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WEIGHT–LENGTH RELATIONSHIP OF 57 FISH SPECIES OF THE COASTAL RIVERS IN SOUTH–EASTERN OF IVORY COAST

K. F.[1*], Konan, A.[1] Ouattara, M.[1] Ouattara, G.[1] Gourčne

Summary

Weight–length relationships (WLR) of 57 fish species belonging to 22 families from the coastal rivers of the south–eastern of Ivory Coast were studied. Samples were collected with two fleets of monofilament gill nets. The value of the exponent b in the WLR ($W=aL^b$) ranged from 2.213 to 3.729. The mean and the median values were 2.892 and 2.899 respectively, whereas 50% of the value ranged between 2.787 and 3.048. For 11 species, these relationships are described for the first time for this sub–region.

Key words: Weight–length relationship; Fish; Coastal rivers; Ivory Coast; West Africa.

INTRODUCTION

The relationship between length and weight (WLR) has been referring by Haimovici and Velasco (2000) and da Costa and Araàjo (2003) as a very important key witch has widely used in fish biology with several purposes. This useful tool provides important information concerning the structure and function of fish populations (Anderson and Neumann, 1996). Moreover, it was used to predict weight from length measured in yield assessment (Ecoutin and Albaret, 2003), to calculate the standing crop biomass (Martin — Smith, 1996), to evaluate the index of well–being of the fish population (Bolger and Connolly, 1989; Safran, 1992), to assess growth rates and age structure of the fish population (Kolher *et al.,* 1995), to make morphometric comparisons between species and populations (King, 1996; Gonçalves *et al.,* 1997) and life history comparisons between regions (Weatherley and Gill, 1987; Petrakis and Strergiou, 1995). For practical reasons, the majority of the fishing campaigns were privileged the

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acquisition of the data on the length of fish to the detriment of those on the weight (Ecoutin and Albaret, 2003). Moreover, Vazzoler (1991) and Gonzales *et al.* (2000) were pointed out that although it is desirable to use the already established relations for the same species in other sites or country (Kulbicki *et al.,* 1993; Duarte *et al.,* 1999), local data are better for quantitative assessments in the area because according to Sparre *et al.* (1989) these parameters have spatial disparities. Andrade and Campos (2002) were stressed that the value of the coefficient estimated for a species can vary between stocks and even between areas.

In West Africa, information on the WLR are available for some estuary and freshwater fish. The majority of these studies relate to Nigeria, Ghana, Burkina Faso and Benin. But in Ivory Coast, only a few (Bauchot and Bauchot, 1978; de Mérona, 1980) estimates of species–specific WLR parameters are available for fishes in general and especially for freshwater fish. Our aim is therefore to remedy this deficiency. That could provide a useful tool to sustainable management of the artisan fisheries of the South–East Rivers of Ivory Coast.

MATERIALS AND METHODS

Samplings were conducted at five rivers (Bia, Soumié, Eholié, Ehania and Noé) between 1995 and 1997 for the first quoted and between 2003 and 2005 for the others. These coastal rivers are located in the south–east of Côte d'Ivoire (Fig. 1).

Fishes were collected using two fleets of monofilament gill nets (10 mm to 60 mm stretch mesh). All fish's specimens were identified following Lévêque *et al.* (1990, 1992) and Paugy *et al.* (2004). Each specimen was weighted (body weight) to the nearest milligram using an electronic balance and measured (standard length) to the nearest millimetre using measuring board. As Lalèye (2006), only the species presenting a sample size higher than 10 individuals were taken into account.

The WLR of fish was usually estimated by using the equation: $W = a\,L^b$, where a is the intercept and b is the allometry coefficient. After logarithmic transformation of this relation ($log_e\, W = log\, a + b\, log_e\, L$), parameters a and b were determined via least–squares linear regression (Zar, 1999). For each species, the data thus collected are validated by the analysis of the graph corresponding to length–weight (Andrade and Campos, 2002; Ecoutin and Albaret, 2003). In order to check if the value of b was significantly different from 3, the Student's t–test (Zar, 1999) was conducted ($p=0.05$). The value of b gives information on the kind of growth of fish: the growth is isometric if $b = 3$ and the growth is allometric if $b = 3$ (negative allometric if $b < 3$ and positive allometric if $b > 3$). The same method was used to compare the b value for those species appearing both in this study and those given by other studies. Normality of b distribution was also tested through Shapiro–Wilk normality test at 0.05 level.

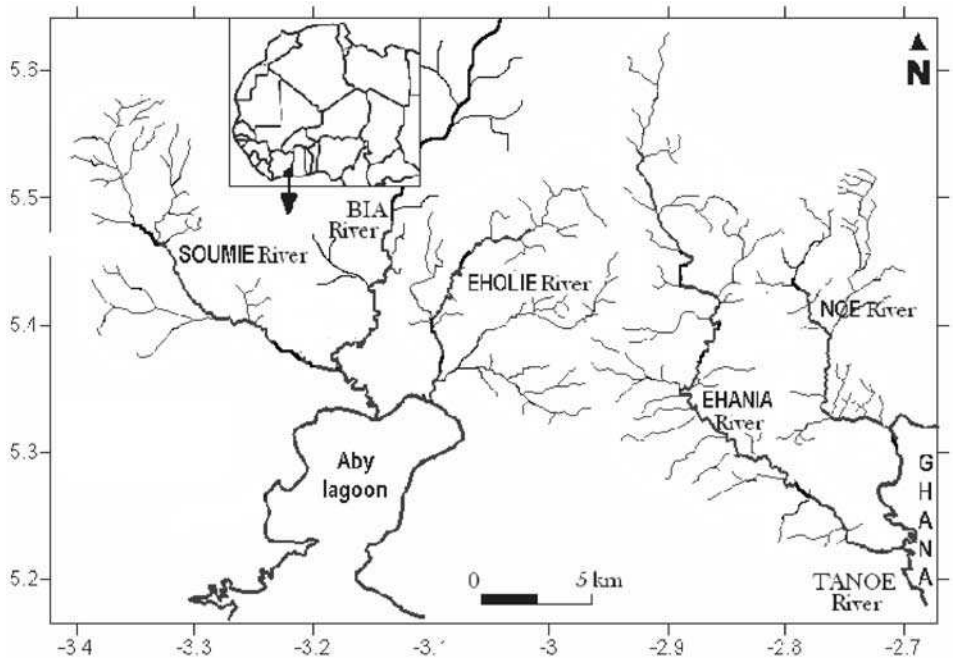

Figure 1. Study area and locations of the rivers. Soumié River, Eholié River, Ehania River, Noé River, Bia River.
Slika 1. Područje istraživanja i položaji rijeka Soumié, Eholié, Ehania, Noé i Bia.

RESULTS

The results of the WLR analysis of 57 species belonging to 22 families are summarized in Table 1. The five species described with the highest size (more than 1000 specimens) were *Hemichromis fasciatus, Brycinus longipinnis, Marcusenius ussheri, Sarotherodon melanotheron* and *Schilbe mandibularis*. Those which were described with weakest size, less than 20 individuals, were *Polydactylus quadrifilis, Brienomyrus brachyistius, Micralestes occidentalis, Eleotris senegalensis, Eucinostomus melanopterus* and *Barbus wurtzi*. Fish sizes variations were ranged from 13 mm (*Micralestes occidentalis*) to more than 500 mm (*Mormyrops anguilloides, Heterotis niloticus*). On the 57 collected species, 12 were described with intervals of sizes lower than 100 mm.

Correlation coefficients (r^2) are ranged from 0.833 (*Pellonula leonensis*) to 0.998 (*Schilbe intermedius*) (Table 1) and all regressions were highly significant ($p < 0.001$). Only 4 of the species (*P. leonensis, Micralestes elongatus, Brycinus longipinnis* and *Barbus trispilos*) presented values of r^2 lower than 0.90 while 25 were between 0.90 and 0.95 and 28 are higher than 0.95. Fifty percent of the values were ranged between 0.917 and 0.968 (Fig. 2a).

The coefficient *b* ranged from 2. 213 for *Micralestes occidentalis* to 3.729 for *Parailia pellucida* (Table 1). The mean and the median values were equal

Table 1. Descriptive statistics, estimated parameters and type of growth of the weight–length relationship for 57 species caught of the south–eastern rivers of Ivory Coast. SE (b): standard errors of b; I: isometric; –(A): negative allometric; +(A): positive allometric.
Tablica 1. Prikaz statistike, parametara i načina rasta težinsko–dužinskog odnosa za 57 vrsta riba ulovljenih u jugoistočnim rijekama Obale Bjelokosti. SE (b); standardne pogreške od b; I: izometrične; –(A): neg. izometrija; +(A): poz. izometrija

		Length — dužina (mm)			Weight — težina (g)			Parameters of weight — length relationship				Type of growth — način rasta
Species — vrste	Nb	Min	Max	Moy	Min	Max	Moy	a	b	SE (b)	r2	(b=3; p=0.05)
MASTACEMBELIDAE												
Aethiomastacembelus nigromarginatus	21	142	365	272.5	5	81	45.45	0.005	2.867	0.141	0.956	I
ANABANTIDAE												
Ctenopoma petherici	216	30	158	102.6	4.6	199	53.74	0.019	2.811	0.061	0.917	–(A)
MORMYRIDAE												
Brienomyrus brachyistius	16	90	190	126.1	9.23	65	22.48	0.017	2.541	0.217	0.917	–(A)
Marcusenius furcidens	224	90	320	184.4	12.11	515	96.14	0.008	2.988	0.051	0.940	I
Marcusenuis senegalensis	25	96	273	169.1	10	248	67.81	0.009	3.022	0.133	0.973	I
Marcusenius ussheri	1176	63	268	139	3.42	226.4	44.86	0.008	2.986	0.020	0.948	I
Mormyrops anguilloides	219	91	633	294.2	5.57	2453	288.3	0.008	2.845	0.037	0.985	–(A)
Mormyrus rume	454	125	480	251	15.6	868	155.5	0.007	2.954	0.025	0.968	I
Petrocephalus bovei	438	55	107	81.06	4.43	21	10.27	0.016	2.846	0.045	0.903	–(A)
Pollimyrus isidori	74	52	96	67.26	2.75	17	6.382	0.020	2.611	0.110	0.906	–(A)
ALESTIDAE												
Brycinus imberi	492	98	163	98.25	3.76	124.9	30.23	0.014	2.842	0.042	0.922	–(A)
Brycinus longipinnis	1065	48	107	74.27	3.6	41	11.64	0.013	2.945	0.054	0.846	I
Brycinus macrolepidotus	582	54	300	164.5	4.39	722	129.4	0.009	3.060	0.020	0.977	+(A)

Cont. Table 1 — Nastavak tablice 1

		Length — dužina (mm)			Weight — težina (g)			Parameters of weight — length relationship				Type of growth — način rasta
Species — vrste	Nb	Min	Max	Moy	Min	Max	Moy	a	b	SE (b)	r2	(b=3; p=0.05)
Brycinus nurse	396	53	205	121.4	5.2	212	57.54	0.009	3.086	0.032	0.966	+(A)
Micralestes occidentalis	17	43	56	49.94	3	5	3.575	0.040	2.213	0.033	0.963	–(A)
Micralestes elongatus	43	49	73	63.07	3.56	10.01	6.749	0.029	2.425	0.046	0.844	–(A)
CHARACIDAE												
Chromidotilapia guntheri	419	50	180	121.1	4	200.1	63.1	0.012	2.971	0.041	0.928	I
Hemichromis bimaculatus	44	39	75	56.68	3.39	18.19	7.809	0.031	2.473	0.121	0.908	–(A)
Hemichromis fasciatus	1033	44	193	114.9	4.16	322	64.64	0.009	3.126	0.019	0.980	+(A)
Oreochromis niloticus	135	68	266	146.8	13.01	857	134.6	0.024	2.696	0.060	0.938	–(A)
Sarotherodon melanotheron	1303	44	264	128.8	3.72	375	102.5	0.018	2.815	0.024	0.911	–(A)
Tilapia busumana	106	49	165	79.1	5.28	134	26.65	0.018	2.816	0.050	0.969	–(A)
Tilapia guineensis	78	40	170	90.27	2.81	223	42.84	0.016	2.899	0.052	0.977	I
Tilapia mariae	106	57	210	129.6	3	410	117.9	0.014	3.098	0.095	0.927	I
Tilapia zillii	208	55	245	112.1	5.94	530	69.27	0.017	2.837	0.047	0.947	–(A)
Tylochromis jentinki	88	65	205	124.2	12	222	65.25	0.011	3.555	0.090	0.956	I
Tylochromis leonensis	47	95	205	117.8	34.6	287	58.43	0.021	2.703	0.115	0.924	–(A)
CLAROTEIDAE												
Chrysichthys maurus	242	55	365	154.2	4.36	723	90.91	0.015	2.784	0.044	0.943	–(A)
Chrysichthys nigrodigitatus	392	58	425	137.2	4.9	1500	68.67	0.011	2.899	0.040	0.938	I
CLARIIDAE												
Clarias anguillaris	183	90	580	320.5	7	2284	449.1	0.007	2.972	0.068	0.959	I
Clarias ebriensis	28	84	367	203.3	7.7	425	118.9	0.012	2.227	0.164	0.979	–(A)
Heterobranchus isopterus	327	72	440	224.7	8.7	1195	203	0.012	2.852	0.031	0.978	–(A)

Cont. Table 1 — Nastavak tablice 1

		Length — dužina (mm)			Weight — težina (g)			Parameters of weight — length relationship				Type of growth — način rasta
Species — vrste	Nb	Min	Max	Moy	Min	Max	Moy	a	b	SE (b)	r2	(b=3; p=0.05)
Heterobranchus longifilis	102	64	466	221	7.07	1401	188.2	0.023	2.528	0.050	0.963	–(A)
HEPSETIDAE												
Hepsetus odoe	886	75	442	197.3	9.26	854	130	0.006	3.060	0.032	0.968	+(A)
OSTEOGLOSSIDAE												
Heterotis niloticus	134	120	682	389.1	26.56	2667	900.4	0.018	2.672	0.036	0.985	–(A)
MUGILIDAE												
Liza falcipinnis	80	130	270	170.6	41.64	354.4	86.98	0.014	2.824	0.155	0.904	I
MALAPTERURUDAE												
Malapterurus electricus	31	130	335	201.9	60.62	836	238.3	0.021	2.693	0.110	0.954	–(A)
NOTOPTERIDAE												
Papyrocranus afer	171	122	555	320.3	12	1069	188.3	0.006	2.922	0.065	0.924	I
CHANNIDAE												
Parachanna obscura	55	69	308	217	6.47	361	135.6	0.010	3.023	0.104	0.979	I
SCHILBEIDAE												
Parailia pellucida	129	68	107	88.45	1.57	15	6.284	0.001	3.729	0.121	0.915	+(A)
Schilbe intermedius	34	70	210	125.7	4.15	119.2	29.12	0.003	3.360	0.029	0.998	+(A)
Schilbe mandibularis	1844	62	285	138.9	7.61	360	39.93	0.006	3.081	0.022	0.911	+(A)
MOCHOKIDAE												
Synodontis bastiani	203	45	225	118.5	1.94	218	47.35	0.019	2.675	0.051	0.932	–(A)
Synodontis schall	394	55	225	128.5	4.47	326	66.61	0.008	3.128	0.032	0.960	+(A)
CYPRINIDAE												
Barbus ablabes	316	47	90	65.34	3.38	22	8.329	0.013	2.875	0.057	0.912	–(A)

Cont. Table 1 — Nastavak tablice 1

		Length — dužina (mm)			Weight — težina (g)			Parameters of weight — length relationship				Type of growth — način rasta
Species — vrste	Nb	Min	Max	Moy	Min	Max	Moy	a	b	SE (b)	r2	(b=3; p=0.05)
Barbus trispilos	164	45	100	69.83	3.33	22	9.188	0.023	2.570	0.074	0.884	–(A)
Barbus wurtzi	18	86	245	174.7	16.93	377	157.1	0.014	2.853	0.124	0.971	I
Labeo coubie	43	78	183	110.5	10	77	27.94	0.010	3.051	0.246	0.901	I
Labeo parvus	567	61	225	134	5.95	278	72.8	0.009	3.055	0.032	0.964	+(A)
Raiamas senegalensis	119	69	250	117.3	6.11	308	41.8	0.005	3.161	0.057	0.964	+(A)
CLUPEIDAE												
Pellonula leonensis	177	65	140	84.33	3	38	8.1	0.007	3.038	0.139	0.833	I
HAEMULIDAE												
Pomadasys jubelini	34	93	220	145.1	19.75	309	90.84	0.009	3.048	0.083	0.977	I
ELEOTRIDAE												
Eleotris senegalensis	18	78	222	140.3	7.95	150	73.14	0.009	3.015	0.178	0.947	I
ELOPIDAE												
Elops lacerta	83	110	270	189.5	9.5	241	85.13	0.007	2.968	0.066	0.962	I
GERREIDAE												
Eucinostomus melanopterus	18	56	110	87.56	6.6	40.51	20.76	0.015	2.840	0.146	0.959	I
POLYPTERIDAE												
Polypterus endlicheri	38	90	485	294.1	9.67	1093	301.7	0.009	2.787	0.032	0.983	–(A)
POLYNEMIDAE												
Polydactylus quadrifilis	11	180	380	266.7	92.8	1036	403.3	0.007	3.114	0.123	0.968	+(A)

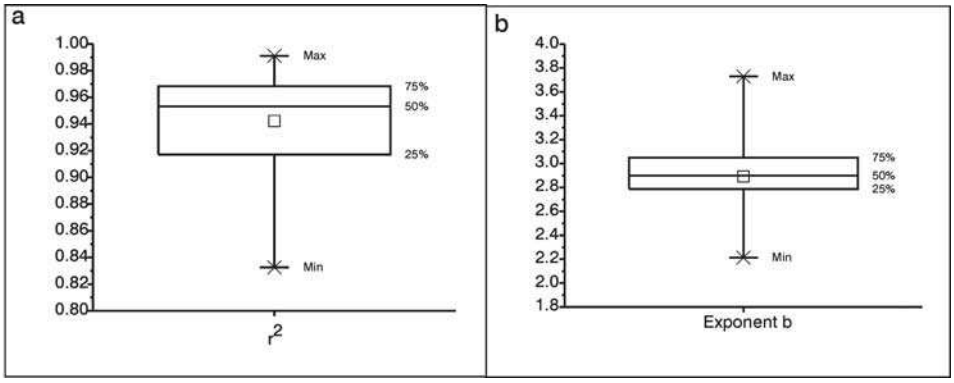

Figure 2. Box plots of parameters b and the coefficient of determination (r^2) of the WLR for 57 fish species caught in Ivory Coast south–eastern rivers. The box covers 75 % of data values: The central box shows the median, and the vertical line represents the range of values.
Slika 2. Prikaz parametara b i koeficijenta determinacije (r^2) WLR–a za 57 vrsta riba ulovljenih u jugoistočnim rijekama Obale Bjelokosti. Pravokutnici pokrivaju 75% vrijednosti. Središnji kvadrat pokazuje srednju, a okomita linija krajnje vrijednosti.

to 2.892 and 2.899 respectively and 50% of the values ranged between 2.787 and 3.048 (Fig. 2b). For 38.6 % of the species (22 species), the value of b is equal to 3 (Student t–test: $p = 0.05$) (Table 1). These species showed isometric growth. For the 61.4 % other species, b was significantly (Student t–test: $p < 0.05$) different from 3. Twenty four of this last category showed a negative allometric growth ($b < 3$) and the 11 last ones showed a positives allometric growth ($b > 3$). The distribution of the exponent b of the 57 species is asymmetrical and the curve towards the left is noticeable (Log likelihood ratio statistic (G) = 5.8376, $p < 0.05$) and exhibited non normal distribution (Shapiro–Wilk normality test: $p < 0.05$). The exponent WLR (b) presented an inverse relationship with the logarithm of the intercept ($\log(a)$) (Fig. 3). This negative correlation curve is represented by the following equation: $y = -0.1188x + 1.1143$ ($r^2 = 0.81$) (Fig. 4). The tendency is that the higher b occurs with lower a values.

DISCUSSION

For the 57 species retained during this work, the average of the coefficient of allometry was established to 2,885 with a standard deviation of 0.233. This value is significantly different from 3 (Student t–test: $p = 0.05$). So as Muto *et al.* (2000) observed in there work on marine fish of south–eastern Brazil, the »cube law« cannot be applied to most of the species in the Ivory Coast south–eastern rivers.

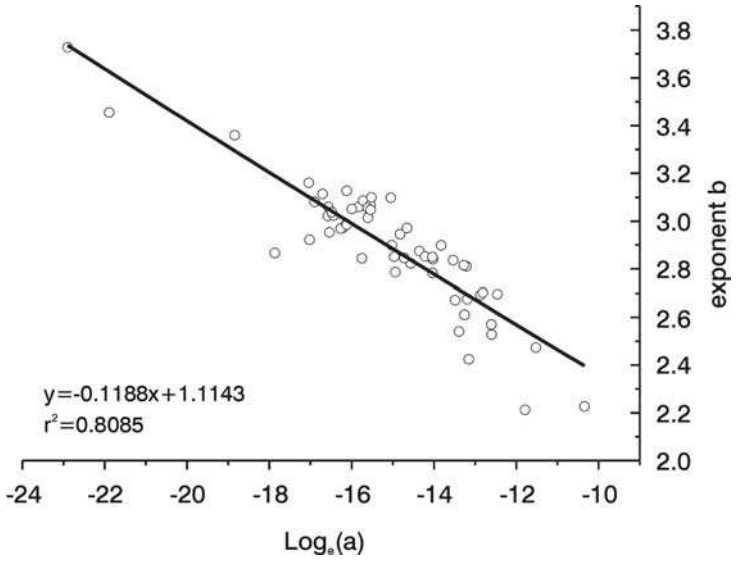

Figure 3. Regression of parameters b and loge(a) of the WLR for 57 fish species caught in Ivory Coast south–eastern rivers.
Slika 3. Regresija parametara b i loge(a) WLR–a kod 57 vrsta riba ulovljenih u jugoistočnim rijekama Obale Bjelokosti.

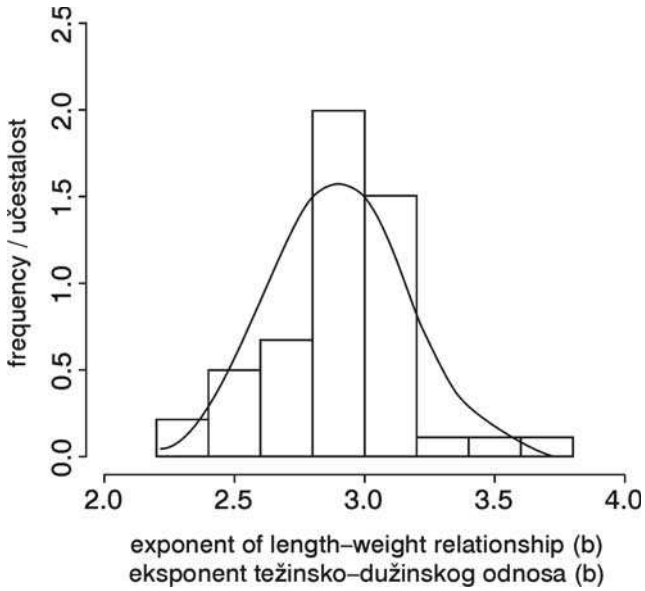

Figure 4. Distribution of the value of the WLR for 57 fish species caught in Ivory Coast south–eastern rivers.
Slika 4. Prikaz vrijednosti WLR–a kod 57 vrsta riba ulovljenih u jugoistočnim rijekama Obale Bjelokosti.

On the other hand, Ecoutin and Abaret (2003) out of 52 species of lagoon and estuary of West Africa, Entsua–Mensah *et al.* (1995) out of 45 fresh water species of Ghana which observed that the value of *b* does not differ significantly from 3. The difference between these results could be related to the types of prospected habitats.

Indeed Ecoutin and Abaret (2003) worked in brackish medium (estuaries and lagoons). On 13 species appearing both in this study and those obtained by these authors in the Ebrié lagoon, 7 (*Schilbe intermedius, S. mandibularis, Eleotris senegalensis, Pellonula leonensis, Thylochromis jentenki, Sarotherodon melanotheron, Chrysichthys nigrodigitatus*) have values of *b* which differ significantly (Student t–test: p = 0.05) and 6 (*C. maurus, Hemichromis fasciatus, Tilapia guineensis, Elops lacerta, Pomadasys jubelini, Liza falcipinnis*) have similar *b*. The Volta River on which Entsua–Mensah *et al.* (1995) worked is located in savanna area while this study was carried out in coastal and forest area. Several others factor could be explained this variation in *b* values such as sexual dimorphism (Artigues *et al.,* 2003), period of year and stage of maturity (Weatherley and Gill, 1987), water quality or food availability on fish growth (Mommsen, 1998), sampling procedure (sample size and length range) (Ecoutin and Abaret, 2003).

For 11 of these species (*Barbus ablabes, Barbus wurtzi, Eleotris senegalensis, Eucinostomus melanopterus, Heterobranchus isopterus, Micralestes elongatus, Micralestes occidentalis, Tilapia busumana, Tilapia guineensis, Tylochromis jentinki* and *Tylochromis leonensis*), information on the parameters of the length–weight relationship is new for the African western area (Ecoutin and Abaret, 2003; Fiogbe, 2003; Ecoutin *et al.,* 2005; Froese and Pauly, 2006, Lalèyè, 2006).

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Sažetak

TEŽINSKO–DUŽINSKI ODNOS 57 RIBLJIH VRSTA U RIJEKAMA JUGOISTOČNOG DIJELA OBALE BJELOKOSTI

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U radu je istraživan težinsko–dužinski odnos (WRL) 57 vrsta riba koje su pripadale 22–dvjema porodicama, a koje se nalaze u rijekama jugoistočnog dijela Obale Bjelokosti. Uzorci su sakupljeni dvjema vrstama mreža. Vrijednost

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eksponenta *b* u WRL ($W=aL^b$) kretao se između 2,213 i 3,729. Prosječna i srednja vrijednost bile su 2,892, odnosno 2,899, dok je 50% te vrijednosti bilo između 2,787 i 3,048. Za 11 vrsta ti su odnosi opisani prvi put u ovoj podregiji.

Ključne riječi: težinsko–dužinski odnos, riba obalne rijeke, Obala Bjelokosti, zapadna Afrika

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