Length–weight relationship of 58 fish species in French Guiana streams

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Technical contribution

Length-weight relationships of 58 fish species in French Guiana streams

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Summary

Length-weight relationship parameters of the form $W = aL^b$ are presented for 58 fish species representing 36 genus and 19 families captured in streams of French Guiana. LWRs for 53 of the species are estimated for the first time.

Introduction

Although an increasing interest is given to the Amazonian and Guiana shield freshwaters, most studies have dealt with large rivers, with only a few studies devoted to the fish fauna in small streams (however, see Mol and Ouboter, 2004; Brosse et al., 2011, 2013; Allard et al., 2014). Hence, biological information on fish fauna in streams remains scarce. A recent survey of fish was conducted in over 95 streams of French Guiana. Collected fishes were used to provide estimates of the length-weight relationship (LWR) parameters for 58 species, for which at least 20 individuals per species were caught, weighed and measured.

Materials and methods

Fishes were collected during the dry season (from September to December) in 2011 and 2012. The 95 study sites were dispersed throughout French Guiana and belong to the seven main river basins (Oyapock, Approuague, Comté, Sinnamary, Kourou, Mana and Maroni); however, fishes were also collected from tributaries of smaller coastal rivers. All sites were small streams (<1 m deep and <10 m width). Fish were collected using PREDATOX, a 6.6% emulsifiable solution of rotenone extracted from *Derris elliptica* by Saphyr, Antibes, France. This allowed the capture of all fishes from the study area without body size selectivity. All individuals were identified to species in the laboratory according to Planquette et al. (1996), Keith et al. (2000) and Le Bail et al. (2000). Taxonomy was then actualised according to Le Bail et al. (2012). All fishes were standard length (SL) measured to the nearest mm and weighed (TW) to the nearest 0.01 g, with a calliper and a Sartorius-talent weighing scale, respectively. Standard length was preferred to total or fork lengths as SL is not sensitive to caudal fin injuries. This also avoided bias due to particular fish morphologies (e.g. Loricariidae, which can have caudal filaments).

The length-weight relationships in fish have the form:

$$\mathrm{TW} = a\mathrm{SL}^b, \quad (1)$$

where TW is total weight (g), SL the standard length (mm), a the intercept, and b the slope; Standard errors of b were calculated to detect significant deviation from isometric growth ($b = 3$, Froese, 2006).

The linearized equation of the (1) is of the form:

$$\mathrm{TW} = \log(a) + b\log(\mathrm{SL}). \quad (2)$$

Parameters estimates and fit of (2) was done with linear regression. LWRs were limited to species represented by at least 20 individuals to ensure the relevance of the linear regression models. All linear regressions were carried out with the R software (R Development Core Team, 2011). Data was carefully checked when a and b values fell beyond the 95% confidence interval given in FishBase (Froese and Pauly, 2013).

Results

A total of 8827 individuals belonging to 58 species and 19 families were weighed and measured. The sample size, minimum and maximum SL and TW were measured for each species. Results of the length-weight linear regression analysis of the 58 fish species are given in Table 1, as well as the determination coefficient (r^2), the intercept a, the slope b and their 95% confidence interval. All regressions were highly significant ($P < 0.001$), with the determination coefficient ranging from 0.909 for *Characidium zebra* to 0.996 for *Satanoperca rhynchitis*.

Discussion

Of the 58 length-weight relationships, 53 LWRs are new. To our knowledge, among the species considered the LWRs have been reported only for *Astyanax bimaculatus*, *Characidium zebra*, *Hoplias malabaricus*, *Leporinus friderici* and *Rhamdia quelen* from rivers and reservoirs in Brazil (Benedito-Cecilio, 1997; Gubiani et al., 2009; Orsi and Britton, 2012; Antonetti et al., 2014; Da Costa et al., 2014). Comparing our results

Table 1
Standard length (SL) (mm) – weight (TW) relationship for 58 fishes from French Guiana streams, based on TW = aSL^b

		SL		TW				
	n	Min	Max	Min	Max	*a*	*b*	r^2
Order: Characiformes								
Curimatidae								
Cyphocharax helleri (Steindachner, 1876)[a]	38	2.6	10.0	0.35	29.20	0.0180 [0.0155–0.0210]	3.22 [3.14–3.31]	0.994
Cyphocharax spilurus (Günther, 1864)[a]	21	2.3	9.0	0.18	18.80	0.0172 [0.0134–0.0221]	3.16 [3.01–3.32]	0.990
Anostomidae								
Anostomus brevior (Géry, 1963)[a]	23	3.6	9.2	0.58	15.00	0.0115 [0.00849–0.0157]	3.12 [2.96–3.27]	0.988
Hypomasticus despaxi (Puyo, 1943)[a]	23	5.0	9.3	2.27	14.40	0.0193 [0.0108–0.0347]	2.99 [2.70–3.28]	0.957
Leporinus friderici (Bloch, 1794)	25	5.4	18.2	2.70	125.00	0.0141 [0.0101–0.0197]	3.11 [2.96–3.25]	0.988
Leporinus gossei (Géry, Planquette & Le Bail,1991)[a]	33	4.8	15.5	2.35	97.40	0.0172 [0.0138–0.0214]	3.14 [3.04–3.23]	0.993
Leporinus granti (Eigenmann, 1912)[a]	91	3.7	18.7	1.17	230.00	0.0184 [0.0151–0.0225]	3.08 [3.00–3.16]	0.983
Leporinus nijsseni (Garavello, 1990)[a]	30	4.9	14.4	3.17	72.90	*0.0498 [0.0286–0.0867]*	*2.67 [2.43–2.91]*	0.948
Crenuchidae								
Characidium zebra (Eigenmann, 1909)	221	1.8	**7.4**	0.10	6.27	0.00913 [0.00759–0.0110]	3.26 [3.12–3.40]	0.909
Melanocharacidium blennioides (Eigenmann, 1909)[a]	30	1.6	**5.5**	0.04	2.02	0.00971 [0.00645–0.0146]	3.21 [2.90–3.51]	0.942
Characidae								
Astyanax bimaculatus (Linnaeus, 1758)	132	2.4	9.7	0.24	28.10	0.0106 [0.00952–0.0117]	*3.44 [3.38–3.50]*	0.989
Astyanax validus (Géry, Planquette & Le Bail, 1991)[a]	240	3.8	12.0	1.37	52.90	0.0184 [0.0166–0.0204]	3.20 [3.15–3.25]	0.985
Bryconops affinis (Günther, 1864)[a]	911	1.7	10.8	0.06	22.80	0.0157 [0.0152–0.0163]	3.08 [3.06–3.10]	0.990
Bryconops caudomaculatus (Günther, 1864)[a]	150	1.3	10.3	0.04	15.10	0.0130 [0.0118–0.0143]	3.12 [3.05–3.18]	0.984
Bryconops aff. *Caudomaculatus*[a]	66	3.2	9.2	0.40	12.30	0.0181 [0.0130–0.0253]	3.00 [2.81–3.20]	0.939
Bryconops melanurus (Bloch, 1794)[a]	72	2.3	10.2	0.10	13.40	0.0148 [0.0128–0.0172]	2.99 [2.90–3.07]	0.985
Hemibrycon surinamensis (Géry, 1962)[a]	196	2.2	**9.5**	0.10	19.40	*0.0140 [0.0122–0.0160]*	3.23 [3.15–3.31]	0.968
Jupiaba abramoides (Eigenmann, 1909)[a]	261	2.0	11.7	0.10	41.00	0.0143 [0.0130–0.0156]	3.29 [3.24–3.34]	0.986
Jupiaba keithi (Géry, Planquette & Le Bail, 1996)[a]	151	2.3	7.5	0.30	10.20	0.0196 [0.0172–0.0223]	3.13 [3.03–3.22]	0.965
Moenkhausia chrysargyrea (Günther, 1864)[a]	290	1.9	8.9	0.16	28.00	0.0153 [0.0141–0.0167]	*3.37 [3.33–3.42]*	0.984
Moenkhausia georgiae (Géry, 1965)[a]	97	2.2	**12.1**	0.28	47.40	0.0252 [0.0220–0.0289]	3.06 [2.99–3.14]	0.986
Moenkhausia hemigrammoides (Géry, 1965)[a]	72	1.5	3.7	0.09	1.35	0.0204 [0.0172–0.0242]	3.22 [3.05–3.38]	0.955
Moenkhausia moisae (Géry, Planquette & Le Bail, 1995)[a]	130	2.0	**10.6**	0.10	29.70	0.00855 [0.00783–0.00935]	*3.60 [3.54–3.66]*	0.991
Moenkhausia oligolepis (Günther, 1864)[a]	754	2.1	9.7	0.30	105.0	0.0251 [0.0232–0.0272]	3.11 [3.07–3.16]	0.963
Moenkhausia surinamensis (Géry, 1965)[a]	141	2.6	10.3	0.36	34.60	0.0188 [0.0165–0.0215]	3.21 [3.14–3.28]	0.983
Poptella brevispina (Reis, 1989)[a]	347	2.0	**8.8**	0.08	18.00	0.0272 [0.0243–0.0306]	3.01 [2.94–3.08]	0.954
Acestrorhynchidae								
Acestrorhynchus falcatus (Bloch, 1794)[a]	52	6.3	24.3	2.50	212.00	*0.00899 [0.00632–0.0128]*	3.11 [2.97–3.25]	0.977
Erythrinidae								
Erythrinus erythrinus (Bloch & Schneider,1801)[a]	53	2.7	14.5	0.30	73.10	*0.0136 [0.0118–0.0156]*	3.18 [3.11–3.25]	0.994
Hoplias aimara (Valenciennes, 1847)[a]	72	1.6	43.5	0.06	1960.0	*0.0164 [0.0117–0.0230]*	3.06 [2.89–3.23]	0.947
Hoplias malabaricus (Bloch, 1794)	52	5.3	23.0	2.20	245.00	0.0130 [0.0111–0.0154]	3.11 [3.04–3.18]	0.994
Lebiasinidae								
Pyrrhulina filamentosa (Valenciennes, 1847)[a]	563	1.7	**11.1**	0.05	11.90	0.0105 [0.00982–0.0113]	3.16 [3.11–3.21]	0.970
Order: Siluriformes								
Cetopsidae								
Helogenes marmoratus (Günther, 1863)[a]	675	1.6	**7.9**	0.08	8.57	*0.0111 [0.0104–0.0120]*	3.21 [3.16–3.26]	0.965
Loricariidae								
Ancistrus cf. *leucostictus* (Günther, 1864)[a]	116	1.7	8.3	0.07	16.40	0.0159 [0.0142–0.0179]	3.27 [3.18–3.35]	0.981
Ancistrus aff. *hoplogenys* (Günther, 1864)[a]	83	1.2	8.2	0.06	15.30	0.0138 [0.0113–0.0168]	3.25 [3.11–3.40]	0.962
Guyanancistrus brevispinis (Heitmans, Nijssen & Isbrücker, 1983)[a]	36	2.0	9.0	0.14	18.00	0.0170 [0.0148–0.0196]	3.21 [3.13–3.3]0	0.995
Hypostomus gymnorhynchus (Norman, 1926)[a]	66	1.0	**26.6**	0.05	253.00	0.0161 [0.0136–0.0190]	3.14 [3.03–3.25]	0.980
Lithoxus planquettei (Boeseman, 1982)[a]	62	2.2	5.7	0.19	3.84	0.0116 [0.00959–0.0141]	*3.33 [3.19–3.47]*	0.975
Pseudopimelodidae								
Batrochoglanis raninus (Valenciennes, 1840)[a]	121	1.9	10.4	0.14	37.60	0.0235 [0.0195–0.0283]	3.07 [2.95–3.18]	0.959
Heptapteridae								
Chasmocranus longior (Eigenmann, 1912)[a]	150	2.7	11.3	0.10	13.40	0.00762 [0.00669–0.00866]	3.06 [3–3.13]	0.982
Pimelodella cristata (Müller & Troschel, 1849)[a]	193	4.2	21.0	0.69	74.40	0.0148 [0.0121–0.0183]	2.86 [2.76–2.95]	0.946
Pimelodella geryi (Hoedeman, 1961)[a]	23	3.2	**10.8**	0.30	14.00	0.0127 [0.00938–0.0172]	2.93 [2.76–3.1]	0.984
Pimelodella procera (Mees, 1983)[a]	199	3.2	**11.7**	0.20	15.10	0.00776 [0.00689–0.00874]	3.11 [3.05–3.17]	0.982
Rhamdia quelen (Quoy & Gaimard, 1824)	114	6.5	22.5	3.72	203.00	0.0111 [0.00937–0.0131]	3.11 [3.05–3.18]	0.989

Table 1
(Continued)

		SL		TW				
	n	Min	Max	Min	Max	*a*	*b*	r^2
Order: Gymnotiformes								
Gymnotidae								
Gymnotus coropinae (Hoedeman, 1962)[a]	274	3.8	**34.5**	0.12	83.50	0.00371 [0.00293–0.0047]	*2.75 [2.65–2.85]*	0.913
Sternopygidae								
Sternopygus macrurus (Bloch & Schneider, 1801)[a]	218	2.9	52.9	0.09	151.00	0.00297 [0.00232–0.0038]	*2.79 [2.71–2.87]*	0.954
Hypopomidae								
Brachyhypopomus beebei (Schultz, 1944)[a]	21	4.4	12.5	0.30	5.65	0.00512 [0.00286–0.00916]	*2.69 [2.40–2.99]*	0.951
Order: Perciformes								
Cichlidae								
Cleithracara maronii (Steindachner, 1881)[a]	50	2.8	6.8	1.03	20.60	*0.0572 [0.0472–0.0692]*	3.03 [2.90–3.15]	0.980
Crenicichla albopunctata (Pellegrin, 1904)[a]	37	2.5	13.5	0.25	43.10	0.0151 [0.0121–0.0188]	3.06 [2.94–3.18]	0.987
Crenicichla saxatilis (Linnaeus, 1758)[a]	209	2.1	18.8	0.14	110.00	0.0124 [0.0116–0.0132]	3.14 [3.10–3.17]	0.993
Guianacara geayi (Pellegrin, 1902)[a]	67	1.4	**9.1**	0.06	27.50	*0.032 [0.0289–0.0353]*	3.16 [3.09–3.22]	0.993
Guianacara owroewefi (Kullander & Nijssen, 1989)[a]	27	1.8	6.0	0.13	7.90	0.0272 [0.0212–0.0349]	3.23 [3.05–3.41]	0.982
Krobia aff. *guianensis* sp.[a]	194	0.7	12.1	0.01	84.30	0.0302 [0.0281–0.0324]	3.23 [3.17–3.30]	0.983
Krobia itanyi (Puyo, 1943)[a]	26	1.8	9.5	0.20	34.80	0.0264 [0.0201–0.0346]	3.19 [3.02–3.36]	0.983
Nannacara aureocephalus (Allgayer, 1983)[a]	330	1.2	5.8	0.06	6.20	0.0367 [0.0341–0.0394]	2.94 [2.87–3.01]	0.955
Satanoperca rhynchitis (Kullander, 2012)[a]	28	2.3	13.5	0.35	73.40	*0.0317 [0.0273–0.0369]*	2.99 [2.92–3.07]	0.996
Order: Cyprinodontiformes								
Rivulidae								
Anablepsoides igneus (Huber, 1991)[a]	32	1.3	8.4	0.02	9.90	0.0106 [0.00864–0.0131]	3.11 [2.97–3.25]	0.986
Anablepsoides lungi (Berkenkamp, 1984)[a]	48	1.7	7.1	0.10	4.25	0.0206 [0.0161–0.0264]	*2.73 [2.55–2.92]*	0.951
Laimosemion geayi (Vaillant, 1899)[a]	91	1.0	3.1	0.02	0.50	0.0139 [0.0121–0.016]	3.13 [2.92–3.34]	0.911

n, Sample size; Min, Minimum; Max, maximum; *a*, intercept of the relationship; *b*, slope of the relationship $TW = aSL^b$; r^2, coefficient of determination of the relationship.
95% confidence intervals for *a* and *b* in brackets. New maximum size data highlighted in bold. Italics – value of *a* and *b* outside range reported in FishBase. Length–weight relationships for all species significant at $P < 0.001$. Species are listed alphabetically within orders and families.
[a]First report of length–weight relationship for the species.

with those given in FishBase reveals some discrepancies (Froese and Pauly, 2013). Indeed, the *a* and *b* parameters of the LWRs given in FishBase arise from a compilation of estimates from different genus or species belonging to the same family and having the same body shape (Froese et al., 2013). Our results hence represent the first direct estimates of the LWRs for most of the considered species. The size ranges we report are consistent with those found in the literature and thus we are confident that these ranges encompass all sizes range for the species considered. These were verified for all species but one, as *Hoplias aimara* can grow much bigger in large rivers than in small streams (up to more than 100 cm SL; Planquette et al., 1996). The LWR for *H. aimara* should only be used within the observed length range of the species. Although sampling was carried out only during the dry season, the LWRs given here remain useful for most fish studies in the Amazonian and Guiana shield streams, as those studies are often conducted during the dry season to make fish capture easier and more efficient (e.g. Mol and Ouboter, 2004; Brosse et al., 2011, 2013; Allard et al., 2014).

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