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B.E. MARSHALL *is from the Department of Biological Sciences, University of Zimbabwe, P.O. Box MP 167, Mount Pleasant, Harare, Zimbabwe.*

Growth, Mortality, Maturity and Length-Weight Parameters of Fishes in Lake Kariba, Africa

JEPPE KOLDING
EYÜP MÜMTAZ TIRAŞIN
LAWRENCE KARENGE

Abstract

This preliminary compilation presents vital parameters for 22 species of freshwater fish from Lake Kariba. The majority of the growth parameters are derived from tables in Balon and Coche's "Lake Kariba: a man-made tropical ecosystem in central Africa". The rest of the parameters are compiled from more recent sources and unpublished data.

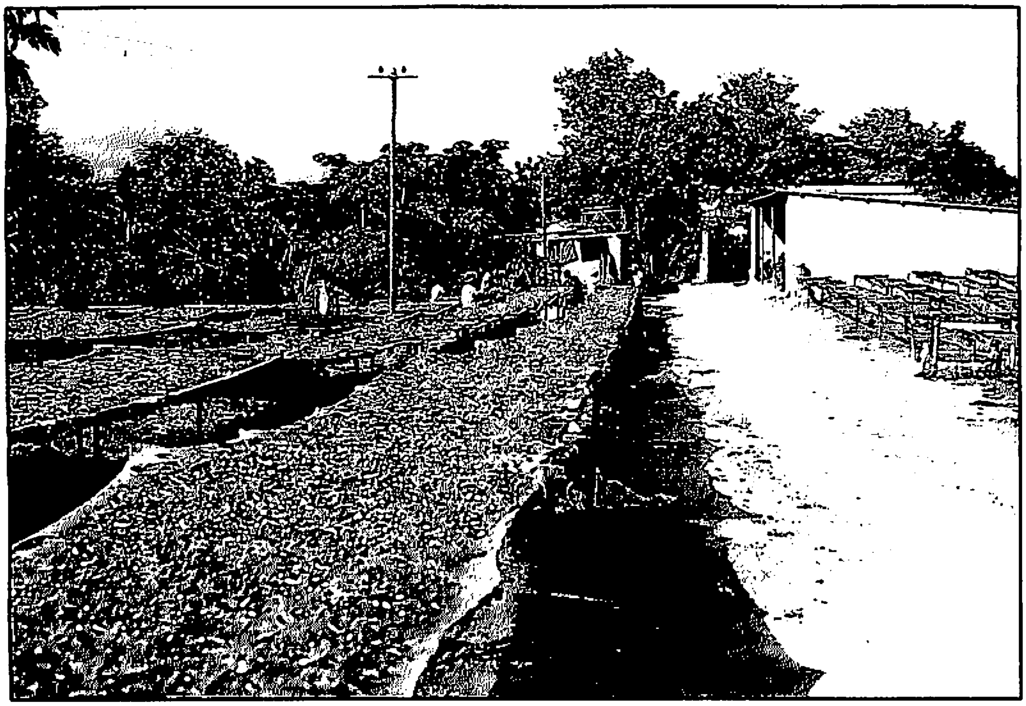
Introduction

Lake Kariba (277 km long; 5,300 km^2; 29 m mean depth and 120 m max. depth) was dammed in 1958 and filled in 1963. It is shared almost equally by the two riparian countries, Zambia and Zimbabwe, and the fisheries yields some 35,000 t/year. Despite the rather extensive present literature on various aspects of the lake ecosystem (e.g., Marshall 1984; Machena 1988), only few and scattered estimates of von Bertalanffy growth parameters, length-weight coefficients and size of maturity of the fish species have been published. This contribution is an attempt to assemble an array of important parameters of fishes from Lake Kariba.

About 40 species of fish occur in the lake (Bell-Cross and Minshull 1988; also see Torres, p. 42). Vital parameters from 22 of the most important and common species are presented here, although four species of the commercially exploited genera *Distichodus* and *Labeo* are missing due to lack of data. The remaining species not included are mainly small cyprinids and cichlids, not important to the fisheries.

Materials and Methods

Nonlinear methods were used to fit the length-at-age data in Balon and Coche (1974). The programs used were the VONBER algorithm implemented in the LFSA package (Sparre 1987) and the simplex algorithm in the SYSTAT (1990) statistical package (both programs provided identical results). Because back calculated length-at-age of fish from fish at different age classes were derived from unequal sample sizes (Balon and Coche 1974), the data were weighed by the sample size of each age group. However, for some species (*Brycinus lateralis, Serranochromis codringtonii, Clarias gariepinus, Heterobranchus longifilis, Labeo altivelis, Malapeterus electricus, Synodontis nebulosus* and *S. zambezensis*) the programs did not reach convergence indicating that the data did not follow the von Bertalanffy growth function (VBGF). Graphical plots of these data showed nearly linear growth. In such cases, tentative



*Kapenta (*Limnothrissa miodon*) being dried on racks in Kariba.* (This spread's photos by C. Machena)

used to estimate the parameters a and b of length-weight relationships of the form ($W=aL^b$). The growth parameters of *Serranochromis codringtonii* are from Karenge (in prep.), based on length-frequency analysis. For the two small cichlids, *Pharyngochromis darlingi* and *Pseudocrenilabrus philander*, all parameters were taken from Hustler and Marshall (1990). Growth parameters, based on otolith readings, and total mortality (Z) of Kapenta (*Limnothrissa miodon*), the most important commercial species, were obtained from Anon. (1992). Natural mortality (M) was calculated from Pauly's (1980) empirical equation using 20°C as the mean water temperature (T). M for *L. miodon* was omitted due to an unrealistic low value. Total mortality estimates (Z) were obtained from the P/B ratios given in Mahon and Balon (1977).

estimates of asymptotic length L_∞ were calculated from $L_\infty=L_{max}/0.95$ (Pauly 1984). L_{max} here, when not taken from Balon and Coche (1974), refers to the value derived by averaging the size from several of the largest specimens (Pauly 1984). These data were obtained from a large database containing some 120,000 individual fish measurements spanning 30 years of continuous sampling (Karenge, in prep.). This database also provided the estimates of median (50%) size at maturity, and was also

Results and Discussion

Table 1 presents the compiled results with 95% confidence limits in brackets, when these were obtainable. All growth parameters, i.e. L_∞, K, t_0 and ϕ' (= $\log K + 2\log_{10} L_\infty$, Pauly and Munro 1984), should be regarded as preliminary estimates only. The averaged back calculated lengths at age given in Balon and Coche (1974) were generally insufficient and did not conform to the VBGF in several

Table 1. Growth, maturity and mortality related parameters of 22 species of freshwater fish from Lake Kariba, Africa. Ninety-five percent confidence limits (in brackets) were calculated when possible. Names after Bell-Cross and Minshull (1988).

Family	Species	Length type[a]	L_{max} (cm)	L_∞ (cm)	K (year^{-1})	t_0 (year)	ϕ'	$L_{mat(50\%)}$ (cm)[b]	a[b]	b[b]	M (year^{-1})	Z (year^{-1})[c]
Characidae	*Brycinus imberi*	T	17[b]	14.8	1.404	0.589	2.488	12♂/12♀	0.036	2.79	2.32	1.91
Characidae	*Brycinus lateralis*	T	14	14.7[d]	-	-	-	-	-	-	-	3.87
Characidae	*Hydrocynus forskahlii*	S	58[b]	56.7[e](±5.04)	0.323 (±0.100)	-0.338 (±0.396)	3.016	27♂/30♀	0.020	2.98	0.61	0.68
Characidae	*Micralestes acutidens*	S	-	7.2	0.627	-0.489	1.512	-	-	-	1.67	2.48
Cichlidae	*Oreochromis mortimeri*	T	48	54.3[f](±2.58)	0.256 (±0.026)	0.351 (±0.055)	2.878	29♂/22♀	0.023	2.98	0.53	0.83
Cichlidae	*Pharyngochromis darlingi*[g]	T	10	15.7	0.660	-0.293	2.211	-	0.008[h]	3.01	-	5.28
Cichlidae	*Pseudocrenilabrus philander*[g]	T	8	8.4	1.620	-0.137	2.058	-	0.008[h]	3.03	-	8.28
Cichlidae	*Serranochromis codringtonii*[b]	T	39	37.3(±11.8)	0.799 (±0.439)	-0.189	3.046	24♂/21♀	0.019	3.05	-	1.00
Cichlidae	*Tilapia rendalli*	T	38[b]	48.5[f](±1.20)	0.145 (±0.005)	-0.419 (±0.014)	2.533	23♂/21♀	0.034	2.89	0.38	1.16
Clariidae	*Clarias gariepinus*	T	82	86.3[d]	-	-	-	37♂/34♀	0.015	2.83	-	0.44
Clariidae	*Heterobranchus longifilis*	T	115[b]	121.1[d]	-	-	-	-	0.003	3.22	-	0.59
Clupeidae	*Limnothrissa miodon*[i]	T	10	13.5 (±7.00)	0.950 (±0.900)	-0.020 (±0.130)	2.238	-	0.00001[h]	2.86	-	4-6
Cyprinidae	*Labeo altivelis*	T	49	51.6[d]	-	-	-	25♂/27♀	0.023	2.96	-	0:60
Malapteruridae	*Malapterurus electricus*	S	85	89.5[d]	-	-	-	-	-	-	-	1.08
Mochokidae	*Synodontis nebulosus*	S	14	14.7[d]	-	-	-	-	-	-	-	0.94
Mochokidae	*Synodontis zambezensis*	T	31	32.6[d]	-	-	-	18♂/15♀	0.009	3.18	-	0.90
Mormyridae	*Hippopotamyrus discorhynchus*	T	32[b]	34.9 (±0.15)	0.158 (±0.001)	-0.634 (±0.003)	2.284	/13♂/11♀	0.057	2.53	0.44	1.87
Mormyridae	*Marcusenius macrolepidotus*	T	30[b]	44.3[f](±3.44)	0.121 (±0.015)	-1.319 (±0.092)	2.376	14♂/11♀	0.025	2.76	0.34	1.30
Mormyridae	*Mormyrops deliciosus*	S	100	136.8[f](±14.35)	0.078 (±0.012)	-1.116 (±0.097)	3.164	46♂/44♀	0.015	2.87	0.19	0.53
Mormyridae	*Mormyrus longirostris*	T	80[b]	70.8 (±1.04)	0.224 (±0.009)	-1.207 (±0.051)	3.050	47♂/34♀		0.018	2.86	0.450.53
Schilbeidae	*Schilbe depressirostris*	T	36[b]	42.4[f](±2.00)	0.095 (±0.006)	-0.762 (±0.026)	2.232	15♂/16♀		0.015	2.89	0.300.97
Schilbeidae	*Schilbe mystus*	S	34	38.4[f](±7.17)	0.081 (±0.009)	-0.801 (±0.048)	2.077	-	-	-	0.28	0.68

[a]T = Total length; S = standard length. [b]Data from Karenge (In prep.). [c]Data from Mahon and Balon (1977). [d]Program did not converge; preliminary estimation of asymptotic length (Pauly 1984). [e]Unweighed data. [f]Probably overestimated. [g]Data from Hustler and Marshall (1990). [h]Total length in mm. [i]Data from Anon. (1992).

Tigerfish (Hydrocynus vittatus) at a weighing bay during one of Kariba International tiger fishing tournaments.

cases. Weighing by sample size did help, but the results were still biased. The single samples were heavily biased in two ways (Balon and Coche 1974): i) "by a size-selective collection in the sampled area, e.g., juveniles in order of decreasing size are less completely sampled...", and ii) "by immigration or emigration of different age groups into the different habitats sampled...". These biases probably influenced the quantitative samples more strongly than any variability in yearclass strength". These biases therefore also apply to the total mortality estimates as they are based on production and biomass calculations from the same samples (Mahon and Balon 1977). Growth, and particularly mortality estimates of *Limnothrissa miodon* are still controversial but probably the most reliable estimates available (Anon. 1992). Median size-at-maturity estimates and length-weight coefficients were derived from relatively large samples (from 500 to several thousands) over a long time span and are considered reasonably reliable.

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J. KOLDING *and* E.M. TIRASIN *are from the Department of Fisheries and Marine Biology, University of Bergen, High Technology Centre, N-5020, Bergen, Norway.* L. KARENGE *is from the Department of National Parks and Wildlife Management, Aquatic Research, P.O. Box 8365 Causeway, Harare, Zimbabwe.*