Weight-Fecundity Relationships of Nigerian Fish Populations

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Abstract

Parameters a and b of the power body weight (W) – fecundity (F) relationships ($F=a{\cdot}W^b$) are presented for 25 populations comprising 15 species of Nigerian fishes. Estimates of b varied between 0.511 (*Parauchenoglanis akiri*) and 1.654 (*Periophthalmus barbarus*) with a mean of 1.087 (s.d. = 0.520). The maximum weight of populations examined did not significantly influence the relative magnitude of b. The parameters α and β of the linear weight-fecundity relationship ($F=\alpha+\beta W$) are also presented for 27 fish populations from 22 species. Estimates of β ranged from 4.22 (*Chromidotilapia guntheri*) to 2 062.94 (*Pellunula miri*), with a mean of 243.80 (s.d. = 477.89). The magnitudes of β declined with increasing maximum weights of fishes examined.

Introduction

In fisheries biology, absolute fecundity (F) is defined as the number of ripe eggs in the ovaries prior to spawning of an individual female fish (Bagenal 1978). This attribute is fundamental to the comprehension of the reproductive life history of fishes and is useful in various applied aspects of fisheries biology and pisciculture (King 1997). Absolute fecundity is positively correlated with fish body weight (Bagenal 1978). In the allometric weight-fecundity relationship (WFR), the parameters are crucial in pragmatic applications including *inter alia*: (i) assessment of population egg production capacity; (ii) estimation of the mean egg production capacity of a given group; (iii) spatio-temporal trends in egg production capacity as may be influenced by dynamics in diet, foraging performance and abiotic habitat conditions; (iv) evaluation of oncogenicity in egg production capacity; and (v) interspecific and interpopulational comparisons of egg production capacity.

King (1997) presented a seminal compilation of species-specific length-fecundity relationships of Nigerian fish populations. The present contribution presents a compilation of species-specific WFRs of Nigerian fish populations.

Materials and Methods

Fishes were sampled from several waterbodies in Nigeria during 1985 to 1995. The fishing gears included gillnets, castnets, scoop nets, hooks and traditional valved basket traps. The fishes were identified nomenclature of the taxa conformed to Levêque et al. (1992) and Teugels et al. (1992) and weighed (g) to determine total weight (TW). They were dissected and sexed by examination of the gonads. Ovaries with ripe eggs were weighed (g) to determine the ovary weight (OW). The somatic weight (SW) was then calculated thus:

$$SW = TW - OW \qquad ...1)$$

Absolute fecundity was estimated by direct counts of all the eggs or by gravimetric method (King 1991b). For each species or population, the parameters a (proportionality constant or regression intercept) and b (regression exponent) of the allometric WFR of the following form (Bagenal 1978) were estimated:

$$F = a{\cdot}W^b \qquad ...2)$$

This was done via base 10 logarithm transformation of equation 2:

$$\text{Log } F = \log a + b \log W \qquad ...3)$$

and using WFR data pairs and least squares linear regression.

A linear WFR function of the form:

$$F = \alpha + \beta W \qquad ...4)$$

was also estimated for some of the fish species or populations, where α = regression intercept and β= slope. Additional power and linear WFR parameters (equations 2 and 4) of certain species or populations were obtained from both published and unpublished literature, some of which lacked relevant ancilliary statistics such as sample sizes, body weight ranges and mean fecundity estimates. Variability in the value of b (equation 2) or β (equation 4) was evaluated by the coefficient of variation (CV).

Results and Discussion

The WFR data of 34 fish populations, representing 10 families, 15 genera and 23 species were analyzed. Table 1 summarizes the population-specific results, along with available information on sample sizes, weight ranges, fecundity means and ranges. These comprised 15 cases analyzed from original data and 19 cases derived from the literature. All recorded WF correlations were significant at

Table 1. Weight-fecundity relationships and related statistics for 34 fish populations occurring in Nigeria.

Family/Species	Locality	n	Weight range[a] (g)	Fecundity Min.	Fecundity Max.	Fecundity Mean	Power Fecundity a	Power Fecundity b	Linear Fecundity α	Linear Fecundity β	Source[b]
Family											
Polyteridae											
Erpeloichthys calabaricus	Ikpa River	18	17.0-46.5 TW	264	730	478	16.8	0.98	-0.7	15.82	This study
Erpeloichthys calabaricus	Iba-Oku Stream	29	18.4-50.1 TW	242	715	438	9.4	1.13	-90.7	18.02	This study
Clupeidae											
Ilisha africana	Off Lagos coast	46	16.2-102.7 TW	2089	11687	5227	99.1	1.05	—	—	Marcus and Kusemiju (1984)
Ilisha africana	Qua Iboe estuary	31	9.3-60.0 TW	2142	12602	6716	391.2	0.82	—	—	King (1991)
Ilisha africana	Qua Iboe estuary	31	10.1-57.7 SW	2142	12602	6716	481.5	0.78	—	—	King (1991b)
Ilisha africana	Qua Iboe estuary	31	9.3-60.0 TW	2142	12602	6716	—	—	854.1	187.86	This study
Pellonula miri	Lagos lagoon	54	1.8-10.7 TW	330	33649	—	—	—	-945.1	2062.94	Ikusemiju et al. (1983)
Cyprinidae											
Barbus callipterus	Mfangmfang Pond	16	3.0-4.4 TW	631	2216	1572	35.9	3.0	-22270.4	1097.78	This study
Bagridae											
Parauchenoglanis akiri	Ikpa River	28	22.2-53.7 TW	207	339	257	43.6	0.51	125.5	3.95	This study
Parauchenoglanis fasciatus[c]	Iba-Oku stream	15	14.2-29.2 TW	86	156	124	20.4	0.62	54.0	3.91	Okon (1994)
Chrysichthys auratus	Ogula Lake	40	20.0-120.0 TW	550	2450	1406	—	—	-226.9	23.57	Nwadiaro and Okorie (1986)
Chrysichthys walkeri	Lekki Lagoon	21	28.1-172.9 TW	896	4168	2084	—	—	818.5	19.93	Ikusemiju (1976)
Chrysichthys nigrodigitatus	Asejire Dam	99	—	189	2884	—	22.2	0.95	36.3	19.00	Fagade and Adebisi (1979)
Clariidae											
Clarias buthupogon	Anambra River	23	—	3848	29960	12267	—	—	-1226.4	189.34	Ezenwaji (1992)
Clarias agboyiensis	Anambra River	33	—	2498	35720	9596	—	—	-1296.9	162.95	Ezenwaji (1992)
Clarias macromystax	Anambra River	31	—	2136	37250	14942	—	—	-3998.7	209.00	Ezenwaji (1992)
Clarias ebriensis	Anambra River	48	—	2746	54216	14730	—	—	-3964.3	197.94	Ezenwaji (1992)
Malapteruridae											
Malapterurus electricus	Ikpa River	20	33.4-259.0 TW	112	2955	775	1.7	1.26	11.9	5.95	This study
Malapterurus electricus	Ikpa River	20	32.7-239.0 SW	112	2955	775	2.1	1.22	—	—	This study
Malapterurus electricus	Ikpa River	23	33.7-82.2 TW	89	446	308	0.8	1.45	-43.8	5.85	Okon (1994)
Schilbeidae											
Schilbe mystus	Kainji Lake	9	60.0-145.0 TW	13905	26675	17952	1232.2	0.59	6584.4	119.70	Olatunde (1978)
Parailia pellucida	Kainji Lake	15	2.2-14.0 TW	1145	3923	2321	917.0	0.42	973.9	153.36	Olatunde (1978)
Aplocheilidae											
Aphyosemion spendopleure	Mfangmfang Pond	19	0.244-0.744 TW	24	53	39	69.8	0.78	9.1	62.79	This study
Aphyosemion gardneri	Mfangmfang Pond	28	0.204-0.510 TW	6	20	13	51.1	1.31	-2.9	45.98	This study
Epiplatys sexfasciatus	Adada River	112	0.659-2.747 TW	13	110	49	54.1	0.81	—	—	Inyang and Anozie (1987)
Cichlidae											
Tilapia mariae	New Calabar River	32	39.95-223.8 TW	339	1881	—	62431.0	1.18	-149.9	8.57	Camara (1984)
Tilapia mariae	Iba-Oku Stream	52	75.0-243.7 TW	953	3200	1982	50.2	0.71	665.0	7.62	This study
Tilapia mariae	Iba-Oku Stream	52	85.0-238.0 SW	953	3200	1982	56.0	0.70	693.4	7.83	This study
Tilapia guineensis	Lekki Lagoon	61	35.0-467.0 TW	1035	11170	—	—	—	450.0	23.15	Fagade (1978)
Chromidotilapia guentheri	Ikpa River	46	12.0-95.0 TW	30	457	185	1.6	1.17	-47.0	4.22	This study
Gobiidae											
Periopthalmus barbarus	Cross River estuary	23	5.0-19.7 TW	1360	17200	4888	103.03	1.65	-4434.2	975.95	Mkpanam (1990)
Periopthalmus barbarus	Cross River estuary	40	5.0-19.7 TW	1245	18200	4579	121.0	1.58	-4187.2	949.83	This study
Periopthalmus barbarus	Imo River estuary	34	4.9-32.0 TW	900	23933	12175	1134.5	0.94	—	—	This study
Periopthalmus barbarus	Imo River estuary	34	4.8-31.6 SW	900	23933	12175	233.2	1.59	—	—	This study

[a] TW-total weight, SW-somatic weight

[b] Original source of weight/fecundity equation and/or raw data from which equations presented here were computed.

[c] Misidentified by Okon (1994) as *Auchenoglanis occidentalis*.

P = 0.05 or better. There were 25 power and 27 linear WFR models.

For the power WFRs, interpopulational variability in values of **b** was moderately heterogeneous (CV = 47.8%) and ranged from b_{min} = 0.51 in *Parauchenoglanis akiri* to b_{max} = 1.65 in *Periophthalmus barbarus* (i.e., 3.2-fold variation). The overall mean of the weight exponent (**b** = 1.09; s.d. = 0.52) is not significantly different from 1.0 (t = 0.785, df = 24, P = 0.05), thus depicting that fecundity relates linearly to fish weight. Since fish body weight relates to volume which is indexed by a cube function of its length, the above is as expected, considering that an earlier study by King (1997) found that the mean of the exponent of the length-fecundity relationship of Nigerian fishes is not significantly different from 3.0. From the foregoing, the general use of relative fecundity (i.e., number of ripe eggs in the ovaries per unit body weight) for interpopulational comparisons of egg production capacity is recommended (Bagenal 1978). Variance-mean ratio of **b** was significantly less than unity (VMR = 0.248: t = 2.605, df = 24, P = 0.02), thus suggesting that **b** is a uniformly dispersed variate among the populations studied.

A regression of fish maximum weight (ln W_{max}) examined *vs.* weight exponent (ln b) was non-significant (r = -0.145, df = 22, P = 0.05), thus implying that the maximum weight of fish examined has no significant influence on the relative magnitude of the weight exponent of the WFR. A similar result was found by King (1997) in the case of the exponent of length-fecundity relationship of Nigerian fishes. It can thus be inferred that both maximum length and weight of fishes examined have no remarkable impact on the rate of fecundity increase per unit body length and weight.

For the linear WFR models, β depicts the egg production capacity in terms of increase in egg number per gram increase in body weight. Values of β were highly heterogeneous (CV = 196.0%) and varied from β_{min} = 3.81 in *Parauchenoglanis fasciatus* to β_{max} = 2 062.94 in *Pellunula miri* (i.e., 542-fold variation. Overall mean β = 243.80 (s.d. = 477.89).

The two species of the genus *Parauchenoglanis* had closely similar egg production capacities per gram of body weight β (CV = 2.6 %). The three *Chrysichthys* species from contrasting lentic habitats also had similar β values (CV = 11.6%). Habitat attributes probably have limited impacts on the egg production capacity of members of this genus. This assertion is corroborated by the slope of the linear FWR of the allied *Chrysichthys velifer* in Côte d'Ivoire (Albaret 1982):

$$F = 138 + 18\,W \quad (r = 0.94;\ n = 17) \qquad ...5)$$

which compares well with those of the Nigerian species presented in Table 1. Little interpopulational variations in values of β were exhibited by the clariids (CV = 10.3%), schilbeids (CV = 17.4%) and cyprinodonts (CV = 21.9%).

Conversely, marked interpopulational variation occurred in values of β in respect of the clupeids (CV = 117.8%) and cichlids (CV = 71.9%). In the latter group, β was lowest in the mouth-brooder, *Chromidotilapia guntheri* and highest in the substrate-spawner *Tilapia guineensis*, while *Tilapia mariae* (a substrate-spawner) had intermediate values. This trend is attributable to the fact that *T. mariae* is considered to occupy a transitional position in the ecoethological evolution of the mouth-brooding habit from ancestral substrate-spawners (King 1991a). This notion is corroborated by the convergence in various ecomorphological attributes of *T. mariae* which are independently typical of the tilapiine mouth-brooders and substrate-spawners.

Across the 22 fish populations for which complete W_{max} - β data pairs are available, a significant inverse relationship existed between ln (W_{max}) and ln (β) (r = 0.485, df = 20, P = 0.05). It thus implies that as the maximum body weight of the fish increases, the number of eggs produced per gram increase. This trend could be linked to the biomechanism whereby a fish continues to grow after the fecundity has stabilized, so that the fecundity for a given size appears to decline albeit remaining constant (Bagenal 1978). Although this phenomenon is best known in individual species, the present result reveals its existence in multispecies populations.

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NTAFP News

CTSA Opens New Website

The Center for Tropical and Subtropical Aquaculture (CTSA), Hawaii launched its new home page on the Internet. The CTSA is one of the five regional aquaculture centers funded by the United States Department of Agriculture whose mission is to support aquaculture research, development, demonstration and extension education to enhance aquaculture viability and profitability. The home page is another value-added information service of the CTSA-funded project titled *Pacific Regional Aquaculture Information Service for Education* or *PRAISE* (see also *Aquabyte News*, *Naga* July 1997 issue for more information on *PRAISE* and other CTSA publications). CTSA's location on the Internet is provided by the University of Hawaii which co-administers CTSA with The Oceanic Institute. The CTSA Website address or URL is http://library.kcc.hawaii.edy/CTSA/. The site now contains the following: i) back issues of *Regional Notes*, CTSA's newsletter; ii) the Center's calendar of events; iii) a number of CTSA publications that can be downloaded; iv) the 1997 Annual Accomplishment Report; v) the Center's revised procedures; vi) profile and contact numbers of CTSA staff; and vii) link to The Oceanic Institute's home page. CTSA funds aquaculture research, development and demonstration projects which span the *American Insular Pacific*. For more information on aquaculture research updates, please contact the Center for Tropical and Subtropical Aquaculture, The Oceanic Institute, 41-202 Kalanianaole Hwy., Makapu'u Point, Waimanalo, Hawaii 96795, USA; Telephone: (808) 2597951; Fax: (808) 2598395.