FISHBYTE SECTION

Fishbyte is the Newsletter
of the Network of Tropical Fisheries Scientists

Editorial

This issue of *Fishbyte* includes five papers dealing with population parameters of various fishes. The data-rich contributions of R. King (on length-fecundity relationships of Nigerian fishes), Valle et al. (on population parameters of Cuban fishes) and Garcia-Arteaga et al. (on length-weight relationships of Cuban fishes) compile numerous parameters from sources which are quite difficult to access. J. Barragan provides estimates of population parameters of *Penaeus californiensis*, while K. Purnomo provides length-girth relationships for two cyprinid species. The issue ends with the usual news items and announcements from NTFS members.

I will be joined commencing with the April 1997 issue by Dr. Villy Christensen who will co-edit *Fishbyte* and bring his expertise in fish stock assessment and ecosystem modelling to bear on forthcoming issues. The need for a co-editor is a tribute to the depth and breadth of expertise - and to the dedication! - of the previous editor of *Fishbyte*, Dr. Daniel Pauly. He has certainly left big shoes to fill in keeping the *Fishbyte* issues readable, relevant, current and exciting!

I urge all of you to read on and to keep the contributions coming.

G.T. Silvestre

Length-Fecundity Relationships of Nigerian Fish Populations

Rapports longueur-fécondite chez des populations de poissons nigérians

Richard P. King

Abstract

Parameters of the exponential body length (L)-fecundity (F) relationship of the form $F = a.L^b$ are presented for 47 populations and 26 species of Nigerian fishes. Estimates of b varied between 1.563 (*Ilisha africana*) and 5.771 (*Barbus callipterus*) with a mean of 3.054 (s.d. = 1.024). The maximum sizes of fish populations examined did not significantly influence the relative magnitudes of b. The parameters α and β of the linear length-fecundity relationships of the form $F = \alpha + \beta L$ are also presented for five fish populations. Estimates of β ranged from 243.5 (*Chrysichthys walkeri*) to 1 334 895 (*Tilapia mariae*).

Les paramètres des rapports entre la longueur corporelle exponentielle (L) et la fécondité (F) selon lesquels $F = a.L^b$*, sont donnés pour 47 populations et 26 espèces de poissons nigérians. Les valeurs de b varient entre 1,563* (Ilisha africana) *et 5,771* (Barbus callipterus) *avec une moyenne de 3,054 (écart-type = 1,024). Les tailles maximales des populations de poissons examinées n'influencent pas significativement les valeurs relatives de b. Les paramètres* α *et* β *des rapports linéaires longueur-fécondité selon lesquels* $F = \alpha$ *et* βL *sont aussi donnés pour cinq populations de poissons. Les valeurs de* β *sont comprises entre 243,5* (Chrysichthys walkeri) *et 1.334.895* (Tilapia mariae).

Introduction

Knowledge about the fecundity (egg production capacity) of fishes is important for comprehension of their life history. Fecundity assessment of fishes has been useful in racial distinction, progeny survival studies, stock evaluation, and aquaculture-based induced spawning and egg incubation (Bagenal 1978; Alvarez-Lajonchere 1982; Marcus 1982; Coates 1988).

The absolute fecundity (F), which is the total number of ripe eggs in the ovaries prior to spawning of an individual female fish (Bagenal and Braum 1978), is a function of its body length (L). This length-fecundity relationship (LFR) is a critical allometric function in fisheries biology due to the relevance of the parameters in various pragmatic applications, including: (i) assessment of population fecundity (Bagenal 1978); (ii) estimation of the average fecundity of fish of a given length group; (iii) interspecific and interpopulational comparison of egg production capacity; (iv) spatio-temporal regimes in egg production capacity (as may be influenced by dynamics in foraging performance and habitat conditions); and (v) the estimation of egg production capacity as growth proceeds (Roff 1986).

Only limited species-specific LFR information is available for Nigerian fish populations. This contribution is intended to help fill this gap by documenting the LFRs of some Nigerian fish populations and making them available for incorporation into existing databases such as FishBase (Froese 1990; Pauly and Froese 1991).

Materials and Methods

Fishes were sampled from several waterbodies in Nigeria over a period of eleven years (1985-1995 inclusive) using a variety of methods and gear, including gillnets, scoop nets, hooks and traditional valved basket traps. The fish were identified and measured in cm to find out total (TL) and/or standard (SL) lengths. Nomenclature of the fish taxa conformed to Lévèque et al. (1992) and Teugels et al. (1992).

For each species or population, the parameters a (proportionality constant or intercept) and b (exponent) of the allometric LFR of the following form (Bagenal 1978) were estimated:

$$F = a \cdot L^b \qquad ...1)$$

This was done via base-10 logarithm transformation of equation 1:

$$\log F = \log a + b \log L \qquad ...2)$$

and using LF data pairs and least squares linear regression.

The LF parameters of certain species or populations were obtained from the literature, some of which lacked relevant ancillary information (e.g., sample sizes, body size limits, and mean fecundity estimates).

Linear LF functions of the form:

$$F = \alpha + \beta L \qquad ...3)$$

were also taken from the literature for some of the fish populations where α = regression intercept and β = slope.

Variability in the value of b (equation 1) was evaluated by the coefficient of variation (CV) (Lowentin 1966) and its distribution pattern by the Pearsonian coefficient of skewness (SK) (Walpole 1982).

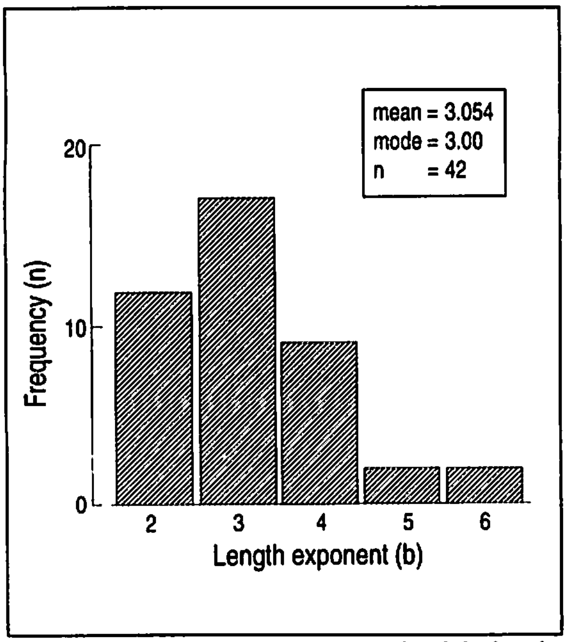

Fig. 1. Distribution of length exponent (b) of the length-fecundity relationships of Nigerian fish populations.

Results and Discussion

The LF data of 47 fish populations, comprising 10 families, 15 genera and 26 species were analyzed. The population-specific results are summarized in Table 1, along with ancillary statistics such as sample sizes, length ranges, fecundity ranges, and means. All recorded LF correlations were highly significant at P = 0.05 or better. There were 42 exponential and 5 linear LFR models. No further analyses were performed on the parameters of the latter.

For the exponential LFRs, interpopulational variability in values of b was moderately heterogenous (CV = 33.5%) and ranged from b_{min} = 1.563 in *Ilisha africana* to b_{max} = 5.771 in *Barbus callipterus* (i.e., 3.7-fold variation). These values fall outside the limits reported by Bagenal (1978) of b = 2.3-5.3 for most fishes. Similarly, Kock and Kellermann (1991) recorded b = 1.088 - 6.0899 for Antarctic notothenioid fishes. It thus appears that the lower and upper limits of b set by Bagenal (1978) can no longer be accepted as a norm for teleosts.

The mean of the length exponent (b = 3.054; s.d. 1.024) is not significantly different from 3 (t = 0.342, df = 41, P>0.05), thus showing that the 'cube law' can be applied to most of the fishes studied. Hence, body volume is an important morphometric determinant of fecundity change in the fishes investigated. This is in agreement with Bagenal (1978) that the value of b is usually about 3 for most fishes. The expectation embodied in the cube function assumes that egg size remains constant and does not vary with fish length (Coates 1988). It thus implies that fishes (Table 1) with b considerably less or more than 3 exhibit substantial fish size - egg size changes.

A regression of fish maximum size (ln (L_{max});cm) examined *vs.* length exponent (ln(b)) was non-significant (r = -0.091, df = 39, P>0.05), thus implying that the maximum size of fish examined has no significant influence on the relative magnitude of the length

Table 1. Length-fecundity relationships and related statistics for 47 populations of Nigerian fish.

Family/species	Locality	N	Length range			Fecundity (F) Min.	Max.	Mean	Length-fecundity parameters (α)	(β)	Source[2]
POLYPTERIDAE											
Erpetoichthys calabaricus	Ikpa River	18	20.2-30.8	cm	TL	264	730	478	0.1305	2.495	This study
Erpetoichthys calabaricus	Ikpa River	18	19.5-29.6	cm	SL	264	730	478	0.1308	2.522	This study
CLUPEIDAE											
Pellonula leonensis	Kainji Lake	139	18.0-20.0	mm	SL	94	2 595	313	1.6982	1.580	24
Pellonula miri	Kainji Lake	185	28-65	mm	SL	140	4 900	871	1.5849	1.960	24
Pellonula miri	Lagos Lagoon	54	5.8-9.1	cm	SL	330	33 649	-	4 262.5927*	26 157.930*	12
Ilisha africana	Off Lagos Coast	46	14.0-25.4	cm	TL	2089	11 687	5 227	0.349	3.291	19
Ilisha africana	Qua Iboe Estuary	31	7.4-20.3	cm	TL	2142	12 602	6 716	44.4182	1.793	14
Ilisha africana	Qua Iboe Estuary	31	5.0-17.3	cm	SL	2142	12 602	6 716	112.1368	1.563	14
CYPRINIDAE											
Barbus callipterus	Mfangmfang Pond	16	5.5-7.0	cm	TL	631	2 216	1 572	0.0348	5.771	This study
Barbus callipterus	Mfangmfang Pond	16	4.3-5.5	cm	SL	631	2 216	1 572	0.1679	5.631	This study
BAGRIDAE											
Parauchenoglanis akiri	Ikpa River	28	7.2-16.7	cm	TL	207	339	257	3.4575	1.655	This study
Parauchenoglanis fasciatus[1]	Iba-Oku stream	15	10.6-14.5	cm	TL	86	156	124	1.0102	1.931	22
Parauchenoglanis fasciatus[1]	Iba-Oku stream	15	9.2-11.6	cm	SL	86	156	124	1.0954	2.050	22
Chrysichthys auratus	Tiga Lake	46	10.3-18.3	mm	TL	327	1 466	946	0.0112	2.280	27
Chrysichthys auratus	Oguta Lake	40	11-21	cm	SL	550	2 450	1 406	4.4310 x 10^{5}	3.362	21
Chrysichthys walkeri	Lekki Lagoon	21	13.3-24.5	cm	TL	896	4 168	2 084	-197.97*	243.5*	11
Chrysichthys nigrodigitatus	Lake Asegire	99	13.0-25.2	mm	TL	189	2 884	-	0.0227	3.053	8
CLARIIDAE											
Clarias buthupogon	Anambra River	23	15.0-27.0	mm	TL	3 848	29 960	12 267	2.8 x 10^{5}	3.270	7
Clarias agboyiensis	Anambra River	33	13.2-24.4	mm	TL	2 498	35 720	9 596	3.3 x 10^{6}	3.642	7
Clarias macromystax	Anambra River	31				2 136	37 250	14 942	6 x 10^{6}	3.965	7
Clarias ebriensis	Anambra River	48	13.5-35.0	mm	TL	2 746	54 216	14 730	1.04 x 10^{4}	2.996	7
MALAPTERURIDAE											
Malapterurus electricus	Ikpa River	20	12.8-28.1	cm	TL	112	2 955	775	0.0136	2.495	This study
Malapterurus electricus	Ikpa River	20	10.7-23.0	cm	SL	112	2 955	775	0.0186	3.772	This study

continued

Table 1 (continued)

Family/species	Locality	N	Length range	Fecundity (F) Min.	Max.	Mean	Length-fecundity parameters (α)	(β)	Source[2]
Malapterurus electricus	Iba-Oku Stream	23	12.8-19.6 cm TL	89	446	308	0.0070	3.632	22
Malapterurus electricus	Iba-Oku Stream	23	10.7-16.4 cm SL	89	446	308	0.0168	3.746	22
SCHILBEIDAE									
Schilbe intermedius	Cross River	7	14.9-22.0 cm TL	7 808	35 000	15 916	2.7677	2.973	29
Schilbe intermedius	Cross River	7	12.9-18.5 cm SL	7 808	35 000	15 916	2.8776	3.133	29
Schilbe mystus	Kainji Lake	9	17.0-21.1 cm SL	13 905	26 675	17 952	27 134.482*	2 332.5*	23
Parailia pellucida	Kainji Lake	15	6.2-11.6 cm SL	1 145	3 923	2 321	578.694*	307.430*	23
CYPRINODONTIDAE									
Aphyosemion bivittatum	Mfangmgang Pond	35	2.1-2.8 cm TL	6	15	10	1.0244	2.586	This study
Aphyosemion splendopleure	Mfangmgang Pond	19	2.9-4.0 cm TL	24	53	39	1.5691	2.579	This study
Aphyosemion splendopleure	Mfangmgang Pond	19	2.4-3.4 cm SL	24	53	39	2.4376	2.568	This study
Aphyosemion gardneri	Mfangmgang Pond	28	2.8-3.6 cm TL	6	20	13	0.0332	4.837	This study
Aphyosemion gardneri	Mfangmgang Pond	28	2.4-3.0 cm SL	6	20	13	0.0984	4.837	This study
Epiplatys sexfasciatus	Adada River	112	3.8-5.7 cm TL	13	110	-	0.8260	2.628	13
CICHLIDAE									
Chromidotilapia guntheri	Ikpa River	46	9.0-16.5 cm TL	30	457	185	0.0022	4.295	This study
Chromidotilapia guntheri	Ikpa River	46	6.8-13.0 cm SL	30	457	185	0.0276	3.647	This study
Tilapia mariae	New Calabar River	32	14.0-20.0 cm TL	339	1881	-	-1 287.580*	1 334 895*	4
Tilapia mariae	New Calabar River	32	14.0-20.0 cm TL	339	1881	-	1.0479	2.393	4
Tilapia mariae	Iba-Oku Stream	52	15.7-21.3 cm TL	953	3200	1982	9.2421	1.820	This study
Tilapia mariae	Iba-Oku Stream	52	12.0-16.4 cm SL	953	3200	1982	8.7595	2.012	This study
Tilapia guineensis	Editas Pond	-	7.3-14.0 cm SL	451	2150	-	13.2130	2.401	6
GOBIIDAE									
Periophthalmus barbarus	Cross River Estuary	40	6.2-13.6 cm SL	1 245	18 400	4 579	4.3058	3.247	This study
Periophthalmus barbarus	Cross River Estuary	40	7.6-15.0 cm TL	1 245	18 400	4 579	0.8215	3.688	This study
Periophthalmus barbarus	Cross River Estuary	23	7.6-15.0 cm TL	1 360	17 200	4 888	0.7049	3.754	20
Periophthalmus barbarus	Imo River Estuary	34	7.7-13.5 cm TL	900	23 933	12 175	0.47995	3.285	This study
Periophthalmus barbarus	Imo River Estuary	34	6.5-11.6 cm SL	900	23 933	12 175	25.5681	2.903	This study

1. Misidentified by Okon (1994) as *Auchanoglanis occidentalis*.
2. Original source of length/fecundity equations and/or raw data from which equations presented here were computed (see References on p. 33).
* α and β parameters of linear length-fecundity relationships.

exponent of the LFR. In order to examine the distribution pattern of the length exponents, the b values were rounded-up to nearest whole numbers owing to the relatively low number of cases (n = 42). Fig. 1 depicts that the distribution is slightly positively skewed (SK = 0.158) with the mode at 3.

The LF data presented here indicate that absolute fecundities of most of the fishes are dependent on the cube of their lengths and hence, body volume. This may be associated with the available visceral volume for holding the eggs. The LFRs presented (Table 1) provide useful tools for estimating egg production capacity of similar species.

Acknowledgements

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References

(The superscript numbers are referred to as Source in Table 1)

[1]Alvarez-Lajonchere, L. 1982. The fecundity of mullet (Pisces, Mugilidae) from Cuban waters. J. Fish Biol. 21: 607-613.

[2]Bagenal, T.B. 1978. Aspects of fish fecundity, p. 75-101. *In* S.D. Gerking (ed.) Ecology of freshwater fish production. Blackwell Scientific Publications, Oxford.

[3]Bagenal, T.B. and H. Braum. 1978. Eggs and early life history, p. 165-201. *In* T.B. Bagenal (ed.) Methods for assessment of fish production in fresh water. IBP handbook No. 3. Blackwell Scientific Publications, Oxford.

[4]Camara, O. 1984. Fecondité et maturité du *T. mariae* (Pelmatotilapia) et essai d'élevage semi-intensif du *O. niloticus* et *T. galilea* en polyculture en eau douce a Okigwe. African Regional Aquaculture Centre, Aluu, Port Harcourt, Nigeria. M. Tech thesis.

[5]Coates, D. 1988. Length-dependent changes in egg size and fecundity in females, and brooded embryo size in males, of fork-tailed catfishes (Pisces: Ariidae) from the Sepik River, Papua New Guinea, with some implications for stock assessments. J. Fish Biol. 33:455-464.

[6]Etim, L., I. Etcheri and O. Umoren. 1989. Aspects of reproductive biology of *Tilapia guineensis* (Perciformes: Cichlidae) in Editas Pond, Nigeria. J. Afr. Zool. 103:127-134.

[7]Ezenwaji, H.M.G. 1992. The reproductive biology of four African catfishes (Osteichthyes: Clariidae) in Anambra River basin, Nigeria. Hydrobiologia 242:155-164.

[8]Fagade, S.O. and A.A. Adebisi. 1979. On the fecundity of *Chrysichthys nigrodigitatus* (Lacépède) of Asejire dam, Oyo State, Nigeria. Nig. J. Nat. Sci. 1:127-131.

[9]Froese, R. 1990. FishBase: an information system to support fisheries and aquaculture research. Fishbyte 8(3):21-24.

[10]Fryer, G. and T.D. Iles. 1972. The cichlid fishes of the great lakes of Africa. Oliver and Boyd, Edinburgh.

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

[12]Ikusemiju, K., Oki, A.A. and M. Grahma-Douglas. 1983. On the biology of an estuarine population of the clupeid *Pellonula afzeliusi* (Johnels) in Lagos Lagoon, Nigeria. Hydrobiologia 102:55-59.

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

[14]King, R.P. 1991. Some aspects of the reproductive strategy of *Ilisha africana* (Bloch, 1795) (Teleostei, Clupeidae) in Qua Iboe estuary, Nigeria. Cybium 15(3):239-257.

[15]Kock, K-H. and A. Kellermann. 1991. Reproduction in antarctic notothenioid fish. Antarctic Sci. 3(2):125-150.

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

[17]Lowentin, R.C. 1966. On the measurement of relative variability. System. Zool. 15:141-142.

[18]Marcus, O. 1982. The biology of the clupeid, *Ilisha africana* (Bloch) of the Nigerian coast. University of Lagos, Lagos, Nigeria. Ph.D. thesis.

[19]Marcus, O. and K. Kusemiju. 1984. Some aspects of the reproductive biology of the clupeid, *Ilisha africana* (Bloch) off the Lagos coast, Nigeria. J. Fish Biol. 25:679-689.

[20]Mkpanam, N.B. 1990. Some aspects of reproductive biology and feeding habits of *Periophthalmus papilio* (Pisces: Periophthalmidae) in the mangrove swamp of Calabar River, Nigeria. University of Cross River State, Nigeria. B.Sc. thesis.

[21]Nwadiaro, C.S. and P.U. Okorie. 1986. Some aspects of the reproductive biology of *Chrysichthys filamentosus* Boulenger 1912 (Siluroidei, Bagridae) in Oguta Lake, Imo State, Nigeria. Rev. Zool. Afr. 99:233-241.

[22]Okon, E.E. 1994. Some aspects of the feeding habits and reproductive biology of *Malapterurus electricus* and *Auchenoglanis occidentalis* in Awa and Akpa Atak Eka streams in Uyo, Nigeria. University of Uyo, Uyo, Nigeria. B.Sc thesis.

[23]Olatunde, A.A. 1978. Sex, reproductive cycle and variations in the fecundity of the family Schilbeidae (Osteichthyes: Siluriformes) in Lake Kainji, Nigeria. Hydrobiologia 57(2):125-142.

[24]Otobo, F.O. 1978. The reproductive biology of *Pellonula afzeliusi* Johnels, and *Sierrathrissa leonensis* Thys Audenaerde in Lake Kainji, Nigeria. Hydrobiologia 61(2):99-112.

[25]Pauly, D. and R. Froese. 1991. FISHBASE: assembling information on fish. Naga, ICLARM Q. 14(4):10-11.

[26]Roff, D.A. 1986. Predicting body size with life history models. BioScience 36(5):316-323.

[27]Strum, M.G.De. L. 1984. On the biology of the catfish *Chrysichthys auratus* (Geoffory) in the man-made Tiga Lake in Northern Nigeria. Freshwat. Biol. 14:43-51.

[28]Teugels, G.G., Reid, G.McG. and R.P. King. 1992. Fishes of the Cross River basin (Cameroon-Nigeria): taxonomy, zoogeography, ecology and conservation. Musée Royal de L'Afrique Centrale, Tervuren, Belgique. Ann. Sci. Zool. Vol. 266, 132 p.

[29]Udo-Osoh, U.I. 1995. Some aspects of the reproductive biology of the schilbeids along the Cross River system, Nigeria. University of Uyo, Uyo, Nigeria. B.Sc thesis.

[30]Walpole, R.E. 1982. Introduction to statistics. 3rd ed. Macmillan Publishing Co., Inc., New York. 521 p.

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