Length-weight Relationships of Nigerian Freshwater Fishes

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Abstract

Length-weight relationships of 73 fish populations, covering 20 families, 28 genera and 40 species inhabiting freshwater ecosystems in Nigeria, were estimated (73 cases) or assembled from the literature (20 cases), and tested for difference between ecosystem types. There were no significant differences in the exponent of these relationships between lotic and lentic systems.

Introduction

Length-weight relationships (LWR) of fish are important in fisheries biology because they allow inter alia:

(i) estimation of average weight of the fish of a given length group (Beyer 1987);

(ii) conversion of length-growth equations to weight-growth equivalents (i.e., length-at-age to weight-at-age) in yield-per-recruit and related models;

(iii) interspecific and interpopulational morphometric comparison of fish species; and

(iv) assessing the relative well-being of fish populations (Bolger and Connolly 1989).

Only limited species-specific LWR data are available for the freshwater fish resource of Nigeria, West Africa, and the present contribution is aimed at partly compensating for this.

Materials and Methods

Fishes were sampled from different freshwater bodies (both lotic and lentic systems) in Nigeria from 1984 to 1994, using a variety of methods/gears, including gillnets, dip-nets, hooks and traditional valved basket traps. They were identified, measured (cm, total or standard length) and weighted (g, total fresh weight). Nomenclature of the fish taxa conforms to Lévêque et al. (1992).

For each species, the parameters a (proportionality constant) and b (exponent) of the LWR of the form:

$$W = a \cdot L^b \quad \text{...1)}$$

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

$$\log W = \log a + b \cdot \log L \quad \text{...2)}$$

Whenever possible, LWR were determined separately, and for both sexes (including immature fishes). These different estimates are being treated here as separate "populations". Additional LWR parameters were obtained from the literature; in some cases here, important information was missing, e.g., sample sizes, correlation coefficients and/or the range of sizes considered (though in some cases, the size ranges could be read off graphs).

Results and Discussion

The LW data of 73 inland water fish populations, from 20 families, 28 genera and 40 species were analyzed.

Two species (*Mondactylus sebae* and *Bostrycus africana*) of brackishwater origin but which consistently maintained populations in fresh waters were included in the analyses.

Table 1. Length-weight relationships and related statistics of 73 populations of fish occurring in the inland waters of Nigeria.

Family/Species	Sex	Length type	Length (cm) min	max	a	b	N	r	Area	Reference
Polypteridae										
Erpetoichthys calabaricus		T	22.3	34.2	0.0033	2.749	152	0.977	Mfangmfang pond	this study
Erpetoichthys calabaricus		T	21.6	41.4	0.0010	3.103	180	0.969	Cross River	this study
Erpetoichthys calabaricus		T	20.1	33.6	0.0050	2.581	146	0.933	Qua Iboe River	this study
Notopteridae										
Papyrocranus afer		S	10.3	39.8	0.00004	2.663	162	0.979	Ikpa River	this study
Mormyridae										
Brienomyrus brachyistius		T	3.1	16.0	0.1821	2.538	50	0.972	Ikpa River	King (1989)
Isichthys henryi		T	20.0	31.9	0.0267	2.252	148	0.997	Imo River	this study
Petrocephalus ansorgii	M	T	10.9	15.0	0.0075	3.125	142	0.942	Ikpa River	this study
Petrocephalus ansorgii	F	T	10.9	15.2	0.0629	2.299	160	0.883	Ikpa River	this study
Gymnarchidae										
Gymnarchus niloticus		T	50.0	150.0	0.0039	2.978	58	0.985	Lake Chad	Sagua (1986)
Characidae										
Brycinus longipinnis		T	6.5	11.0	0.0129	3.109	60	0.932	Ikpa River	Oni et al. (1983)
Brycinus longipinnis		T	7.5	11.6	0.0025	3.733	42	0.947	Qua Iboe River	Oni et al. (1983)
Brycinus macrolepidotus		T	12.6	24.7	0.0137	2.906	33	0.999	Ikpa River	Oni et al. (1983)
Brycinus nurse		S	-	-	0.0390	2.668	10	0.998	River Galma	Oni et al. (1983)
Brycinus imberi	M	T	18.9	32.8	0.0315	2.688	148	0.971	Cross River	Oni et al. (1983)
Brycinus imberi	F	T	17.1	22.0	0.0093	3.143	135	0.953	Cross River	Oni et al. (1983)
Brycinus imberi		T	17.1	32.8	0.0549	2.523	283	0.980	Cross River	Oni et al. (1983)
Brycinus imberi		T	10.5	15.7	0.0260	2.722	136	0.954	Ikpa River	Oni et al. (1983)
Hepsetidae										
Hepsetus odoe		T	9.2	17.1	0.0069	2.986	47	0.964	Adadama Lake	this study
Hepsetus odeo		T	13.0	35.5	0.0022	3.376	60	0.9950	Ikpa River	this study
Distichodontidae										
Nannaethiops unitaeniatus		T	3.2	5.8	0.0653	2.158	82	0.980	Mfangmfang pond	this study
Cyprinidae										
Barbus callipterus		T	4.9	7.0	0.0103	2.845	180	0.936	Qua Iboe River	this study
Barbus callipterus		T	4.8	7.4	0.0254	2.603	96	0.864	Mgangmfang pond	this study
Bagridae										
Parauchenoglanis akiri		T	6.5	10.0	0.0125	2.974	87	0.994	Qua Iboe River	this study
Parauchenoglanis akiri		T	7.2	16.7	0.0197	2.841	111	0.989	Ikpa River	this study
Parauchenoglanis fasciatus		T	4.8	13.5	0.0312	2.627	147	0.939	Ikpa River	this study
Parauchenoglanis fasciatus		T	12.4	18.0	0.0052	3.245	170	0.949	Zaria	this study
Chrysichthys auratus		T	9.0	24.0	0.0160	2.880	70	0.974	Zaria	Nwadiaro and Okorie (1985)
Chrysichthys walkeri		T	7.0	24.0	0.0074	3.114	-	-	Zaria	Ikusemiju (1976)
Clariidae										
Clarias macromystax		T	6.5	10.0	0.0125	2.974	87	0.994	Qua Iboe River	this study
Clarias buthupogon		T	7.2	16.7	0.0197	2.841	111	0.989	Ikpa River	this study
Clarias buthupogon		T	4.8	13.5	0.0312	2.627	147	0.939	Ikpa River	this study
Clarias gariepinus	M	S	12.4	18.0	0.0052	3.245	170	0.949	Cross River	Olatunde (1985)
Clarias gariepinus	F	S	9.0	24.0	0.0160	2.880	70	0.974	Oguta Lake	Olatunde (1985)
Clarias gariepinus		S	7.0	24.0	0.0074	3.114	-	-	Lekki Lagoon	Olatunde (1985)

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Table 1. Continued.

FFamily/Species	Sex	Length type	Length (cm) min	max	a	b	N	r	Area	Reference
Malapteruridae										
Malapterurus electricus		T	7.7	17.7	0.0018	2.893	222	0.992	Qua Iboe River	this study
Malapterurus electricus		T	14.5	28.8	0.0080	3.160	124	0.985	Cross River	this study
Malapterurus electricus		T	11.4	22.0	0.0108	3.069	150	0.983	Imo River	this study
Mochokidae										
Synodontis schall		S	-	-	0.1380	2.333	10	0.999	River Galma	Oni et al. (1983)
Synodontis schall	M	S	7.9	17.8	0.0162	3.170	111	0.990	Zaria	Olatunde (1989)
Synodontis schall	F	S	9.8	19.1	0.0200	3.110	150	0.830	Zaria	Olatunde (1989)
Schilbeidae										
Eutropius niloticus	M	S	10.0	20.0	0.0102	3.020	109	0.980	Lake Kainji	Olatunde (1979)
Eutropius niloticus	F	S	7.0	22.4	0.0091	3.070	474	0.990	Lake Kainji	Olatunde (1979)
Schilbe mystus	M	S	6.8	15.0	0.0148	2.930	26	0.990	Lake Kainji	Olatunde (1979)
Schilbe mystus	F	S	9.0	20.0	0.0063	3.240	111	0.980	Lake Kainji	Olatunde (1979)
Schilbe mystus		T	14.7	20.1	0.0284	2.506	70	0.944	Ikpa River	this study
Aplocheilidae										
Epiplatys sexfasciatus	M	T	-	-	0.0290	2.730	130	-	Adada River	Inyang and Anozie (1987)
Epiplatys sexfasciatus	F	T	-	-	0.0060	3.520	129	-	Adada River	Inyang and Anozie (1987)
Epiplatys sexfasciatus		T	-	-	0.0140	2.660	146	-	Adada River	Inyang and Anozie (1987)
Aphyosemion splendopleura		T	3.3	4.8	0.0179	2.683	39	0.865	Mfangmfang pond	this study
Aphyosemion gardneri		T	1.5	5.3	0.0141	2.649	311	0.864	Mfangmfang pond	this study
Aphyosemion arnoldi		T	2.7	7.4	0.0239	2.672	72	0.983	New Calabar River	this study
Aphyosemion sjoestedti		T	2.8	4.9	0.0252	2.435	70	0.942	New Calabar River	this study
Channidea										
Parachanna obscura		T	3.8	33.9	0.0098	2.904	192	0.990	Cross River	this study
Parachanna obscura		T	9.5	56.0	0.0063	3.134	40	0.983	Adadama Lake	this study
Parachanna obscura		T	10.9	32.3	0.0059	3.088	160	0.989	Imo River	this study
Parachanna africana		T	12.0	22.2	0.0065	3.041	112	0.957	Ikpa River	this study
Monodactylidae										
Monodactylus sebae		T	9.3	17.5	0.0489	2.799	67	0.987	Ikpa River	this study
Cichlidae										
Chromidotilapia guntheri		T	9.0	16.5	0.0343	2.843	111	0.991	Mfangmfang pond	this study
Chromidotilapia guntheri		T	8.3	23.5	0.0142	3.179	128	0.910	Qua Iboe River	this study
Thysochromis ansorgii		T	6.0	12.5	0.0273	2.845	118	0.901	Mfangmfang pond	this study
Thysochromis ansorgii		T	4.5	14.4	0.0112	3.173	156	0.988	Cross River	this study
Hemichromis fasciatus		T	6.5	11.1	0.0456	2.605	33	0.947	Adadama Lake	this study
Hemichromis fasciatus		T	5.0	12.3	0.0488	2.495	138	0.992	Imo River	this study
Hemichromis fasciatus		T	5.9	14.8	0.0102	3.225	104	0.992	Mfangmfang pond	this study
Tilapia mariae		T	4.0	21.0	0.030	3.218	46	0.960	New Calabar River	Bongonyinge (1984)
Tilapia mariae		T	5.0	25.0	0.7412	2.588	375	0.929	Ikpa River	this study
Tilapia mariae		T	8.0	32.3	0.0336	2.852	51	0.992	Iba-Oku stream	this study
Tilapia mariae		T	6.2	11.7	0.0145	3.169	211	0.989	Qua Iboe River	this study
Tilapia zillii		T	7.0	15.0	0.0115	3.210	11	-	New Calabar River	Bongonyinge (1984)
Eleotridae										
Bostrychus africanus		T	4.1	13.0	0.0157	2.890	37	0.995	Cross River	this study
Anabantidae										
Ctenopoma kingsleyae		T	10.3	18.3	0.0083	3.364	65	0.989	Imo River	this study
Ctenopoma kingsleyae		T	10.0	16.7	0.0312	2.840	146	0.946	Ikpa River	this study
Phractolaemidae										
Phractolaemus ansorgei		*T*	*4.5*	*23.6*	*0.0061*	*3.170*	*80*	*0.972*	*Imo River*	*this study*

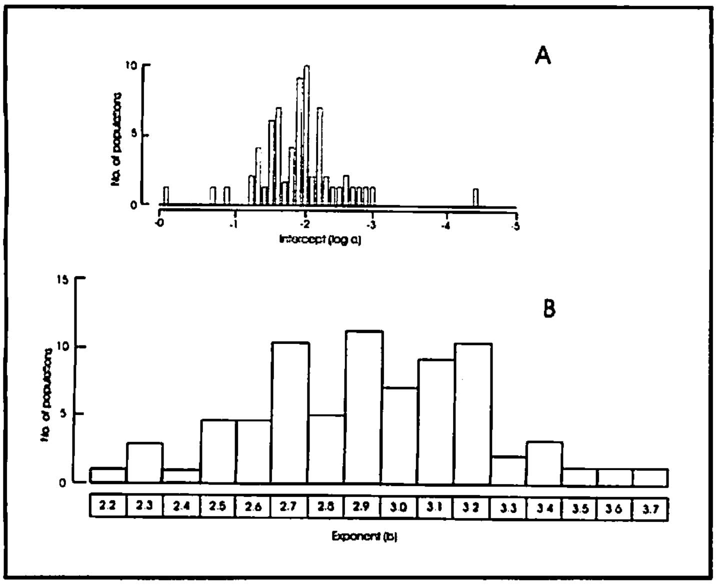

Fig. 1. Distribution of the parameters of length-weight relationships in 73 populations of freshwater fishes of Nigeria. A: distribution of a values; B: distribution of b values.

Of the population studied, 50 were from lotic systems and 18 from lentic waters. Habitat-types were unspecified for five populations (see Olatunde 1985, 1989).

The results are summarized by population in Table 1. Since most of the LW data were based on relatively large samples, the resultant parameters may be considered reasonably reliable and representative. All correlations were highly significant ($P<0.05$) with coefficients of determination ranging from 69 to 100%.

Interpopulational variability in the values of "a" was highly heterogenous (C.V. = 282%) and ranged from $a_{min} = 4x10^{-5}$ in *Papyrocranus afer* to $a_{max} = 7.412x10^{-1}$ in *Tilapia mariae.* Conversely, interpopulational variability in "b" was low (CV = 10.8%), ranging from $b_{min} = 2.158$ in *Nannaethips unitaeniatus* to $b_{max} = 3.376$ in *Hepsetus odoe.* These values fall well within the limits reported by Carlander (1969, b = 2.5-3.5), Royce (1972, $\bar{b}$ = 2.0-3.5) and Lagler et al. (1977, b = 2.5-4.0) for most fishes (Table 1, Fig. 1).

The mean exponent (b = 2.911; s.d. = 0.313) is significantly <3 ($\hat{t}$ = 2.405, df = 72, $P < 0.02$). Torres (1991) also reported a value of $\bar{b}$ < 3 in a multispecies study of LWRs. As an "assemblage", the inland water fishes of Nigeria therefore exhibit a negative allometric LWR, i.e., they tend to become thinner as they grow larger.

The exponents of fish populations inhabiting lotic ($\bar{b}$ = 2.911) and lentic ($\bar{b}$ = 2.873) systems were not significantly different ($\hat{t}$ = 0.478, df = 66, $P > 0.05$), thus suggesting that these broad categories of aquatic ecosystems were not different in terms of their impacts on the shape of their fish populations.

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References

Beyer, J.E. 1987. On length-weight relationships. Part I: Computing the mean weight of the fish of a given length class. Fishbyte 5(1):11-13.

Bolger, T. and P.L. Connolly. 1989. The selection of suitable indices for the measurement and analysis of fish condition. J. Fish Biol. 34:171-182.

Bongonyinge, C. 1984. Some observations on aspects of the biology of *Tilapia mariae* Boulenger and culture of tilapias in freshwater pond. African Regional Aquaculture Centre, Aluu, Port Harcourt, Nigeria. M. Tech. Thesis.

Carlander, K. 1969. Handbook of freshwater fishery biology. Vol. 1. Iowa State University Press, Ames, Iowa.

Ikusemiju, K. 1976. Distribution, reproduction and growth of the catfish, *Chrysichthys walkeri* (Günther) in the Lekki Lagoon, Nigeria. J. Fish Biol. 8:453-458.

Inyang, N.M. and G.N. Anozie. 1987. Some aspects of the biology of *Epiplatys sexfsciatus* (Pisces: Cyprinodontidae) in Adada River, southeastern Nigeria. Nigeria J. Appl. Fish. Hydrobiol. 2:59-63.

King, R.P. 1989. Distribution, abundance, size and feeding habits of *Brienomyrus brachyistius* (Gill, 1862) (Teleostei, Mormyridae) in a Nigerian rainforest stream. Cybium 13(1):23-36.

Lagler, K.F., J.E. Bardach, R.R. Miller and D.R.M. Passino. 1977. Ichthyology. 2nd ed. John Wiley and Sons, New York. 506 p.

Lévêque, C., D. Paugy and G.G. Teugels, Editors. 1992. Faune des poissons d'eaux douces et saumâtres de l'Afrique de l'Ouest (Tome 2). ORSTOM et MRAC Tervuren and Paris, 902 p.

Nwadiaro, C.S. and P.U. Okorie. 1985. Biometric characteristics, length-weight relationship and condition factors in *Chrysichthys filamentosus* (Pisces: Bagridae) from Oguta Lake, Nigeria. Biol. Afric. 2(1):48-57.

Olatunde, A.A. 1979. The biology of the family Schilbeidae (Osteichthyes: Siluriformes) in Lake Kainji, Nigeria, p. 393-412. *In* Proceedings of the International Conference on Kainji Lake and River Basins Development in Africa. Kainji Lake Research Institute, New Bussa, Nigeria.

Olatunde, A.A. 1985. Length-weight relationship and the diets of *Clarias lazera* (Cuvier and Valenciennes), Family Clariidae (Osteichthyes: Siluriformes) in Zaria, Nigeria, p. 183-192. *In* Proceedings of the Annual Conference of the Fisheries Society of Nigeria (FISON), Kainji Lake Research Institute, New Bussa, Nigeria.

Olatunde, A.A. 1989. Some aspects of the biology of *Synodontis schall* (Bloch & Schneider) in Zaria, Nigeria. J. Aquat. Sci. 4:49-54.

Oni, S.K., J.Y. Olayemi and J.D. Adegboye. 1983. Comparative physiology of three ecologically distinct freshwater fishes, *Alestes nurse* Rüppell, *Synodontis schall* Bloch and Schneider and *Tilapia zillii* Gervais. J. Fish Biol. 22:105-109.

Royce, W.F. 1972. Introduction to the fishery sciences. Academic Press, New York and London. 351 p.

Sagua, V.O. 1986. Studies on the biology of *Gymnarchus niloticus* in Lake Chad: age determination and growth; meristic and morphometric characters, p. 179-190. *In* Proceedings of the Annual Conference of the Fisheries Society of Nigeria (FISON), Kainji Lake Research Institute, New Bussa, Nigeria.

Torres, F. Jr. 1991. Tabular data on marine fishes from southern Africa, Part I: length-weight relationships. Fishbyte 9(1):50-53.

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