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Morphometrics, length-weight relationship and condition of *Rastrineobola argentea* (Pellegrin 1904) in the Winam Gulf of Lake Victoria (Kenya)

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ABSTRACT

Correlation between total length (TL), fork length (FL) and standard length (SL) of *Rastrineobola argentea* (Pellegrin 1904) in the Winam Gulf of Lake Victoria indicate that FL = 0.92 TL - 0.74 and SL = 0.90 TL - 1.74. Length-weight relationship of log-transformed data shows that the slopes of the regression lines were 3.06 to 3.22 for juveniles, 2.70 to 3.05 for males and 3.24 to 3.71 for females. Thee slopes were significantly different between groups at at a = 0.05. The Fulton's condition factor (K) was highest in December (1.019-1.073) and March /April (1.015-1.030) but lowest in June (1.00-1.025) for all stations. Significant differences between groups demands for the use of different growth models for juveniles, males and females especially for the von Bertalanffy growth equation which uses length-weight relationship. Observed cyclic variations in condition factor suggests two peak breeding seasons for this species in the Winam Gulf. The practical implication of these results in stock assessment using length-based fish stock assessment methods is briefly discussed.

INTRODUCTION

The family Cyprinidae are known as typical marine family. However, several members of the family are lake inhabitants. Some of these lacustrine cyprinids have not only adopted a pelagic way of life, but also their shape and silvery camouflage (GREENWOOD, 1966; WANINK, 1989) resemble marine pelagic fish such as herring (*Clupea sp.*). The pelagic cyprinids endemic to some East and Central African lakes were previously placed in one genus, *Engraulicypris*, until a revision by HOWES (1980). In Lakes Victoria, Kyoga and Nabugabo, this group of fishes is represented by *Rastrineobola argentea* (Pellegrin) according to the current classification by Howes (*op. cit.*) and *Chelaethiops sp.* in Lake Tanganyika which is of no economic value (OKEDI, 1981B; WANINK, 1989). *R. argentea* is locally known as "omena" in Kenya, "mukene" in Uganda and "nsalali" in Tanzania (GRAHAM, 1929; GREENWOOD, 1966). The name "dagaa" became popular in the early 1970s when a light fishery for this species reached commercial significance. The fishermen of Lake Victoria adopted this name from the clupeids of Lake Tanganyika which were also caught by light attraction (OKEDI, 1981A; 1981B; WANINK, 1989).

Fish stock assessment has been carried out in the Winam Gulf of Lake Victoria using bottom trawls (KUDHONGANIA and CORDONE, 1974; MARTEN *et al.*, 1976; BENDA, 1981; MULLER and BENDA, 1981), a catch assessment survey on the artisanal fishery (RABUOR, 1988) and length-frequency analysis (GETABU, 1988; ASILA and OGARI, 1988). Very little scientific information on the biology and ecology of *Rastrineobola argentea* is available. The earlier works of GRAHAM (1929); GREENWOOD (1966) were brief summaries covering all the known fish species of Lake Victoria at that time. The preliminary observations by OKEDI (1973) on the breeding ecology and fecundity of *Rastrineobola* in Lake Victoria may be considered as the pioneerig work on the biology and ecology of the species in Lake Victoria. Recent work on *R. argentea* includes those of WANINK (1989); MANYALA (1991); CHITAMWEBWA (1992); WANDERA (1992); KATUNZI (1992); MANYALA *et al.* (1992) on the general biology and ecology of the species in Lake Victoria. MANNINI (1992) reviewed the characteristics of *R. argentea* in Lake Victoria and compared it to other small pelagics from other African Great Lakes.

The aim of this study was to establish the relationships between different forms of length measurements for *R. argentea* hitherto used by different researchers, the length-weight relationship and Fulton's condition factor in the Winam Gulf of Lake Victoria. The objective of the study was therefore to obtain conversion factors for length measurements, objective growth forms and estimate breeding seasons.

MATERIALS AND METHODS

Sample collection

Monthly samples from commercial artisanal fisheries were obtained from five stations on the southern zone of the Winam Gulf of Lake Victoria (Fig. 1). Standard length (SL), fork length (FL) and total length (TL) of each fish were measured to the nearest mm using a fish measuring board, in the first sampling month (August). Only TL was measured for subsequent months. Weight of all fish were taken to the nearest 0.1 g using a trip pan balance. Each individual was dissected from the ventral side and sex determined according to the subjective methods of BAGENAL and BRAUM (1971), HOPSON (1972) and HOPSON (1975). The females were identified as having thin flat brown to golden brown gonads embedded in the ventral cavity, sometimes swollen and yellow with clearly discernible eggs (HOPSON, 1972;1975). The males were identified as having thin strands of translucent to white gonadal material embedded in the ventral cavity but never flat, according to the same author. The rest of the individuals were classified as immature. Field data were collected for a period of 12 months (from August, 1989 to July 1990). Data on length, weight and sex were used to perform regression analyses on stocks from different portions of the Gulf.

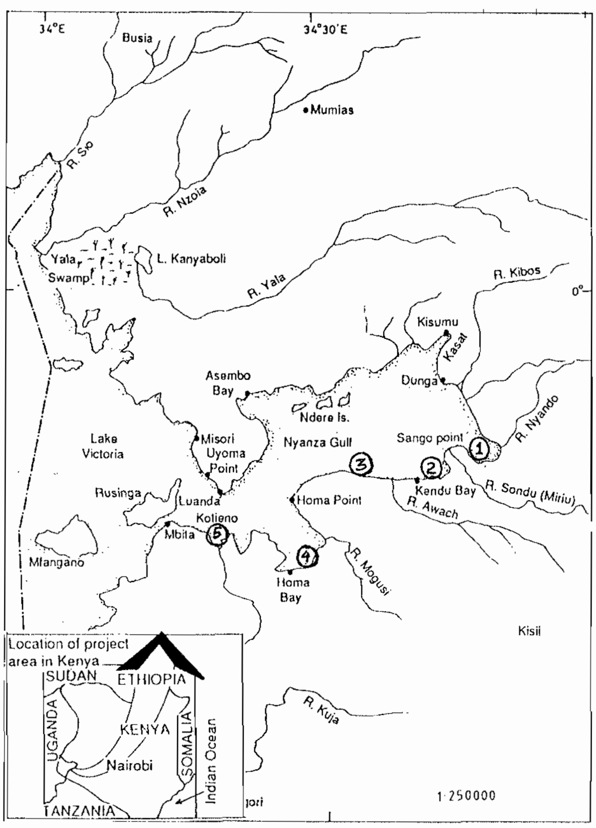

Fig. 1. Map of Winam Gulf of Lake Victoria showing sampling stations.

Data analysis

Regression analyses

Regression analyses of different length measurements (SL, FL and TL) were done by the least square method while length-weight regression was obtained by log L - log W regression the by least square method. The Fultons condition factor (K) was calculated from the relationship:

$$K = W_O/W$$

where,

W_O = observed weight

W = predicted weight

The results of all these analyses were subjected to statistical tests of significance using one-way and/or two-way analysis of variance (ANOVA) between sexes and stations (ZAR, 1984).

RESULTS

Regression analysis

Length regression analyses

The different forms of length measurements were found to be related to each other by the following linear equation:

$$FL = 0.92\ TL - 0.74$$
$$SL = 0.90\ TL - 1.74$$
$$SL = 0.94\ FL - 1.16.$$

The correlation between the different forms of length measurements are shown in Fig. 2 while the details of these regression analyses are given in Table 1. The correlation coefficients in all the analyses were very high ($r^2 = 0.90 - 0.99$) while the standard error of each coefficient was very low (0.01).

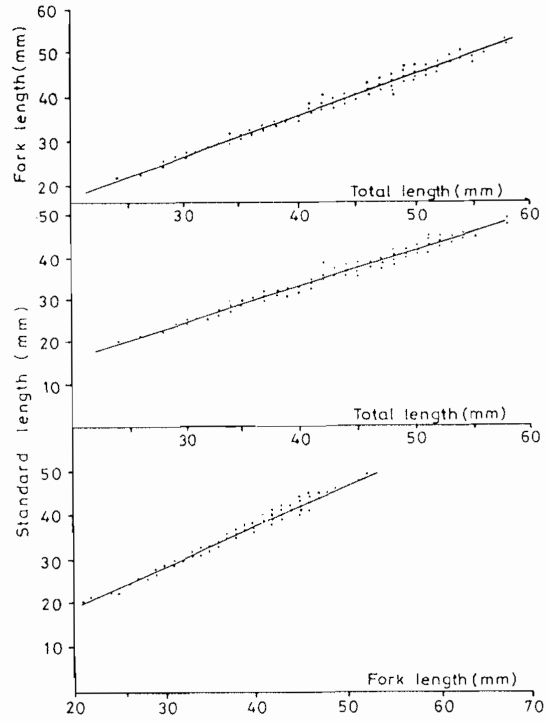

Fig. 2. Correlation between total length (TL), fork length (FL) standard length (SL) of R argentea in the Winam Gulf.

Table 1: Correlation between total length (TL), fork length (FL) and standard length (SL) of *R. argentea* in the Winam Gulf of Lake Victoria.

Station	*Indep. variable*	*Dependent variable*	*Coeff. ± SE*	*Const*	r^2	*n*
Sango	TL	FL	0.9 ± 0	-0.2	0.90	249
	TL	SL	0.8 ± 0	-0.3	0.90	249
	FL	SL	0.9 ± 0	-0.4	0.90	249
Rakwaro	TL	FL	0.9 ± 0,01	-0.8	0.96	285
	TL	SL	0.9 ± 0.01	-0.8	0.96	285
	FL	SL	0.9 ± 0.01	-0.5	0.96	285
Obaria	TL	FL	0.9 ± 0	-1.0	0.99	238
	TL	SL	0.9 ± 0	-4.0	0.99	238
	FL	SL	0.9 ± 0	-2.0	0.99	238
Ngegu	TL	FL	0.9 ± 0.01	-1.3	0.98	239
	TL	SL	0.9 ± 0.01	-1.3	0.98	239
	FL	SL	0.9 ± 0.01	-0.2	0.99	239
Luanda	TL	FL	0.9 ± 0.01	-0.6	0.98	220
	TL	SL	0.9 ± 0.01	-2.4	0.98	220
	FL	SL	0.9 ± 0.01	-2.7	0.98	220

Table 2. Correlation between Log TL and Log W of R. argentea in the Winam Gulf. Similar superscripts indicate no significant differences

Station	*Length-weight relationship*	*n*	r^2
Juveniles:			
Sango[1]	Log W = 3.06 Log TL - 5.42	732	0.60
Rakwaro[1]	Log W = 3.12 Log TL - 5.60	708	0.68
Obaria[1]	Log W = 3.10 Log TL - 5.50	663	0.72
Ngegu[1]	Log W = 3.20 Log TL - 5.84	479	0.66
Luanda[1]	Log W = 3.22 Log TL - 6.00	456	0.84
Males:			
Sango[2]	Log W = 2.70 Log TL - 4.69	754	0.60
Rakwaro[2]	Log W = 2.81 Log TL - 4.70	977	0.69
Obaria[2]	Log W = 3.05 Log TL - 4.90	815	0.64
Ngegu[2]	Log W = 2.94 Log TL - 5.00	822	0.67
Luanda[2]	Log W = 2.75 Log TL - 4.76	985	0.70
Females:			
Sango[3]	Log W = 3.60 Log TL - 6.20	1266	0.66
Rakwaro[3]	Log W = 3.65 Log TL - 6.41	1348	0.72
Obaria[3]	Log W = 3.71 Log TL - 6.50	1144	0.68
Ngegu[3]	Log W = 3.40 Log TL - 5.60	1219	0.68
Luanda[3]	Log W = 3.24 Log TL - 5.45	1337	0.61
F(14,13675)	6.324*		

Length-weight relationship

The mean length-weight relationship of the species from each of the five stations is presented in Table 2. The graphical representation of length-weight relationship is shown in Fig. 3 before any transformation and Fig. 4 after log-log transformation. An analysis of covariance (ANCOVA) revealed significant differences between the slopes of the regression lines (Table 3) while multiple range test, Student Newman-Keuls (SNK) test indicated that there were significant differences between the slopes for juveniles, males and females but no differences within sexes from different sampling stations. These results suggest the use of different growth models for the three groups considered in this study.

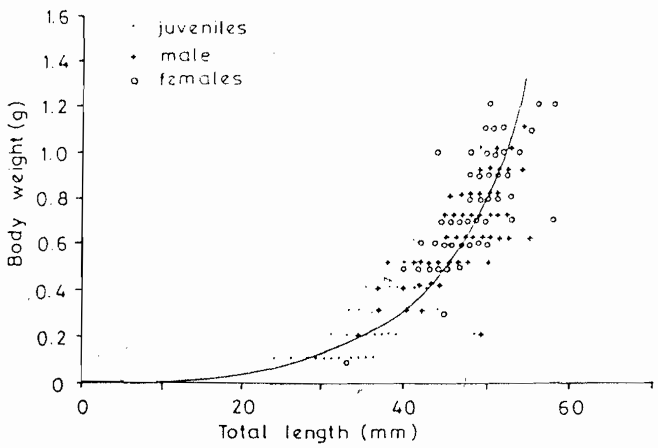

Fig. 3. An example of length-weight relationship of R. argentea in the Winam Gulf from Sango.

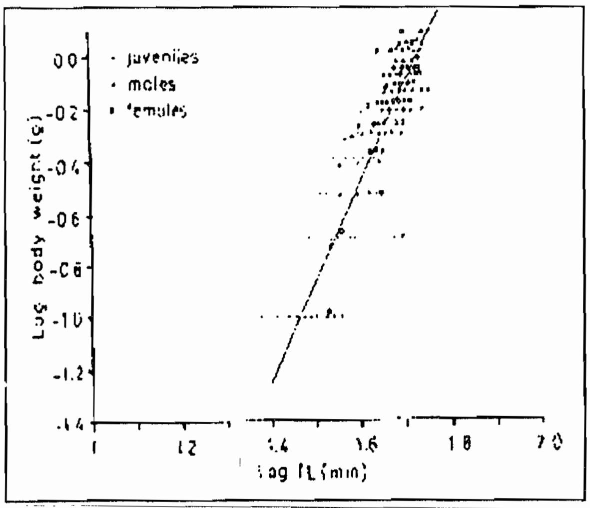

Fig. 4. Correlation between Log L and Log W of *R. argentea* in the Winam Gulf for samples taken from Sango.

Table 3. ANOVA of Fultons condition factor of *R. argentea* in the Winam Gulf of Lake Victoria

Month	*Sango*	*Rakwaro*	*Obaria*	*Ngegu*	*Luanda*
August	1.015	1.011	1.011	1.024	1.015
December	1.073	1.048	1.020	1.024	1.019
January	1.048	1.011	1.019	1.017	1.017
February	1.021	1.013	1.011	1.019	1.016
March	1.036	1.035	1.045	1.025	1.028
April	1.015	1.023	1.024	1.030	1.029
May	1.015	1.023	1.024	1.025	1.027
June	1.000	1.023	1.002	1.025	1.022
July	1.013	1.028	1.013	1.022	1.020
F(4,32)	0.113 ns				stations
F(8,32)	4.323 *				months

Fultons condition factor (K)

There was an initial gain in condition, reaching a peak in December followed by a decline up to February. This decline was followed by a second gain in condition reaching a peak in March/April. Thereafter, there was a general decline in condition up to July. Maximum K value recorded in December was 1.074 while that of March was 1.052. The lowest condition recorded in June was 1.000 and July was 1.006. All stations showed a similar pattern of relative condition factor by months as shown in Fig. 5. Analysis of variance indicated real differences in the Fulton's condition factor (K) in different months but there were no significant differences between stations (Table 4). Weight measurements could not be taken from September to December.

DISCUSSION AND CONCLUSION

The linear equations for the interconversion of different forms of length measurements determined by this study are close to those of WANINK (1989) in the Mwanza Gulf of Lake Victoria and had very high correlation coefficients. The sample size for the Mwanza Gulf was relatively small (45-52) while the large sample size for this study (220-285) confirms these previous results. These values can thus be used to convert one form of length measurement to the other for comparison due to individual preferences in the form of length measurements.

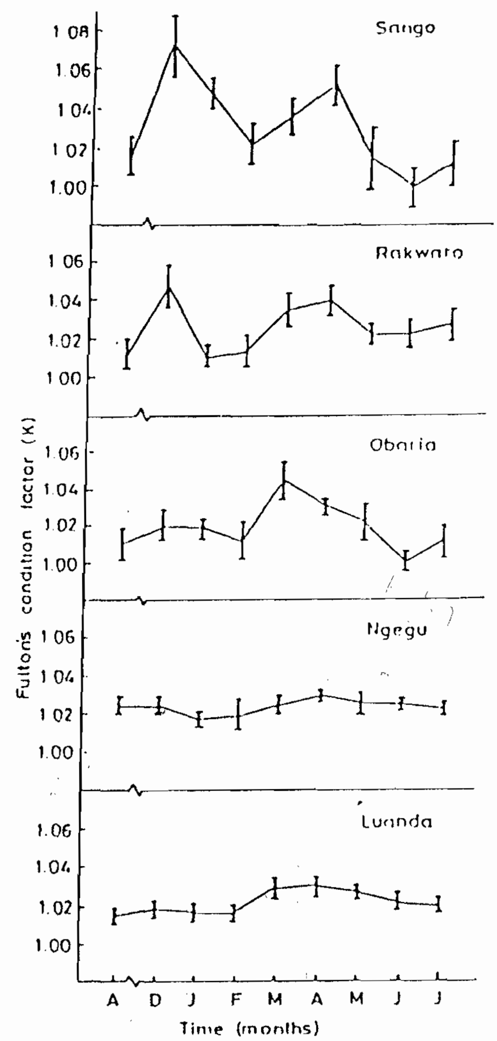

Fig. 5. Fulton's condition factor (K) of R. argentea. vertical bars shows 2SD.

Although no values are available for direct comparison, the length-weight relationships derived by this study can form the basis of future work on this species. Information on length- weight relationship serves two purposes: a) the first is a mathematical description of the relationship between length and weight so that one of the parameters can be connverted into the other. b) the second measures the variation from expected weight- for-length of the individual fish which is used in the calculations of condition factor (DADZIE *et al.*, 1979; DADZIE, 1985). For the length-based fish stock assessment methods, it is important to consider the length-weight relationship in totality before assuming isometric growth. The exponent in the length- weight relationship seemed to be quite high in this study although the growth of *R. argentea* was assumed to be isometric by WANINK (1989). Such a parallel relationship could be attributed to sampling errors in this study. Since weight of the specimens were not recorded from September to November, the observed changes only indicate a general trend in the Fulton's condition factor. The observed changes in Fulton's condition factor could however be attributed to development of the gonadal material during or just prior to the peak breeding seasons. Maximum condition factor incidentally fell within the established rainy seasons for the region and other fish species in Lake Victoria have been established to breed during the same time of the year (OKEDI, 1969; MARTEN, 1979; MULLER *et al.*, 1982; RINNE and WANJALA, 1983; OCHUMBA and MANYALA, 1992).

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