improve the quality of statistics collected by fisheries managers across the Mono basin. In the context of the installation of a new dam at Adjarala (Fig. 1), this study can serve as a benchmark reference for the regular tracking of both species abundance and biomass within the framework of assessing the dam impact on the fisheries.

MATERIAL AND METHODS

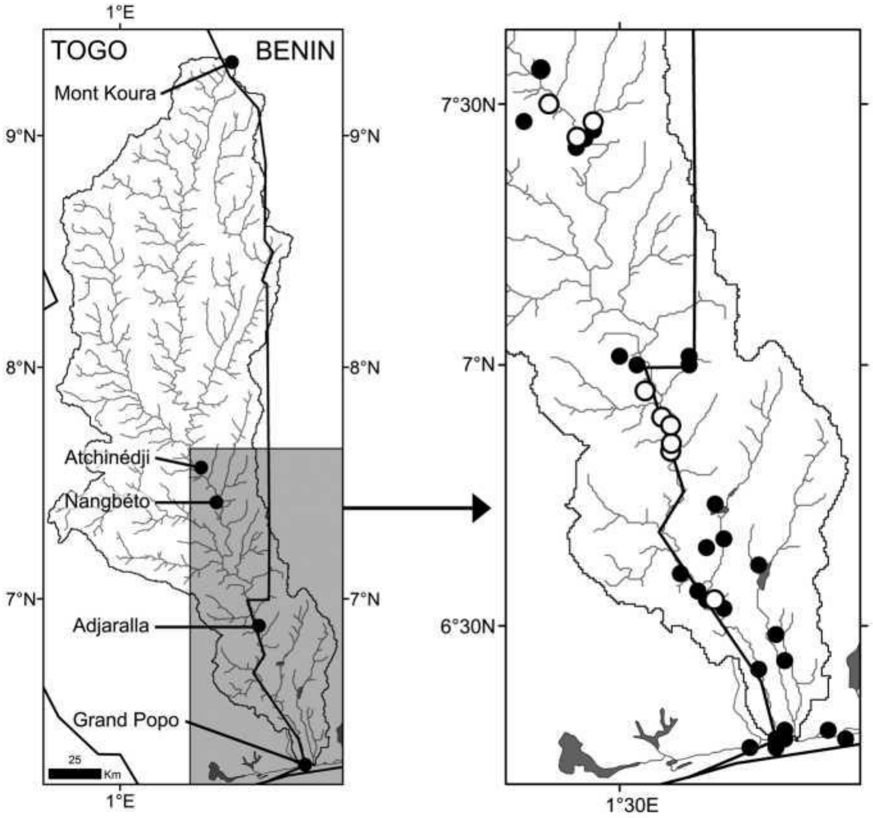
STUDY AREA

The Mono basin is a transboundary coastal basin, with its lower course (approximately 100 km) forming the border between Togo and Benin (Fig. 1). Its source is situated in North-western Benin in the Mountains of Koura at Alédjo (± 9°21'N-01°27'E). The basin has an approximate length of 360 km and drains a watershed of approximately 22,000 km^2 between 6°10' and 9°00' North latitudes and 0°30' and 1°50' East longitudes. The catchment area is made up of two climate zones: (1) the tropical climate zone, situated north of the 8th parallel, is characterized by two seasons, a dry season (November to March) and a rainy season (April to October) with an average total rainfall ranging from 1000 to 1300 mm/year; and (2) the sub-equatorial climate zone is situated south of the 8th parallel and is characterized by four seasons: two dry seasons (December to March and July to September) alternating with two rainy seasons (March to July and September to November), totalling an average from 900 to 1100 mm/year (Paugy and Bénech, 1989; Amoussou, 2010; Laïbi *et al*., 2012). The Nangbéto hydroelectric dam, built ± 180 km upstream from the mouth of the Mono, is the only major man-made structure affecting the hydrology of the watershed. The reservoir, which became operational in 1987, covers an area of ± 180 km^2, has a maximum depth of ± 40 m, and a water storage capacity of ± 1,715 Mm^3 (million cubic meters). A second hydroelectric dam is planned at the site of the Adjarala rapids (Fig. 1), approximately 100 km downstream from Nangbéto (Anonyme, 1992, 1997).

DATA COLLECTION

Some of the data used in this study were collected during fishing expeditions conducted between February 2011 and May 2014 at various stations for the study of fish diversity within the Mono basin. However, the bulk of the data was collected during four experimental fishing trips (in the months of January and September 2012 and 2013) at ten stations (Fig. 1) for the purposes of studying the structure of the ichthyofauna, which will be discussed in more detail in a separate paper. At each of the ten stations, fish were caught during two consecutive nights using five gillnets, each measuring 30 m long and 1.5 m deep, with 10, 12, 17, 20 and 22 mm sided square-opening mesh sizes, respectively.

Figure 1. *- Study area with sampling stations. Some stations were combined into one for being too close to each other.* ***O****: ecological stations; ●: other stations.*



At the other 29 stations, a battery of monofilament gillnets (30 m long and 1.5 m deep) of different mesh sizes (6, 8, 10, 12, 15, 17, 20, 22, 25, 30, 35 mm sided square openings) was used. In addition to gillnets, four main methods were used: traps in marsh zones that are difficult to sample with gill- net, cast nets in riffle areas, hook and fishing line in shallow areas and scoops in backwaters less than 5 cm deep and under vegetation. Additional specimens were bought from local fishermen who used gillnets, beach seine, castnets, fishing lines, traps, and acadjas as tools. Taxonomic identification was performed using the keys in Paugy *et al*. (2003a, b). The fish were measured in the field for total length (TL) and standard length (SL) to the nearest 0.1 cm and were then weighed (fresh weight, BW) to the nearest 0.01 g. Fish identification was certified by the Royal Museum for Central Africa (RMCA-Tervuren) where a reference collection has been deposited.

DATA ANALYSIS

In this study, the relationship between total length and total weight was determined using the equation $BW = a \times TL^b$ (Le Cren, 1951), where *BW* is wet body weight (g), *TL* total length (cm), *a* the intercept and *b* the slope of the linear regression. If $b = 3$, the growth is isometric; however, it is allometric if $b \neq 3$. If *b* is greater than 3, then a better growth has taken place in terms of weight rather than in terms of length; the opposite is true if *b* is less than 3. The 95% confidence limits for *b* were assessed using Statview software version 1992-98 (SAS Institute INC).

In order to check whether *b* is significantly different from 3, Student t-test was conducted following Sokal and Rohlf (1987): $ts = (b - 3) / SE$, where *ts* is the t-test value, *b* the slope, and SE the standard error of *b*. The Shapiro-Wilk W test was used to test the normality in the distribution of values of *b*. All tests were considered significant at the 5% level ($p < 0.05$). As mentioned by Lalèyè (2006), Konan *et al*. (2007) and Tah *et al*. (2012), only species represented by a sample size of more than 10 specimens were taken into account. The LLRs were established using a linear regression analysis, $TL = p + q\ SL$ where *p* and *q* are the intercept and slope, respectively. Condition factor K was estimated using the equation $K = BW / TL^b \times 100$ (Tesch, 1971), where *BW* and *TL* are the variables used to determine the LWRs. The taxonomic order of the families follows that adopted by Nelson (2006) while the genera and species follow an alphabetical order.

RESULTS

A total of 6,591 specimens belonging to 16 families, 25 genera and 30 species were used in this study. The Cichlidae family has the highest number of species (6) followed by the Cyprinidae (4) and Mormyridae (3). The remaining families were represented by one or two species only.

The size of the studied specimens ranged from 3.5 to 43.0 cm TL while the total body weight varied from 0.8 to 903.81 g. *Sarotherodon galilaeus* (Linnaeus, 1758) had the highest number of fish sampled (n = 2,515) and the smallest length and weight recorded. *Marcusenius senegalensis* (Steindachner, 1870) had the smallest sample size (n = 10), with a size ranging from 13.3 to 17.4 cm TL and weight ranging from 22.5 to 51.16 g. The species with the largest size in our catches was *Brycinus macrolepidotus* Valenciennes, 1850 with a total length ranging from 6.8 to 43.0 cm and total body weight ranging from 3.48 to 903.81 g.

For all the species studied, the coefficient of determination (r^2) for LWRs was both positive and significant. It ranged from 0.863 for *Enteromius callipterus* (Boulenger, 1907) to 0.999 for *Labeo parvus* Boulenger, 1902 with an average of 0.957 ± 0.038. Only two species (6.7%) have a coefficient of determination smaller than 0.90 (Tab. I). The intercept (*a*) ranged from 0.004 for *Awaous lateristriga* (Duméril, 1861), *Elops lacerta* Valenciennes, 1847 and *Schilbe intermedius* Rüppell, 1832 to 0.023 for *Lates niloticus* (Linnaeus, 1762) with an average of 0.011 ± 0.005. The allometric coefficient *b* ranged from 2.650 for *Polypterus senegalus* Cuvier, 1829 to 3.468 for *A. lateristriga* with an average of 2.993 ± 0.177 (Tab. I).

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Regarding the type of growth, thirteen species (43.3%) showed isometric growth (*b* = 3). Further, negative allometric growth was observed for eleven species (23.3%) whose *b* coefficient was less than 3 and significantly different from 3. Finally, ten (33.4%) species presented a *b* coefficient greater than 3 and significantly different from 3, indicating that their growth is positive allometric. Frequency distribution for *b* was normal (Shapiro-Wilk W = 0.96, p = 0.35).

For the LLRs (Tab. II), the coefficient of determination r^2 obtained was significant and ranged from 0.905 for *Petrocephalus bovei* (Valenciennes, 1847) to 0.999 for *Parachanna obscura* (Günther, 1861) with an average of 0.973 ± 0.027. Condition factors K varied by an average of 0.406 ± 0.044 in *A. lateristriga* and 2.374 ± 0.805 for *L. niloticus* (Tab. II) with an overall average of 1.145 ± 0.161.

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***Table I.** - Descriptive statistics and estimated parameters of length-weight relationships (BW = a x TLb) for 30 selected fish species collected from the Mono basin. Abbreviations: A+: positive allometric growth; A-: negative allometric growth; a: intercept; b: allometric growth coefficient = slope; BW: body weight; CL: confidence limit; I: isometric growth; J: juvenile; Min: minimum; Max: maximum; N: sample size; r^2: coefficient of determination; TL: total length.*

	N	*TL* (cm)	*BW* (g)	Regression parameters					Growth
		Min-Max	Min-Max	*a*	95% CL of *a*	*b*	95% CL of *b*	r^2	
Polypteridae									
Polypterus senegalus Cuvier, 1829	15	22.3-30.3	53.70-126.40	0.015	0.004-0.062	2.650	2.214-3.086	0.93	A-
Mormyridae									
Marcusenius senegalensis (Steindachner, 1870)	10	13.3-17.4	22.50-51.16	0.01	0.001-0.103	2.941	2.109-3.772	0.909	I
Mormyrops anguilloides (Linnaeus, 1758)	18	15.1-40.5	25.11-396.12	0.008	.005-0.014	2.896	734-3.057	0.990	I
Petrocephalus bovei (Valenciennes, 1847)	131	7.7-10.0	3.60-12.47	0.009	0.006-0.015	3.039	2.825-3.251	0.873	I
Elopidae									
Elops lacerta Valenciennes, 1847	27	18.1-22.6	8.90-119.30	0.004	0.004-0.006	3.070	2.992-3.148	0.996	A+
Clupeidae									
Pellonula leonensis Boulenger, 1916	115	7.6-11.3	3.15-11.38	0.015	0.010-0.023	2.716	2.521-2.910	0.902	A-
Cyprinidae									
Enteromius callipterus (Boulenger, 1907)	215	6.1-8.5	2.83-7.61	0.012	0.009-0.018	2.957	2.787-3.127	0.863	I
Enteromius chlorotaenia (Boulenger, 1911)	170	7.0-9.8	4.09-10.63	0.012	0.009-0.019	2.949	2.778-3.120	0.901	I
Labeoparvus Boulenger, 1902	44	7.8-28.0	5.84-242.83	0.008	0.006-0.010	3.099	3.004-3.195	0.999	A+
Labeo senegalensis Valenciennes, 1842	42	10.8-34.6	8.46-368.85	0.008	0.005-0.015	3.043	2.864-3.221	0.968	I
Alestidae									
Brycinus macrolepidotus Valenciennes, 1850	154	6.8-43.0	3.48-903.81	0.008	0.007-0.009	3.075	3.023-3.128	0.988	A+
Hepsetidae									
Hepsetus odoe (Bloch, 1794)	26	10-28.8	8.62-189.50	0.006	0.004-0.009	3.074	2.920-3.228	0.986	I
Clariidae									
Clarias gariepinus (Burchell, 1822)	57	15.0-31.3	20.73-179.92	0.01	0.005-0.016	2.839	2.669-3.009	0.953	A-

Claroteidae									
Chrysichthys auratus (Geoffroy Saint-Hilaire, 1808)	13	17.0-19.3	4.00-66.70	0.012	0.006-0.026	2.801	2.536-3.066	0.980	I
Chrysichthys nigrodigitatus (Lacepède, 1803)	30	6.8-33.2	3.55-279.70	0.017	0.012-0.023	2.731	2.610-2.853	0.987	A-
Schilbeidae									
Schilbe intermedius Rüppell, 1832	20	11.3-25.5	7.99-37.45	0.004	0.002-0.014	3.128	2.737-3.519	0.947	A+
Schilbe mystus (Linnaeus, 1758)	230	8.1-35.2	2.31-37.45	0.005	0.004-0.006	3.046	2.977-3.115	0.971	I
Mugilidae									
Liza falcipinnis (Valenciennes, 1836)	45	9.3-34.0	6.31-330.46	0.007	0.006-0.008	3.072	3.006-3.139	0.995	A+
Mugil cephalus Linnaeus, 1758	60	10.1-29.4	8.66-272.15	0.01	0.007-0.014	3.015	2.875-3.156	0.972	I
Latidae									
Lates niloticus (Linnaeus, 1762)	17 (J)	5.0-32.4	3.71-437.4	0.023	0.008-0.063	2.754	2.367-3.141	0.938	A-
Carangidae									
Caranx hippos (Linné, 1766)	23 (J)	6.4-12.5	3.51-28.22	0.012	0.008-0.020	3.035	2.821-3.249	0.976	I
Cichlidae									
Chromidotilapia guntheri (Sauvage, 1882)	64	5.3-13.0	2.58-36.60	0.012	0.009-0.015	3.197	3.080-3.314	0.980	A+
Hemichromis fasciatus Peters, 1858	71	6.1-16.1	3.05-71.21	0.009	0.006-0.015	3.305	3.117-3.494	0.962	A+
Oreochromis niloticus Günther, 1889	219	8.4-23.1	11.80-71.21	0.022	0.016-0.031	2.934	2.804-3.065	0.901	I
Sarotherodon galilaeus (Linnaeus, 1758)	2515	6.1-24.5	4.00-265.75	0.019	0.018-0.020	3.007	2.989-3.024	0.978	I
Chromidotilapia guntheri (Sauvage, 1882)	64	5.3-13.0	2.58-36.60	0.012	0.009-0.015	3.197	3.080-3.314	0.980	A+
Tilapia guineensis (Bleeker *in* Günther, 1862)	476	5.6-17.2	3.50-322.00	0.017	0.015-0.020	3.050	3.000-3.100	0.969	A+
Gobiidae									
Awaous lateristriga (Duméril, 1861)	133	6.3-13.8	2.27-35.33	0.004	0.003-0.005	3.468	3.358-3.579	0.968	A+
Porogobius schlegelii (Günther, 1861)	124	6.0-12.2	1.57-13.38	0.012	0.008-0.016	2.780	2.634-2.926	0.935	A-
Channidae									
Paracchana obscura Teugels & Daget, 1984	11	16.2-34.2	33.70-413.15	0.005	0.003-0.010	3.154	2.944-3.363	0.992	A+

Table II. *- Descriptive statistics and estimated parameters of length-length relationships (TL = p + q SL)* *and condition factors for 30 selected fish species collected from the Mono basin. Abbreviations: J: juvenile; N: sample size; p: intercept; q: slope; r^2: coefficient of determination; SL: standard length; TL: total length.*

	N	Regression parameters			Condition factor	
		TL = p+q SL	SE of *b*	*r2*	Min-Max	Mean ± SD
Polypteridae						
Polypterus senegalus Cuvier, 1829	15	1.283 + 1.072 SL	0.063	0.963	1.389-1.839	1.536 ± 0.109
Mormyridae						
Marcusenius senegalensis (Steindachner, 1870)	10	3.096 + 0.967 SL	0.100	0.922	0.733-1.251	1.052 ± 0.143
Mormyrops anguilloides (Linnaeus, 1758)	18	-0.493 + 1.145 SL	0.018	0.996	0.820-0.730	0.820 ± 0.062
Petrocephalus bovei (Valenciennes, 1847)	131	1.393 + 1.019 SL	0.032	0.905	0.652-1.338	0.951 ± 0.095
Elopidae						
Elops lacerta Valenciennes, 1847	27	0.597 + 1.257 SL	0.013	0.998	0.401-0.483	0.449 ± 0.017
Clupeidae						
Pellonula leonensis Boulenger, 1916	115	0.479 + 1.178 SL	0.035	0.931	1.272-1.788	1.498 ± 0.117
Cyprinidae						
Enteromius callipterus (Boulenger, 1907)	215	1.012 + 1.146 SL	0.024	0.928	0.806-3.704	1.339 ± 0.296
Enteromius chlorotaenia Boulenger, 1911	170	0.678 + 1.182 SL	0.024	0.941	0.750-2.175	1.272 ± 0.181
Labeo parvus Boulenger, 1902	44	0.312 + 1.278 SL	0.020	0.990	0.677-1.042	0.811 ± 0.085
Labeo senegalensis Valenciennes, 1842	42	0.167 + 1.332 SL	0.029	0.982	0.608-1.011	0.877 ± 0.085
Alestidae						
Brycinus macrolepidotus Valenciennes, 1850	154	0.559 + 1.243 SL	0.006	0.996	0.493-1.656	0.809 ± 0.118
Hepsetidae						
Hepsetus odoe (Bloch, 1794)	26	-0.019 + 1.273 SL	0.018	0.995	0.440-0.727	0.558 ± 0.060
Clariidae						
Clarias gariepinus (Burchell, 1822)	57	-0.210 + 1.179 SL	0.029	0.969	0.250-1.333	0.954 ± 0.139
Claroteidae	13	0.275 + 1.362	0.074	0.969	1.005-1.664	1.249 ±

Chrysichthys auratus (Geoffroy Saint-Hilaire, 1808)		SL				0.166
Chrysichthys nigrodigitatus (Lacepède, 1803)	30	-0.383 + 1.396 SL	0.032	0.986	1.350-2.314	1.686 ± 0.230
Schilbeidae						
Schilbe intermedius Rüppell, 1832	20	0.008 + 1.205 SL	0.023	0.994	0.350-0.573	0.489 ± 0.069
Schilbe mystus (Linnaeus, 1758)	230	0.100 + 1.230 SL	0.007	0.992	0.226-1.008	0.481 ± 0.063
Mugilidae						
Liza falcipinnis (Valenciennes, 1836)	45	0.043 + 1.308 SL	0.016	0.994	0.596-0.764	0.670 ± 0.040
Mugil cephalus Linnaeus, 1758	60	-0.198 + 1.328 SL	0.008	0.998	0.515-1.208	0.989 ± 0.126
Latidae						
Lates niloticus (Linnaeus, 1762)	17 (J)	-0.311 + 1.255 SL	0.023	0.995	0.836-4.980	2.374 ± 0.805
Carangidae						
Caranx hippos (Linnaeus, 1766)	23 (J)	0.368 + 1.285 SL	0.027	0.992	1.012-1.479	1.242 ± 0.123
Cichlidae						
Chromidotilapia guntheri (Sauvage, 1882)	64	-0.260 + 1.344 SL	0.017	0.991	0.970-1.429	1.182 ± 0.101
Hemichromis fasciatus Peters, 1858	71	0.030 + 1.260 SL	0.032	0.964	0.200-1.689	0.949 ± 0.269
Oreochromis niloticus Günther, 1889	219	0.953 + 1.195 SL	0.015	0.965	0.972-3.681	2.240 ± 0.491
Sarotherodon galilaeus (Linnaeus, 1758)	2515	0.281 + 1.298 SL	0.003	0.985	1.437-2.835	1.935 ± 0.174
Sarotherodon melanotheron Rüppell, 1852	1516	-0.044 + 1.307 SL	0.005	0.986	1.262-3.972	2.060 ± 0.216
Tilapia guineensis (Bleeker *in* Günther, 1862)	476	1.165 + 1.1762 SL	0.009	0.975	0.870-2.976	1.758 ± 0.258
Gobiidae						
Awaous lateristriga (Duméril, 1861)	133	0.871 + 1.115 SL	0.025	0.938	0.289-0.514	0.406 ± 0.044
Porogobius schlegelii (Günther, 1861)	124	-1.073 + 1.564 SL	0.038	0.936	0.867-1.811	1.168 ± 0.126
Channidae						
Paracchana obscura Teugels & Daget, 1984	11	0.569 + 1.175 SL	0.013	0.999	0.488-0.602	0.537 ± 0.034

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DISCUSSION

The LWR is the most important biological parameter for the management and conservation of natural fish populations (Hossain *et al*., 2012). Beside its classical function as a tool for predicting length from weight and vice versa, this relationship is also used in biological and biometric studies, as in the case of the study conducted on the fishery condition (Garcia-Berthou and Moreno-Amich, 1993). This is the first LWRs study on fish found within the Mono basin and could, as a result, serve as an effective tool in providing an overview of the growth strategies of the different fish species studied.

An analysis of size frequencies reveals a large variation in fish sizes (3.5 to 43.0 cm), indicating that the sampling has taken into account both juvenile and adult individuals of the studied species. The use of gillnets of different mesh sizes (6, 8, 10, 12, 15, 20, 25, 30, 35 mm) has contributed to this size variation. The high and positive coefficient of determination values (r^2 = 0.957 ± 0.038) for all the species investigated in this study suggests that an increase in length causes an increase in fish weight. Furthermore, the values of *b* are within the usual bracket of 2 to 4 often found in fish according to Bagenal and Tesch (1978). At the same time, all of these values ranged from 2.6 to 3.4, confirming Carlander suggestion that the *b* coefficient should normally fall between 2.5 and 3.5 (Carlander, 1969). According to Carlander (1977), *b* values less than 2.5 or greater than 3.5 are often derived from samples with narrow size ranges, outliers in the data ($r^2 < 0.95$), inclusion of juveniles that have not yet reached adult body shape (Lmin < 0.1 Lmax), low number of individuals (< 10), only juveniles or only adults in data set. Recently, Froese *et al*. (2014) have shown that, for most species, *b* falls between 2.9 and 3.1. 66.7% of the values obtained are within that range. For species studied here, the range for *b* values (2.650 to 3.468) is similar to that recorded by Ecoutin and Albaret (2003). In fact, they have reported *b* values within the range of 2.458 to 3.473 for 52 species in West African lagoons and estuaries, while Lalèyè (2006) has reported 2.330 to 3.518 for 52 species from the Ouémé basin in Benin, Konan *et al*. (2007), 2.213 to 3.729 for 57 species from the coastal rivers of South-eastern Ivory Coast, and Tah *et al*. (2012), 2.173 to 3.472 for 36 species from lakes Ayame I and Buyo in Ivory Coast. The average value of the *b* coefficient estimated at 2.993 ± 0.177 is not significantly different from 3 (Student t-test: p = 0.05), suggesting that "cube law" (Froese, 2006) can be applied to most of the fish species from the Mono basin.

Generally, condition factor (K) is used to compare the "condition", "fatness" or "well-being" of fish and is based on the assumption that heavier fish of a given length are in a better condition (Bagenal and Tesch, 1978; Froese, 2006). The condition factor, however, is strongly influenced by biotic and abiotic environmental conditions and can therefore be used as an index to assess the state of the aquatic ecosystem in which the studied fish are living (Anene, 2005; Baby *et al*., 2011). The methods used to assess the condition of fishes are varied and may include morphometric measurements as well as physiological and biochemical (lipid content) data. The morphometric measurements used in this study reveal that condition factors for the 30 fish species from the Mono basin are between 0.406 and 2.374. However, significant interspecific and intraspecific differences in the condition factors were obtained. The use of total weight, *i.e.*

including gonads of the examined specimens and the mixing of sexes may partially explain the differences between species. In addition, the difference between specimens of the same species may be attributed to the use of total weight, which also includes the mass of the stomach content and gonads. Indeed, stomach content induced bias could result in differing observations from one specimen to another, especially because the stomach content represents an important proportion of the *BW* in some small-sized species. Gonads, on the other hand, are likely to significantly alter the weight of certain species during the breeding season. We did not take into account the sex of individuals in our study and therefore the condition of each species represents an average of the population. An examination of the condition factors calculated for the 30 fish species reveals that all the species have their condition factor outside the range of 2.9 to 4.8 recommended as suitable for matured freshwater species (Bagenal and Tesch, 1978). This could be due to the current status of the Mono River. Since the installation of the Nangbéto dam, a disturbance in the river flow has been observed whereby the discharge has become static with, especially, a capping of the peak discharge rate (Oyédé, 1991). Variations in river flows are known to have major impacts on aquatic habitats and on fish populations (Stalnaker *et al*., 1989; Albert, 1996). Usually, increasing the usable land surface area by means of flooding reduces competition while simultaneously increasing the number of habitats that could support nurseries, as it does the available resources (Albert, 1996). Floods are rare in the Mono basin and thus floodplains are often inaccessible to fish. Also, erratic discharges of large quantities of water in a short time can be a source of stress, affecting the fish's condition. This could explain the low values observed. Seasonal and spatial locations are additional factors that can influence the condition of fishes in a basin. Furthermore, there currently exists in the published literature no work on the condition of fisheries, which can be used as a reference. Consequently, the results presented here will serve as an important basis for future comparisons.

CONCLUSION

Our results contribute to a better understanding of the biological condition of the most abundant fish species within the Mono basin. Specifically, the study provides baseline data on the length-weight and length-length relationships for 30 actinopterygian fish and also provides their condition factors. This study will be useful for further population assessments of these species in the basin. It also provides information that can be used by fishery biologists, managers and conservationists to initiate strategies and regulations for the conservation and sustainable harvesting of fish stocks.

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