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RESEARCH ARTICLE

Evaluation of length-weight and length-length relationships of some of the most abundant commercial fishes from the Couffo River basin (Benin, West Africa)

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Abstract. The Couffo basin is not well known, and neither are its aquatic living resources, such as fish fauna, which are subjected to high exploitation rates. The objectives of this study were to establish length-weight ratios (LWRs) and length-length ratios (LLRs) for the most important species in the catches and those of certain economic value. A total of 12,191 specimens belonging to 40 commercial species of actinopterygian fishes were caught with several fishing gears and methods between February 2018 and March 2021. Allometric coefficient b of the LWRs (BW = $a \times TL^b$) ranged from 2.194 for *Enteromius callipterus* to 3.673 for *Protopterus annectens* with a mean of 2.902 ± 0.315. The growth of thirteen species was isometric, that of fourteen species was negatively allometric, and that of the remaining thirteen species was positively allometric. Coefficient of determination r^2 for the LLRs of 39 of the 40 selected species mentioned above was significant and ranged from 0.781 in *Gobionellus occidentalis* to 0.997 in *Elops senegalensis* with a mean value of 0.951 ± 0.049. The results will be useful for further studies on assessments of population dynamics and the sustainable conservation of the already limited fish stocks in the Couffo River basin.

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Introduction

Beninese continental waters abound with diverse aquatic fauna (Lalèyè et al. 2003, 2004, Moritz et al. 2006, Montchowui et al. 2007, Moritz 2010, Ahouansou Montcho 2011, Lederoun 2015, Lederoun et al. 2018a, 2018b, Adjibade et al. 2019, Imorou et al. 2019, Moritz and Lalèyè 2019) and free access year round (Lederoun et al. 2016a, 2020). This explains the overexploitation of the resources (Niyonkuru 2007, Lederoun et al. 2015, 2016a) and the need to identify sustainable management measures to avoid the depletion of stocks that are still available. Studies in this direction have been conducted in recent years, but they remain focused on the Ouémé (Lalèyè 2006, Niyonkuru et al. 2007, Montchowui et al. 2009, 2011, Lederoun et al. 2018b, 2020) and Mono (Ahouansou Montcho and Lalèyè 2008, Lederoun et al. 2015, 2016a, 2016b, 2020) basins. The Couffo River basin located between these two ecosystems has never been thoroughly investigated despite the importance of its estuarine system (Lake Ahémé-Ahô channel-Coastal lagoon) in the supply of animal protein to the populations of southern Benin (Viaho et al. 2020). The situation is worrying today, especially since no complete data are available on the basin as a whole. The government of Benin decided to rehabilitate the estuarine part of the basin, which is degraded by eutrophication and poor fishing practices, through partial and sectoral dredging. Consequently, studies aiming to establish the reference situation were undertaken in the estuary on ichthyofauna, macro-invertebrates, and sedimentary dynamics in particular. When baseline data are being compiled on fish diversity in the estuary (Viaho et al. 2020), it is desirable that valuable information such as length-weight relationships (LWRs) and length-length relationships (LLRs) for commercially important fish be available to improve in the basin, among other things, fishing statistics before dredging. It is also important to have data on the importance of species of economic interest that is as reliable as possible and up to date. Currently, the lack of reliable catch statistics for the basin is explained by the difficulty of data collection by officials, and determining weight-length and length-length keys will contribute significantly to the improvement of fisheries statistics (Lederoun et al. 2016b, 2018b). Several authors (Sarkar et al. 2009, Muchlisin et al. 2010, Hossain et al. 2012) have mentioned that LWRs and LLRs are the most important biological parameters for the management and conservation of natural populations. Therefore, this study presents the first reference on LWRs and LLRs of the commercial fishes in the Couffo River basin of Benin.

Materials and Methods

Study area

The Couffo River originates in Togo in the Djami Mountains (Fig. 1) at an altitude of 240 m near the Beninese border in the village of Oroukou in Tchétti. It first follows a NW-SE direction and then, after 100 km, it cuts into the Continental Terminal formations and gradually takes a N-S direction (Le Barbé et al. 1993). After 54 km, it flows into Lake Ahémé, which is connected to the Grand-Popo and Ouidah lagoons and the sea through the Ahô channel. Its main course is about 190 km long. It flows in a narrow bed that is totally dry at low water between January and March except at its southern end in Bopa (Fig. 1). The longitudinal profile of the Couffo basin has an exponential rate, and the slopes range from 10 m km^{-1} at the head of the basin to 0.3 m km^{-1} upstream from Lake Ahémé. The main tributaries of the Couffo River are located in the northern part of the basin. They are, on the right bank, the Aiokpé (sub-catchment of 47 km^2), Honvé (166 km^2), and Dra (147 km^2), and on the left bank, the Gougou (36 km^2), Gougan (90 km^2), and Lahoun (Le Barbé et al. 1993).

There are two main climatic regions in the Couffo watershed: (1) the tropical zone that is located north of the 8th parallel is characterized by two seasons, one dry (November to March) and one rainy (April to October), and (2) the sub-equatorial zone that is located south of the 8th parallel is characterized by four seasons, with two dry seasons (December to March and July to September) alternating with two rainy seasons (March to July and September to November) (Amoussou 2010).

Data collection

The data were collected during ichthyological expeditions conducted between February 2018 and March 2021 at 48 sites used to inventory ichthyofauna, six of which were reserved for seasonal experimental fisheries to study ichthyofaunal structure (Fig. 1). Two sets of gillnets of different mesh sizes (8, 10, 12, 15, 20, 25, 30, 35, 40) with a length of 30 m and a drop of 1.5 m were used at the six ecological sites. In addition to gillnets, we used traps in marsh areas that were difficult to sample with gillnets, cast nets in swift areas, and hook and fishing lines in shallow areas. Additional specimens were purchased from local fishermen who used gillnets,

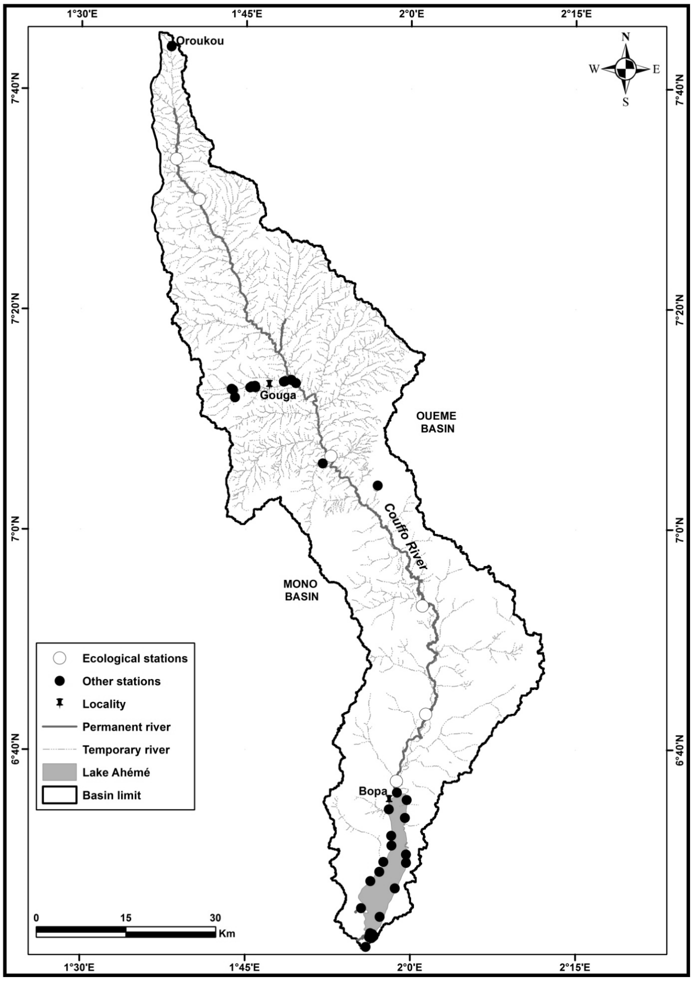

Figure 1. Study area with sampling sites. Some sites were combined since they were too close to each other.

traps dams, acadjas, longlines, and bamboo fishing gear. Taxonomic identification of the sampled species was done using Paugy et al. (2003a, 2003b), Musschoot and Lalèyè (2008), Lederoun and Vreven (2016). The fish sampled were measured in the field for total length (TL) and standard length (SL) to the nearest 0.1 cm and weighed (fresh weight, BW) to the nearest 0.01 g. Part of the samples were deposited at the Royal Museum for Central Africa (RMCA-Tervuren, Belgium) for future reference, which is a first for the Couffo River basin.

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 body weight (g), *TL* is total length (cm), *a* is the intercept, and *b* is the slope of the linear regression. The 95% confidence limits for *b* were assessed using Statview software (v. 5.0.1, SAS Institute). To check whether *b* was significantly different from 3, Student's t-test was performed according to Sokal and Rohlf (1987): $ts = (b-3) / SE$, where *ts* is the t-test value, *b* is the slope, and *SE* is the standard error of *b*. All tests were considered significant at the 5% level ($P < 0.05$). As mentioned by Lalèyè (2006), Konan et al. (2007), Tah et al. (2012), and Lederoun et al. (2016a, 2018b), only species represented by a sample size of more than 10 specimens were considered. LLRs were established using linear regression analysis $TL = p + q\,SL$, where p and q are the intercept and slope,

Table 1

Descriptive statistics and estimated parameters of length-weight relationships (BW = a × TL^b) for 40 selected fish species collected from the Couffo River 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; Min – minimum; Max – maximum; N – sample size; r^2 – coefficient of determination; TL – total length.

Family/Species	N	TL (cm)	BW (g)	Regression parameters					Growth
		Min–Max	Min–Max	*a*	*b*	SE of *b*	95% CL of *b*	r^2	
Polypteridae									
Polypterus senegalus Cuvier, 1829	89	12.5–24.7	8.6–84.08	0.003	3.17	0.072	3.15483–3.18517	0.978	A+
Mormyridae									
Hyperopisus bebe (Lacépéde, 1803)	19	7.6–12	4.8–15.47	0.026	2.512	0.185	2.4228–2.6012	0.957	A-
Marcusenius senegalensis (Steindachner, 1870)	29	6.8–20.2	3.15–54.17	0.024	2.631	0.097	2.5941–2.6679	0.982	A-
Petrocephalus bovei (Valenciennes, 1846)	123	5.1–21.3	1.36–50.6	0.029	2.536	0.079	2.52190–2.55010	0.945	A-
Elopidae									
Elops senegalensis Regan, 1909	30	11.8–28	8.9–119.3	0.004	3.069	0.034	3.05630–3.08170	0.998	A+
Ophichthyidae									
Dalophis boulengeri Blache et Bauchot, 1972	41	34–48.5	11.8–35.7	0.003	2.375	0.213	2.3078–2.4422	0.873	A-
Clupeidae									
Ethmalosa fimbriata (Bowdich, 1825)	652	4.9–15.5	1.3–37.2	0.019	2.689	0.033	2.68646–2.69154	0.954	A-
Pellonula leonensis Boulenger, 1916	12	9.2–20.6	6.32–66.67	0.008	3.008	0.028	2.99021–3.02579	0.999	I
Mochokidae									
Synodontis cf. obesus Boulenger, 1898	50	5–15.3	2.6–32.63	0.046	2.37	0.109	2.3390–2.4010	0.953	A-
Synodontis ouemeensis Musschoot & Lalèyè, 2008	37	8.3–35.9	5.22–293.4	0.022	2.673	0.087	2.6440–2.7020	0.982	A-
Cyprinidae									
Enteromius callipterus (Boulenger, 1907)	136	4.6–10.1	1.2–9.02	0.043	2.194	0.084	2.17975–2.20825	0.915	A-
Enteromius chlorotaenia (Boulenger, 1915)	64	5.6–10	1.98–10.85	0.008	3.104	0.108	3.0770–3.1310	0.964	A+
Labeo parvus Boulenger, 1903	30	9.1–21.6	7.36–98.98	0.01	2.984	0.095	2.9485–3.0195	0.986	I
Labeo senegalensis Valenciennes, 1844	26	9.8–20.8	9.79–90.74	0.011	2.97	0.12	2.9215–3.0185	0.981	I
Alestidae									
Brycinus longipinnis (Günther, 1864)	215	5.4–9.8	1.8–11.93	0.012	3.016	0.063	3.00753–3.02447	0.957	I
Hepsetidae									
Hepsetus odoe (Bloch, 1794)	11	8.1–23.2	6.12–86.55	0.01	2.839	0.178	2.7194–2.9586	0.983	I
Clariidae									
Clarias ebriensis Pellegrin 1920	97	5.6–25.3	1.86–124.59	0.014	2.774	0.074	2.75909–2.78891	0.968	A-
Clarias gariepinus (Burchell, 1822)	86	5.8–41.5	4.05–453.6	0.017	2.723	0.063	2.70949–2.73651	0.978	A-
Claroteidae									
Chrysichthys auratus (Geoffroy Saint-Hilaire, 1808)	164	7.1–19.8	2.6–58.85	0.013	2.763	0.064	2.75313–2.77287	0.959	A-
Chrysichthys nigrodigitatus (Lacepéde, 1803)	23	7.5–33.2	3.1–279.7	0.01	2.913	0.049	2.8918–2.9342	0.997	I
Schilbeidae									
Parailia pellucida (Boulenger, 1901)	96	5.6–19.9	0.9–55.03	0.002	3.406	0.058	3.39425–3.41775	0.987	A+
Schilbe intermedius Rüpell, 1832	94	6.4–21.3	1.41–73.92	0.003	3.286	0.059	3.27392–3.29808	0.986	A+
Mugilidae									
Neochelon falcipinnis (Valenciennes 1836)	18	10.3–14.8	8.31–28.2	0.006	3.127	0.162	3.0464–3.2076	0.979	A+
Carangidae									
Caranx hippos (Linnaeus, 1766)	25	6.4–13.2	3.51–31.1	0.011	3.073	0.089	3.0363–3.1097	0.99	I
Gerreidae									
Eucinostomus melanopterus (Bleeker, 1863)	78	5.7–14.4	2.3–37.7	0.01	3.091	0.053	3.07905–3.10295	0.989	A+
Cichlidae									
Chromidotilapia guntheri (Sauvage, 1882)	29	5.5–17.2	2.44–85.67	0.013	3.116	0.088	3.0825–3.1495	0.99	A+
Coptodon guineensis (Bleeker in Günther, 1862)	2986	3.6–23	1.2–209.12	0.015	3.063	0.016	3.06243–3.06357	0.962	A+
Hemichromis bimaculatus Gill, 1862	29	5.4–8.8	3–12.95	0.02	2.987	0.093	2.9516–3.0224	0.987	I
Hemichromis fasciatus (Peters, 1857)	59	6.3–13	3.6–40.39	0.015	2.994	0.119	2.9630–3.0250	0.958	I
Oreochromis niloticus (Linnaeus, 1758)	25	6.4–18.4	4.1–91.62	0.022	2.856	0.097	2.8160–2.8960	0.987	I
Sarotherodon melanotheron Rüppell, 1852	2563	4.1–27.2	1.2–218.3	0.014	3.102	0.012	3.10154–3.10246	0.981	A+
Eleotridae									
Dormitator lebretonis (Steindachner, 1870)	532	2.8–7.8	0.2–4.8	0.01	3.05	0.049	3.04583–3.05417	0.937	I

cont. Table 1

Family/Species	N	TL (cm)	BW (g)	Regression parameters					Growth
		Min–Max	Min–Max	*a*	*b*	SE of *b*	95% CL of *b*	r^2	
Eleotris senegalensis Steindachner, 1871	16	6.4–18.9	2.85–107.7	0.008	3.132	0.161	3.0462–3.2178	0.982	A+
Gobiidae									
Gobioides sagitta (Günther, 1862)	25	21.7–45	20.4–125.4	0.027	2.203	0.126	2.1510–2.2550	0.964	A-
Gobionellus occidentalis (Boulenger, 1909)	73	12.5–21.4	9.8–43.4	0.011	2.712	0.156	2.6756–2.7484	0.9	A-
Porogobius schlegelii (Günther, 1861)	3459	3.1–18.9	0.20–30–60	0.014	2.705	0.028	2.678–2.732	0.918	A-
Anabantidae									
Ctenopoma petherici Günther, 1864	42	7.4–14.2	7.91–54.27	0.029	2.818	0.16	2.7681–2.8679	0.941	I
Channidae									
Parachanna obscura (Gunther, 1861)	80	8.4–28.8	4.55–266.4	0.007	3.027	0.058	3.01409–3.03991	0.986	I
Paralichthyidae									
Citharichthys stampflii (Steindachner, 1895)	10	12.2–17.6	21.6–71.1	0.005	3.339	0.133	3.1994–3.4786	0.997	A+
Protopteridae									
Protopterus annectens (Owen, 1839)	18	25.2–47	45.44–542.3	0.0003	3.673	0.267	3.5402–3.8058	0.96	A+

respectively. The taxonomic order of families presented follows Nelson et al. (2016), while genera and species are arranged alphabetically.

Results

Table 1 presents the minimum and maximum values of total length, standard length, and total body weight of 12,191 specimens belonging to 40 species, 34 genera, and 22 families. *Porogobius schlegelii* was represented by the largest number of specimens (3,459), while *Citharichthys stampflii* was represented by 10 specimens.

The smallest recorded length was 2.8 cm TL for *Dormitator lebretonis*, while the largest was 47.0 cm TL for *P. annectens*. Weight ranged from 0.20 g for *D. lebretonis* and *P. schlegelii* to 542.3 g for *P. annectens*. The coefficients of correlation (r^2) were both positive for the length-weight relationships and significant for all species studied and ranged from 0.873 for *Dalophis boulengeri* to 0.999 for *Pellonula leonensis*. The intercept (*a*) ranged from 0.0003 for *P. annectens* to 0.046 for *Synodontis cf. obesus* with an average of 0.014 ± 0.010. Thirteen of the 40 species exhibited isometric growth ($b = 3$). The *b* coefficient was significant <3 for fourteen species, meaning that growth was negatively allometric. For the remaining thirteen species, the *b* coefficient was significantly greater than 3, indicating that the growth of these fish was positively allometric.

In the total length-standard length relationship established for 39 of the 40 species mentioned above, the correlation coefficient (r^2) obtained was significant for all species, ranging from 0.781 for *Gobionellus occidentalis* to 0.997 in *Elops senegalensis*, with an average value of 0.951 ± 0.049 (Table 2).

Discussion

Studies on weight-length and length-length relationships are of great importance for fish stock management (Le Cren 1951, Lalèyè 2006, Hossain et al. 2012, Tah et al. 2012, Lederoun et al. 2016b, 2018b). Among other things, these relationships can be used to predict the weight of a fish when its length is known (or vice versa) when assessing fishery yields (Pauly 1993, Écoutin and Albaret 2003, Froese 2006, Froese et al. 2014). Despite its importance, the first studies on LWRs and LLRs in Beninese rivers and water bodies date only from 2006 for the Ouémé River (Lalèyè 2006) and more recently for the Mono basin (Lederoun et al. 2016b) and the Ouémé basin estuary (Lederoun et al. 2018b). The data reported in the current study constitute a first for the Couffo basin, which has long been neglected because of the

Table 2

Descriptive statistics and estimated parameters of length-length relationships (TL = p + q SL) for 39 selected fish species collected from the Couffo River basin. Abbreviations: N – sample size; p – intercept; q – slope; r^2 – coefficient of determination; SL – standard length; TL - total length.

Family/Species	N	TL (cm)	SL (cm)	Regression parameters			
		Min–Max	Min–Max	TL = p + q SL	SE of p	SE of q	r^2
Polypteridae							
Polypterus senegalus Cuvier, 1829	89	12.5–24.7	10.7–22.1	TL= 1.579+1.065*SL	0.477	0.028	0.944
Mormyridae							
Hyperopisus bebe (Lacépéde, 1803)	19	7.6–12	7–10.4	TL= – 0.463+1.169*SL	0.516	0.058	0.96
Marcusenius senegalensis (Steindachner, 1870)	29	6.8–20.2	5.9–18.1	TL= 0.12+1.136*SL	0.199	0.019	0.993
Petrocephalus bovei (Valenciennes, 1846)	123	5.1–21.3	3.2–18.6	TL= 0.833+1.071*SL	0.140	0.021	0.956
Elopidae							
Elops senegalensis Regan, 1909	30	11.8–28	9.1–21.7	TL= 0.733+1.25*SL	0.203	0.013	0.997
Clupeidae							
Ethmalosa fimbriata (Bowdich, 1825)	652	4.9–15.5	4–12.3	TL= 0.066+1.275*SL	0.084	0.012	0.942
Pellonula leonensis Boulenger, 1916	12	9.2–20.6	7.6–17.4	TL= 0.379+1.157*SL	0.345	0.024	0.996
Mochokidae							
Synodontis cf. obesus Boulenger, 1898	50	5–15.3	4.4–10.6	TL= –0.711+1.469*SL	0.429	0.062	0.92
Synodontis ouemeensis Musschoot & Lalèyè, 2008	37	8.3–35.9	6.4–30.8	TL= 1.484+1.197*SL	0.512	0.039	0.964
Cyprinidae							
Enteromius callipterus (Boulenger, 1907)	136	4.6–10.1	3.6–8.3	TL= 1.52+0.953*SL	0.146	0.028	0.895
Enteromius chlorotaenia (Boulenger, 1915)	64	5.6–10	4.6–8.7	TL=1.328+1.015*SL	0.321	0.049	0.875
Labeo parvus Boulenger, 1903	30	9.1–21.6	7.2–17.3	TL= – 0.266+1.291*SL	0.383	0.030	0.986
Labeo senegalensis Valenciennes, 1844	26	9.8–20.8	8–16.5	TL= 0.1666+1.202*SL	1.102	0.083	0.898
Alestidae							
Brycinus longipinnis (Günther, 1864)	215	5.4–9.8	4.1–8.6	TL=1.597+0.98*SL	0.141	0.026	0.872
Hepsetidae							
Hepsetus odoe (Bloch, 1794)	11	8.1–23.2	6.6–19.1	TL= 0.563+1.196*SL	0.551	0.042	0.989
Clariidae							
Clarias ebriensis Pellegrin 1920	97	5.6–25.3	4.4–22.4	TL= 0.263+1.109*SL	0.185	0.012	0.989
Clarias gariepinus (Burchell, 1822)	86	5.8–41.5	4.4–36.2	TL= 0.388+1.138*SL	0.218	0.011	0.992
Claroteidae							
Chrysichthys auratus (Geoffroy Saint–Hilaire, 1808)	164	7.1–19.8	5.4–14.5	TL=0.503+1.286*SL	0.208	0.027	0.933
Chrysichthys nigrodigitatus (Lacepéde, 1803)	23	7.5–33.2	5.4–24.5	TL= –0.092+1.368*SL	0.267	0.021	0.995
Schilbeidae							
Parailia pellucida (Boulenger, 1901)	96	5.6–19.9	5.2–17.2	TL= 0.114+1.164*SL	0.142	0.016	0.981
Schilbe intermedius Rüpell, 1832	94	6.4–21.3	6–17.8	TL= –0.206+1.185*SL	0.187	0.018	0.979
Mugilidae							
Neochelon falcipinnis (Valenciennes 1836)	18	10.3–14.8	7.7–11.1	TL= 0.857+1.21*SL	0.835	0.098	0.904
Carangidae							
Caranx hippos (Linnaeus, 1766)	25	6.4–13.2	4.7–10.5	TL=0.574+1.238*SL	0.3	0.042	0.974
Gerreidae							
Eucinostomus melanopterus (Bleeker, 1863)	78	5.7–14.4	4.2–10.9	TL= 0.257+1.274*SL	0.1	0.013	0.993
Cichlidae							
Chromidotilapia guntheri (Sauvage, 1882)	29	5.5–17.2	4.3–13.2	TL= –0.164+1.309*SL	0.365	0.042	0.973
Coptodon guineensis (Bleeker in Günther, 1862)	2986	3.6–23	3.0–18.0	TL= 0.246+1.287*SL	0.026	0.005	0.964
Hemichromis bimaculatus Gill, 1862	29	5.4–8.8	4.1–7.1	TL= 0.515+1.194*SL	0.178	0.032	0.981
Hemichromis fasciatus (Peters, 1857)	59	6.3–13	4.8–10.2	TL= 0.54+1.196*SL	0.314	0.042	0.935
Oreochromis niloticus (Linnaeus, 1758)	25	6.4–18.4	5.1–14.2	TL= 0.493+1.23*SL	0.262	0.027	0.989
Sarotherodon melanotheron Rüppell, 1852	2563	4.1–27.2	3.1–16.6	TL= 0.267+1.276*SL	0.025	0.004	0.979

cont. Table 2

Family/Species	N	TL (cm)	SL (cm)	Regression parameters			
		Min–Max	Min–Max	TL = p + q SL	SE of p	SE of q	r^2
Eleotridae							
Dormitator lebretonis (Steindachner, 1870)	532	2.8–7.8	1.8–6	TL= 0.222+1.196*SL	0.054	0.014	0.935
Eleotris senegalensis Steindachner, 1871	16	6.4–18.9	5.3–14.6	TL= –0.678+1.308*SL	0.308	0.031	0.992
Gobiidae							
Gobioides sagitta (Günther, 1862)	25	21.7–45	17.1–36.5	TL= 0.445+1.23*SL	0.71	0.027	0.989
Gobionellus occidentalis (Boulenger, 1909)	73	12.5–21.4	8.2–14.2	TL= – 0.489+1.452*SL	1.117	0.091	0.781
Porogobius schlegelii (Günther, 1861)	3449	3.9–18.9	2.9–12.9	TL= –0.26+1.373*SL		0.007	0.926
Anabantidae							
Ctenopoma petherici Günther, 1864	42	7.4–14.2	5.7–10.8	TL= 0.1+1.261*SL	0.286	0.04	0.961
Channidae							
Parachanna obscura (Gunther, 1861)	80	8.4–28.8	7.3–24	TL= 0.728+1.144*SL	0.244	0.018	0.981
Paralichthyidae							
Citharichthys stampflii (Steindachner, 1895)	10	12.2–17.6	9.3–14.1	TL= 1.648+1.136*SL	2.809	0.252	0.835
Protopteridae							
Protopterus annectens (Owen, 1839)	18	25.2–47	22.2–43.1	TL= 2.791+1.018*SL	2.539	0.072	0.925

periodic drying up of its fluvial part and its relatively small surface area (3,323.83 km^2) compared to the adjacent basins of the Ouémé to the right (50,000 km^2) and the Mono to the left (22,000 km^2).

Size ranged from 2.8 cm TL (0.20 g BW) in *Dormitator lebretonis* to 47.0 cm TL (542.3 g BW) in *Protopterus annectens*. Even if this result allows us to affirm that the sampling took into account both juveniles and adults and therefore is presumably representative of the population, it should be pointed out that the use of small-mesh fishing gear by fishers and certain techniques that devastate resources would explain the high number of juveniles in our sampling. This observation also implies that the fish in the basin face a high depletion rate, which is an indication of non-compliance with the fishing regulations in force in the country. Catching juveniles is very common in estuarine parts of basins where, logically, they abound as estuaries are known to harbor high proportions of juveniles that use this particular habitat as nursery and feeding areas (Koffi et al. 2014).

The slope (b) of the LWR varied between 2 and 4 (Hile 1936, Bagenal and Tesch 1978), but it was often close to 3. This expresses the relative shape of fish bodies. If $b = 3$, growth is isometric, but it is $b \neq 3$, growth is allometric. Values of $b > 3$ indicate better growth in weight than in length, while < 3 means the opposite is true. In the present study, the b values obtained were all in the range of 2–4; however, according to Carlander (1969), the *b* value should normally be between 2.5–3.5, which was 90% of the values obtained in the present study. Recently, Froese et al. (2014) reported that b values should be between 2.9 and 3.1 for most species. Only 47.5% of the values obtained in the present study were within this range. For the species studied here, the range of *b* values (2.194–3.673) was similar to that recorded by Tah et al. (2012), who reported *b* values of 2.173–3.472 for 36 species from Lakes Ayame I and Buyo in Ivory Coast, while Lalèyè (2006) reported a range of 2.330–3.518 for 52 species from the Ouémé basin in Benin. Ecoutin and Albaret (2003) reported *b* values of 2.458–3.473 for 52 species in West African lagoons and estuaries, and Konan et al. (2007) reported 2.213–3.729 for 57 species in coastal rivers of southeastern Ivory Coast. The mean value of coefficient *b* estimated at 2.902 ± 0.315 was not significantly different from 3 (Student's t-test: P =

0.05), suggesting that the cube law (Froese 2006) can be applied to most fish species in the Couffo basin, which Lederoun et al. (2016b) reported recently regarding fishes from the Mono basin.

Twenty-one species were common in the present study and in the one conducted in the adjacent Mono basin (Lederoun et al. 2016b), which is linked with the Couffo basin at its estuary. Among these species, five (*Marcusenius senegalensis*, *Petrocephalus bovei*, *Enteromius callipterus*, *E. chlorotaenia*, *Chrysichthys auratus*) exhibited isometric growth in the Mono basin, while five exhibited negative (*M. senegalensis*, *P. bovei*, *E. callipterus* and *C. auratus*) or positive allometric growth (*E. chlorotaenia*) in the Couffo basin. *Pellonula leonensis*, *Labeo parvus*, *Chrysichthys nigrodigitatus*, *Hemichromis fasciatus*, *Paracchana obscura* exhibited isometric growth in the Couffo basin, while in the Mono basin growth was either negatively (*P. leonensis*, *C. nigrodigitatus*) or positively (*L. parvus*, *H. fasciatus*, *P. obscura*) allometric. However, *Labeo senegalensis*, *Hepsetus odoe*, *Caranx hippos*, *Oreochromis niloticus*, *Caranx hippos* (isometric), *Clarias gariepinus*, *Porogobius schlegelii* (negatively allometric), *Schilbe intermedius*, *Neochelon falcipinnis*, *Chromidotilapia guntheri*, *Coptodon guineensis* (positively allometric) exhibited the same growth characteristics in both watersheds.

Polypterus senegalus exhibited positive allometric growth in the Couffo basin, while in the Mono basin growth was negatively allometric. Differences in growth patterns have been reported previously for the same species in the same environment and in different ecosystems. These differences could be related to sample size, season, fishing habitat, sex, maturity stage, diet and stomach fullness, health status, trophic level, and food availability (Bagenal and Tesch 1978, Lowe-McConnell 1987, Oribhabor et al. 2009, Koffi et al. 2014). None of these parameters were considered in this study like the one that was conducted in the Mono basin (Lederoun et al. 2016b). In the current study, we only considered the minimum sample size (n = 10) recommended by several authors (Lalèyè 2006, Konan et al. 2007, Lederoun et al. 2016b, 2018b) for establishing weight-length relationships. For many of the species studied here, samples were collected at different times of the year, in different habitats without distinction of size or sex to establish the weight-length keys. However, the functioning of the two ecosystems can explain the results obtained. Since the construction and commissioning in 1987 of the Nangbéto hydroelectric dam in the lower Mono River, this basin no longer dries up in its lower course with the maintenance of a low water flow and flood capping (Lederoun 2015), whereas the Couffo basin is characterized by its periodic drying up that causes continuous disruptions in fish communities. The periodic rebuilding of this fauna over much of the basin at the beginning of the rainy season might explain the maximum size differences observed between the two basins. Periodic entrenchment in existing pockets of water certainly leads to overpopulation and limits growth through the lack of food availability (Mommsen 1998). Drying up also favors the rise of the halocline in Lake Ahémé and the presence in numbers of species of marine origin that would certainly compete for food.

Conclusion

Through this study, the morphometric characteristics of the fishes of the Couffo River basin were determined from measurements and weights taken on specimens from a series of experimental and artisanal fisheries. The majority of the commercial fishes studied exhibited isometric growth, which indicates good environmental conditions. The weight and length key determined should facilitate improving fishing statistics throughout the basin in general and in the estuary in particular, the latter being the source of almost all the fishes consumed in the area. It would be interesting to continue this study with the objective of discovering the existing relations between variations in the particular environmental conditions of the Couffo River basin (particularly of drying) and those of the morphometric parameters of fishes to determine elements likely to confirm the effects of these changes on the fish populations of the this basin.

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