for females). The slope for males is not significantly different from females (t = 2.02 d.f. 37 p <0.01).

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Length-Weight Relationships of Nigerian Coastal Water Fishes

Rapports de poids pour longueur des poissons du littoral nigérian

R.P. King

Abstract

Length-weight relationships (LWR) of 76 fish populations, distributed among 11 families, 18 genera and 22 species, inhabiting coastal (marine/brackish water) ecosystems in Nigeria were estimated (39 cases) or assembled from the literature (37 cases). The mean exponent (b = 2.912) is significantly less than 3. While the frequency distribution of a was positively skewed, that of b was approximately normal. The mean a and b data are also presented by fish genera and families.

Résumé

Les rapports de poids pour longueur de 76 populations de poissons réparties en 11 familles, 18 genres et 22 espèces formant part des écosystèmes du littoral nigérian (espace marin et saumâtre) ont été calculés pour 39 cas ou restitués de la littérature pour 37 cas. L'exposant moyen ($\bar{b}$ = 2,912) était significativement inférieur à 3. Tandis que la distribution des fréquences de a était positivement biaisée, celle de b était pratiquement normale. Les valeurs moyennes pour a et b sont également représentées par genre et par famille.

Introduction

The length-weight relationships (LWR) of fish are important in fisheries biology. Applications of LWR include: estimation of mean weight of fish of a given body length, determination of body condition factors (an interpretation of relative well-being), and conversion of length-growth models to corresponding weight-growth models (e.g., Tyler and Gallucci 1980; Bolger and Connolly 1989; Kulbicki et al. 1993; King 1996). Only a few estimates of species-specific LWR

parameters are available for Nigerian fishes. An earlier study by King (1996) provided information on the LWR of 73 populations of inlandwater fishes of Nigeria. The present compilation focuses on the length-weight parameters of 76 fish populations in Nigerian coastal (i.e., marine/brackish) waters.

Materials and Methods

Fishes were sampled from Nigerian coastal waters over an 11-year period (1984-1994 inclusive), using set gillnets, beach seine, cast nets, hooks and traditional valved basket traps. They were identified (nomenclature of the taxa conformed to Lévèque et al. (1992) and Teugels et al. (1992)), measured (cm, total or standard length), and weighed (g, total fresh weight) after draining water from the buccal cavity and blot-drying excess water on the body.

For each species or population, the parameter a (proportionality constant or intercepts) and b (exponent) of the LWR of the form:

$$W = a \cdot L^b \qquad \ldots 1)$$

were estimated through base-10 logarithm transformation of length-weight data pairs and ordinary least-squares linear regression (i.e., log transformation version of equation 1) viz:

$$\log W = \log a + b \log L \qquad \ldots 2)$$

Whenever possible, estimates of length-weight parameters were made for male and female fishes, along with estimates for combined sexes. These estimates are treated here as separate populations.

Additional LWR parameters were derived from the literature. In some of these cases, important information was missing (e.g., sample sizes, correlation coefficients and size ranges). All results presented here are cm for lengths and g for weights.

Results and Discussion

Table 1 summarizes the LWR parameters for 76 Nigerian coastal water fish populations from 11 families, 18 genera and 22 species. These comprised 39 cases analyzed using original data, and 37 cases derived from the literature. Interpopulational variability in the value of the intercept a was highly heterogenous (CV = 142.6%) and varied from $a_{min} = 1.1 \times 10^{-3}$ in *Pseudotolithus elongatus* to $a_{max} = 1.533 \times 10^{-1}$ in *Periophthalmus barbarus*. Interpopulational variability in the exponent b revealed high homogeneity (CV = 10.1%), with values ranging from $b_{min} = 2.168$ in *Gobioides ansorgii* to $b_{max} = 3.635$ in *P. elongatus*. These estimates are mostly within the limits reported by Carlander (1969), Royce (1972) and Lagler et al. (1977).

The mean exponent ($\bar{b} = 2.912$, s.d. = 0.295) is significantly less than 3 ($t = 2.597$, $df = 75$, $P < 0.02$). Similarly, Torres (1991) reported a value of $\bar{b} < 3$ in a multispecies study of LWR. As an 'assemblage', thus, the Nigerian coastal water fishes exhibit allometric LWR, i.e., they tend to become thinner with increasing length. It may therefore be erroneous to generally apply the 'cube law (b = 3)' to the length-weight function of the fishes. In an earlier compilation of the LWR of Nigerian freshwater fishes, King (1996) also demonstrated an interpopulational negative allometric function ($\bar{b} = 2.911$, s.d. = 0.313). This estimate does not significantly depart from the $\bar{b}$ for the coastal water fishes ($t = 0.030$, $df = 75$, $P > 0.05$), connoting that the two broad categories of aquatic ecosystems (i.e., fresh and marine/brackish waters) are not different in terms of their impact on the shape of their fish populations.

Population-specific values of b (Table 1) indicate that 33 (43.4%) populations exhibited approximately isometric LWR (b = 2.94 - 3.28), 40 (52.6%) populations revealed negative allometric LWR (b < 2.94) and only 3 (4.0%) populations displayed positive LWR (b > 3.28). Variance-mean ratios were significantly less than unity (i.e., they tend strongly toward zero) in the case of a (VMR = 0.038: $t = 5.891$, $df = 75$, $P < 0.005$) and b (VMR = 0.030: $t = 5.940$, $df = 75$, $P < 0.005$), thus suggesting that both parameters are uniformly dispersed variates among the populations studied. King (1996) similarly noted that a and b were uniformly dispersed among the freshwater fishes of Nigeria.

Table 1. Length-weight relationships and related statistics of 76 populations of fish occurring in the coastal waters of Nigeria.

Family/Species	Sex	Length type	Length (cm) min	Length (cm) max	a	b	N	r	Area	Reference
Bagridae										
Chrysichthys walkeri		T	7.0	24.0	0.0074	3.114	-	-	Lekki Lagoon	Ikusemiju (1976)
Chrysichthys nigrodigitatus		T	14.2	89.0	0.0079	3.042	-	-	Cross River Estuary	Udoh (1994)
Clupeidae										
Pellonula leonensis		S	5.0	7.0	0.0380	2.320	36	0.657	Imo River Estuary	Udoh (1992)
Pellonula leonensis		T	3.5	8.5	0.0130	2.780	113	0.860	Imo River Estuary	Utan (1994)
Pellonula leonensis		T	5.0	12.5	0.0209	2.330	119	-	Imo River Estuary	Utan (1994)
Pellonula leonensis		T	4.0	8.5	0.0162	2.660	130	-	Imo River Estuary	Utan (1994)
Pellonula leonensis		T	5.0	12.5	0.0438	2.134	48	0.903	Imo River Estuary	this study
Pellonula afzeliusis		S	3.5	9.4	0.0067	3.258	962	0.931	Lagos Lagoon	Ikusemiju et al. (1983)
Pellonula afzeliusis	M	S	3.5	9.4	0.0082	3.192	441	0.941	Lagos Lagoon	Ikusemiju et al. (1983)
Pellonula afzeliusis	F	S	3.5	9.4	0.0078	3.288	521	0.953	Lagos Lagoon	Ikusemiju et al. (1983)
Ilisha africana		T	6.0	11.5	0.0012	3.617	46	0.910	Imo River Estuary	Utan (1994)
Ilisha africana		T	4.2	28.7	0.0043	3.141	-	0.999	Off Lagos	Marcus (1982c)
Ilisha africana	M	T	4.2	28.7	0.0045	3.122	-	0.999	Off Lagos	Marcus (1982c)
Ilisha africana		T	4.2	28.7	0.0042	3.155	-	0.999	Off Lagos	Marcus (1982c)
Ilisha africana		T	11.3	21.1	0.0093	2.924	271	0.982	Qua Iboe Estuary	this study
Ilisha africana	M	T	11.3	21.1	0.0131	2.790	129	0.978	Qua Iboe Estuary	this study
Ilisha africana	F	T	11.3	21.1	0.0078	2.992	142	0.986	Qua Iboe Estuary	this study
Ilisha africana		T	3.5	11.5	0.0219	2.535	114	0.950	Imo River Estuary	Utan (1994)
Sardinella maderensis		T	2.6	28.5	0.0140	2.827	-	0.960	Off Nigeria	Marcus (1982a)
Ethmalosa fimbriata		T	15.0	31.5	0.0052	3.183	238	0.950	Off Ondo/Akwa Ibom States	Marcus (1982b)
Ethmalosa fimbriata		T	-	-	0.0127	2.893	-	-	Off Ondo/Akwa Ibom States	Marcus (1984)
Ethmalosa fimbriata	M	T	-	-	0.0167	2.807	-	-	Off Ondo/Akwa Ibom States	Marcus (1984)
Ethmalosa fimbriata	F	T	-	-	0.0113	2.936	-	-	Off Ondo/Akwa Ibom States	Marcus (1984)
Ethmalosa fimbriata		S	8.5	21.0	0.0142	3.103	72	0.998	Cross RiverEstuary	this study
Ethmalosa fimbriata		S	-	-	0.0061	3.380	23	-	Cross River Estuary	Ekeng (1990)
Ethmalosa fimbriata		S	16.0	21.9	0.0101	3.210	40	-	Cross River Estuary	Ekeng (1990)
Ethmalosa fimbriata		S	16.0	20.9	0.0851	2.700	35	-	Cross River Estuary	Ekeng (1990)
Ethmalosa fimbriata		S	18.0	22.9	0.0337	2.800	15	-	Cross River Estuary	Ekeng (1990)
Ethmalosa fimbriata		S	9.0	12.9	0.0159	3.060	40	-	Cross River Estuary	Ekeng (1990)
Ethmalosa fimbriata		S	8.0	10.9	0.0233	2.900	40	-	Cross River Estuary	Ekeng (1990)
Ethmalosa fimbriata		S	8.0	10.9	0.0115	3.200	42	-	Cross River Estuary	Ekeng (1990)
Mugilidae										
Mugil curema		T	10.9	16.8	0.0228	2.638	15	0.973	Qua Iboe Estuary	this study
Mugil cephalus		T	11.3	26.4	0.0110	2.943	24	0.986	Cross River Estuary	this study
Mugil cephalus		S	8.5	20.8	0.0385	2.770	24	0.980	Cross River Estuary	this study
Liza falcipinnis		T	11.0	29.6	0.0096	2.955	31	0.980	Cross River Estuary	this study
Liza falcipinnis		S	8.5	23.3	0.0267	2.873	31	0.983	Cross River Estuary	this study
Liza falcipinnis		T	10.0	24.6	0.0121	2.851	30	0.981	Qua Iboe Estuary	this study
Liza falcipinnis		S	7.2	18.5	0.0232	2.915	30	0.986	Qua Iboe Estuary	this study
Liza falcipinnis		T	10.2	27.3	0.0152	2.783	30	0.970	Imo River Estuary	this study
Liza falcipinnis		S	7.8	20.5	0.0300	2.826	30	0.964	Imo River Estuary	this study
Liza falcipinnis		T	8.5	20.0	0.0120	2.846	30	0.979	Qua Iboe Estuary	this study

continued...

Table 1. continued

Family/Species	Sex	Length type	Length (cm) min	Length (cm) max	a	b	N	r	Area	Reference
Liza falcipinnis		T	3.4	15.7	0.0076	3.054	100	0.956	Bonny Estuary	Nlewadim (1995)
Liza grandisquamis		T	10.1	24.0	0.0168	2.765	30	0.983	Qua Iboe Estuary	this study
Liza grandisquamis		S	7.8	18.0	0.0336	2.792	30	0.971	Qua Iboe Estuary	this study
Liza grandisquamis		T	10.3	24.1	0.0114	2.947	31	0.988	Imo River Estuary	this study
Liza grandisquamis		S	7.3	18.3	0.0387	2.785	31	0.985	Imo River Estuary	this study
Liza grandisquamis		T	10.6	30.4	0.0142	2.834	31	0.985	Cross River Estuary	this study
Liza grandisquamis		S	8.0	23.7	0.0436	2.709	31	0.983	Cross River Estuary	this study
Liza grandisquamis		T	4.0	14.7	0.0039	3.461	100	0.921	Bonny Estuary	Nlewadim (1995)
Liza grandisquamis		T	11.3	23.7	0.0112	2.914	52	0.968	Qua Iboe Estuary	this study
Liza dumeril		T	10.1	23.5	0.0070	3.043	89	0.978	Qua Iboe Estuary	this study
Gobiidae										
Periophthalmus barbarus	M	T	5.4	15.6	0.0093	3.084	453	0.990	Imo River Estuary	this study
Periophthalmus barbarus	F	T	1.3	13.6	0.0111	3.013	620	0.972	Imo River Estuary	this study
Periophthalmus barbarus		T	1.3	15.6	0.1533	2.902	1011	0.921	Imo River Estuary	this study
Periophthalmus barbarus		T	-	-	0.1284	3.088	445	0.979	Imo River Estuary	this study
Periophthalmus barbarus		T	-	-	0.1388	3.013	545	0.946	Imo River Estuary	this study
Periophthalmus barbarus		T	1.5	15.6	0.0145	2.951	692	0.935	Imo River Estuary	this study
Periophthalmus barbarus		T	4.6	12.9	0.1253	3.135	323	0.969	Imo River Estuary	this study
Periophthalmus barbarus		T	5.2	18.0	0.0663	2.200	90	0.968	Cross River Estuary	this study
Gobioides ansorgii		T	4.2	10.5	0.0430	2.168	68	0.988	Imo River Estuary	this study
Eleotridae										
Bostrychus africanus		T	4.1	13.0	0.0157	2.890	37	0.995	Cross River Estuary	this study
Monodactylidae										
Monodactylus sebae		T	9.3	17.5	0.0489	2.799	67	0.987	Cross River Estuary	this study
Cynoglossidae										
Cynoglossus canariensis		T	-	-	0.0025	3.177	-	0.998	Off Escravos and Lagos	Ajayi (1993)
Cynoglossus canariensis	M	T	-	-	0.0028	3.138	-	0.994	Off Escravos and Lagos	Ajayi (1993)
Cynoglossus canariensis	F	T	-	-	0.0020	3.239	-	0.999	Off Escravos and Lagos	Ajayi (1993)
Sciaenidae										
Pseudotolithus elongatus		T	11.5	21.5	0.0049	3.119	36	0.998	Qua Iboe Estuary	this study
Pseudotolithus elongatus		T	5.5	12.5	0.0011	3.635	88	0.988	Imo River Estuary	this study
Pseudotolithus elongatus		S	9.3	17.4	0.0170	2.925	45	0.996	Qua Iboe Estuary	this study
Haemulidae										
Pomadasys jubelini		T	11.8	15.1	0.0191	2.813	17	0.996	Qua Iboe Estuary	this study
Pomadasys jubelini		S	9.7	12.2	0.0201	3.029	26	0.991	Qua Iboe Estuary	this study
Carangidae										
Selene dorsalis		T	3.0	34.0	0.0520	2.309	-	-	Off Nigeria	Isebor (n.d.)
Chloroscombrus chrysurus		T	5.0	28.0	0.0140	2.782	-	-	Off Nigeria	Isebor (n.d.)
Trachinotus teraira		T	6.2	9.5	0.0280	2.556	43	0.961	Qua Iboe Estuary	this study
Trachinotus teraira		S	5.2	7.4	0.0230	2.973	33	0.953	Qua Iboe Estuary	this study
Gerreidae										
Gerres melanopterus		T	3.0	11.0	0.0209	2.330	28	0.882	Qua Iboe Estuary	Ulan (1994)
Gerres melanopterus		T	3.1	10.0	0.0128	2.910	25	0.988	Qua Iboe Estuary	Ulan (1994)

The frequency distribution of a values (expressed as ln(a)) is presented in Fig. 1. The coefficient of skewness (SK = 1.16) portrays a substantial amount of positive skewness. Fig. 1 also illustrates the frequency distribution of b values. The skewness coefficient closely approaches zero (SK = 0.22), thus indicating normality. Cinco (1982), Torres (1992), and Caillouet (1993) have also demonstrated normality in the distribution of b in the studies of other multispecies LWR of marine fishes.

Table 2 presents the intergeneric plasticity in mean length-weight parameters. The intercepts were remarkably heterogenous (CV = 5.2 - 106.3%) and ranged from $\bar{a}_{min}$ = 2.4 x 10^{-3} (*Cynoglossus*) to $\bar{a}_{max}$ = 80.9 x 10^{-3} (*Periophthalmus*). The exponents were homogenous (CV = 1.6 - 16.8%) and ranged from $\bar{b}_{min}$ = 2.620 (*Gerres*) to $\bar{b}_{max}$ = 3.226 (*Pseudotolithus*). Negative allometric LWR occurred in 13 genera while isometric functions were recorded in five genera.

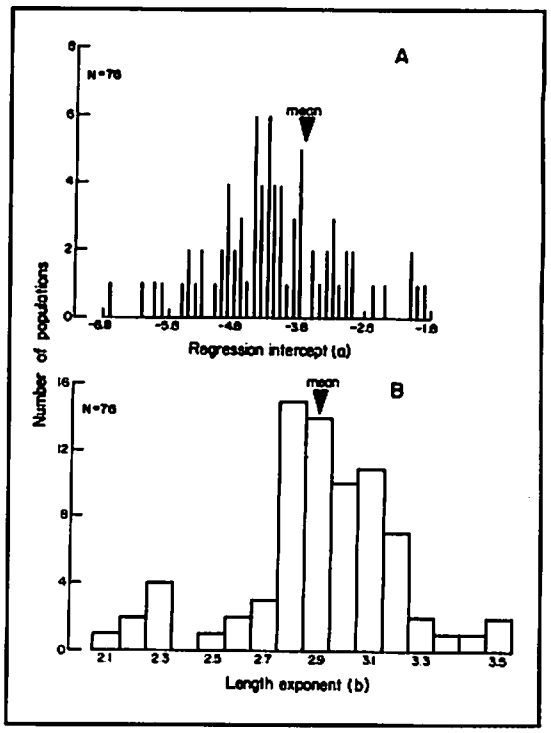

Fig. 1. Frequency distribution of the regression intercept (A) and length exponent (B) of length-weight relationships of fishes from the coastal waters of Nigeria.

Interfamilial plasticity in mean length-weight parameters is given in Table 3. Wide variations were recorded in the intercepts (CV = 5.2 - 107.8%), with values ranging between $\bar{a}_{min}$ = 2.4 x 10^{-3} (Cynoglossidae) and $\bar{a}_{max}$ = 76.7 x 10^{-3} (Gobiidae). Variation in the exponent ranged from $\bar{b}_{min}$ = 2.620 (Gerreidae) to $\bar{b}_{max}$ = 3.226 (Sciaenidae). The fish families constituted close homogenous groups in terms of mean exponents (CV = 1.6 - 15.7%). Isometric and negative allometric LWR were detected in four and seven families, respectively.

From the estimates of $\bar{a}$ and $\bar{b}$ for the fish genera and families (Tables 2 and 3), approximations can be derived when species-specific parameters are unavailable.

Table 2. Mean intercept ($\bar{a}$) and exponent ($\bar{b}$) of the length-weight relationships for 18 genera of coastal water fishes in Nigeria.

Genera	N	Intercept $\bar{a}$	s.d.	CV	Exponent $\bar{b}$	s.d.	CV
Chrysichthys	2	0.0077	0.0004	5.2	3.078	0.051	1.7
Pellonula	8	0.0193	0.0142	73.6	2.745	0.462	16.8
Ilisha	8	0.0083	0.0066	79.5	3.035	0.315	10.4
Sardinella	1	0.0140	-	-	2.827	-	-
Ethmalosa	12	0.0205	0.0218	106.3	3.014	0.206	6.8
Mugil	3	0.0241	0.0138	57.3	2.784	0.153	5.5
Liza	17	0.0186	0.0119	63.9	2.903	0.172	5.9
Periophthalmus	8	0.0809	0.0626	77.4	2.923	0.302	10.3
Gobioides	1	0.0431	-	-	2.168	-	-
Bostrychus	1	0.0157	-	-	2.890	-	-
Monodactylus	1	0.0489	-	-	2.799	-	-
Cynoglossus	3	0.0024	0.0004	16.7	3.185	0.051	1.6
Pseudotolithus	3	0.0077	0.0083	107.8	3.226	0.367	11.4
Pomadasys	2	0.0196	0.0007	3.6	2.921	0.153	5.2
Selene	1	0.0520	-	-	2.309	-	-
Chloroscombrus	1	0.0140	-	-	2.782	-	-
Trachinotus	2	0.0255	0.0035	13.7	2.765	0.295	10.7
Gerres	2	0.0169	0.0057	33.7	2.620	0.410	15.7

Table 3. Mean intercept ($\bar{a}$) and exponent ($\bar{b}$) of the length-weight relationships for 11 families of coastal water fishes in Nigeria.

		Intercept			Exponent		
Genera	N	$\bar{a}$	s.d.	CV	$\bar{b}$	s.d.	CV
Bagridae	2	0.0077	0.0004	5.2	3.078	0.051	1.7
Clupeidae	29	0.0166	0.0166	100.0	2.939	0.333	11.3
Mugilidae	20	0.0195	0.0119	61.0	2.885	0.171	5.9
Gobiidae	9	0.0868	0.0599	78.1	2.839	0.378	13.3
Eleotridae	1	0.0157	-	-	2.890	-	-
Monodactylidae	1	0.0489	-	-	2.799	-	-
Cynoglossiae	3	0.0024	0.0004	16.7	3.185	0.051	1.6
Sciaenidae	3	0.0077	0.0083	107.8	3.226	0.367	11.4
Haemulidae	2	0.0196	0.0007	3.6	2.921	0.153	5.2
Carangidae	4	0.0293	0.0162	55.3	2.655	0.287	10.8
Gerreidae	2	0.0169	0.0057	33.7	2.620	0.410	15.7

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