African Journal of Biotechnology Vol. 10(75), pp. 17362-17366, 28 november, 2011
Available online at http://www.academicjournals.org/AJB
DOI: 10.5897/AJB11.1846
ISSN 1684–5315 © 2011 Academic Journals

Full Length Research Paper

Some morphometric relationships of hatchery reared male population of *Oreochromis mossambicus* from Pakistan

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Accepted 14 October, 2011

In this study, length-weight (LWR), length-length relationships (LLR) and condition factor (K) of male *Oreochromis mossambicus* from Nursery Unit Dera Ghazi Khan, Pakistan were examined. The range of the total length (TL) was determined to be 13.20 to 18.10 cm. This study shows that b-value in the LWR ($W = aL^b$) for male *O. mossambicus* had isometric growth with b = 2.93. Morphometric characters, that is, standard length (SL), head length (HL), head width (HW), pectoral fin length (PtFL), pelvic fin length (PvFL), anal fin base (AFB) and caudal fin length (CFL) indicated high significance ($P < 0.001$), while dorsal fin length (DFL) indicated least significance ($P < 0.05$) correlation with increasing size. The condition factor (K) for *O. mossambicus* ranged between 1.68 and 2.20 and remained constant for total length and body weight.

Key words: Length-weight, length-length, condition factor, *Oreochromis mossambicus*.

INTRODUCTION

Tilapias (Pisces: Cichlidae) are among the most widely distributed exotic fishes in the world (Canonico et al., 2005). Oreochromis mossambicus (Peters, 1852), for example, has established feral populations in every nation in which they have been introduced (De Silva et al., 2004). The first accidental introduction of tilapia outside Africa was that of *O.* mossambicus prior to 1939 in Java (Pullin and McConnell, 1982). Many countries have imported these species because they can live successfully in brackish water (Mirza, 1990). In Pakistan, it was first introduced in 1951 from Indonesia and Thailand (Froese and Pauly, 2011). *O.* mossambicus is also listed by the IUCN among those invasive fishes believed to create the most adverse ecological effects (Lowe et al., 2000). *O. mossambicus* has been described by many researchers as a suitable bioassay organism (Seymore, 1994; Barnhoorn, 2001; Salam et al., 2001; Doup´e and Knott, 2010; Naeem et al., 2011a, b) and is used extensively in biological, physiological and behavioural research (Skelton, 1993).

Morphometry is a field concerned with studying variation and change in the form (size and shape) of organisms (Webster, 2006). Scientists are interested in understating the pattern of shape, variation within and among sample like life stage, populations, species, etc. as well as forming and testing hypothesis regarding the origin of those patterns in the growth variations (Shearer, 1994). Morphometrics enables one to describe complex shapes in a rigorous fashion, and permits numerical

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Abbreviations: LWR, Length-weight; **LLR,** length-length relationship; **K,** condition factor; **TL,** total length; **SL,** standard length; **HL,** head length; **HW,** head width; **PtFL,** pectoral fin length; **PvFL,** pelvic fin length; **AFB,** anal fin base; **CFL,** caudal fin length; **DFL,** dorsal fin length.

Table 1. Determination of external morphology in male *O. mossambicus*.

Body measurement	Mean ± S.D	Range
Total length (TL)	15.96±1.25	13.20-18.10
Standard length (SL)	12.49±1.03	10.10-14.20
Head length (HL)	4.20± 0.42	3.30-5.10
Body girth (BG)	12.09± 1.07	9.60-14.40
Dorsal fin length (DFL)	3.73±0.91	2.00-6.20
Dorsal fin base (DFB)	0.68±0.21	0.10-0.90
Pectoral fin length (PtFL)	3.75±0.41	3.10-4.90
Pectoral fin base (PtFB)	0.70±0.20	0.10-0.90
Pelvic fin length (PvFL)	3.85±0.43	3.00-4.90
Pelvic fin base (PvFB)	0.54±0.11	0.30-0.80
Anal fin length (AFL)	2.60±0.48	1.30-3.80
Anal fin base (AFB)	2.74±0.28	2.10-3.20
Caudal fin length (CFL)	3.47±0.47	1.90-4.30
Caudal fin width (CFW)	4.73±0.69	2.90-6.80

S.D. = Standard deviation.

comparison between different forms (Webster, 2006). Organs or tissues, body proportions change during the course of growth which results in significant alternations of body form. Such relationships have been termed as allometric (Huxley, 1932). Like the mass versus length relationship, size of scales or other calcified tissue versus body length plays an important role in determining the age and growth of fishes, therefore, the study of allometric growth has been largely based on the earlier mentioned parameters (LeCren, 1951).

The length-weight relationships (LWRs) and condition factor of a fish species are the two most significant biological parameters that provide information on growth level and fish condition (Okgerman, 2005) and give insight into the health of a fish and its community (Richter, 2007). Length-weight relationships of fish have a number of practical applications in fishery research (Luff and Bailey, 2000; Zakaria et al., 2000). In addition, the condition factor is regularly calculated to assess the overall health, productivity and physiology of a fish population (Blackwell et al., 2000; Richter, 2007). It also reflects physiological characteristics of the fish such as body morphology, lipid content and growth rate (Bister et al., 2000; Froese, 2006; Stevenson and Woods, 2006; Rypel and Richter, 2008). Length-length relationships (LLRs) are also important in fisheries management for comparative growth studies (Moutopoulos and Stergiou, 2002).

The present work was done to analyze different external morphometric variables in relation to body size and condition factor in male *O. mossambicus*. The aim of this study was to provide basic data on external morphology and analyze growth variability of the characters studied.

MATERIALS AND METHODS

41 samples of male *O. mossambicus* were sampled (ranging from 13.2 to 18.1 cm in length and 44.00 to 111.59 g in body weight) from Nursery Unit Dera Ghazi Khan, Pakistan with the help of a drag net. The collected samples were transferred alive to the laboratory for further analyses. The samples were killed with a blow on the head and dried with a paper towel. These were then weighed on an electronic digital balance (Chyo, MP-3000, Japan) to the nearest 0.01 g. Body length measurements were made by using wooden measuring tray and vernier calipers to the nearest 0.01 cm. Total length (TL) was taken from the tip of snout to the tip of tail. The standard length (SL) was taken as the length from terminal mouth to the hidden base of the caudal fin. Similarly, head length (HL) was measured as the distance from the most anterior part of snout to the posterior edge of opercular bones. Length and base values of the fins, that is, pectoral fin (PtF), pelvic fin (PvF), dorsal fin (DF), anal fin (AF) and caudal fin (CF) were also measured. A log-log plot of data was done for all species, outliners were identified and removed (Froese, 2006), and redoing of regressions were made.

The statistical relationship between total length (TL) and total body weight (W) of the fish was derived using the formula:

$$\log W = \log a + b \log TL$$

Where, W is the weight of fish (g); a is the intercept (constant); TL is the total length of fish (cm) and b is the regression coefficient (slope).

Moreover, length-length relationships of different body parts were also calculated by linear regression. Condition factor was calculated with the following formula:

$$\text{Condition factor (K)} = W/L^3 \times 100$$

RESULTS

The results of the measurements of body parts, ranges and indexes of the male *O. mossambicus* were indicated

Table 2. Descriptive statistics and regression parameters of total length (TL, cm), body weight, condition factor and different morphometrics for male *O. mossambicus*.

Equation	Relationship parameters		95% CI of a	95% CI of b	r	r^2
	a	b				
W = a + b TL	-1.625	2.93	-1.9663 to -1.285	2.65 - 3.21	0.958***	0.918
K = a + b TL	0.3742	-0.07	0.0337 to 0.7146	-0.35 - 0.21	0.080^{ns}	0.006
SL = a + b TL	-0.0657	0.97	-0.2142 to 0.0829	0.84 - 1.09	0.930***	0.865
HL = a + b TL	-0.6102	1.03	-0.9050 to -0.3154	0.78 - 1.27	0.804***	0.647
HW = a + b TL	-0.8920	0.88	-1.3567 to -0.4272	0.50 - 1.27	0.595***	0.354
BG = a + b TL	0.1464	0.78	-0.1745 to 0.4674	0.51 - 1.04	0.471**	0.686
DFL = a + b TL	-0.7597	1.10	-1.9058 to 0.3865	0.14 - 2.05	0.349*	0.122
DFB = a + b TL	1.0481	-1.05	-1.6918 to 3.7880	-3.33 -1.23	0.147*	0.022
PtFL = a + b TL	-0.5322	0.92	-0.9155 to -0.1489	0.60 - 1.24	0.682***	0.465
PtFB = a + b TL	1.4046	-1.33	-1.1935 to 4.0028	-3.49 - 0.83	0.196^{ns}	0.038
PvFL = a + b TL	-0.6453	1.02	-1.0174 to -0.2733	0.71 - 1.33	0.731***	0.534
PvFB = a + b TL	-1.0033	0.60	-1.9959 to -0.0108	-0.22 - 1.43	0.230^{ns}	0.053
AFL = a + b TL	-0.1432	0.46	-1.0434 to 0.7571	-0.29 - 1.21	0.195^{ns}	0.038
AFB = a + b TL	-0.5530	0.82	-0.9433 to -0.1627	0.50 - 1.15	0.634***	0.402
CFL = a + b TL	-0.9336	1.22	-1.5108 to -0.3565	0.74 - 1.70	0.636***	0.405
CFW = a + b TL	0.0342	0.53	-0.6557 to 0.7241	-0.04 - 1.10	0.286^{ns}	0.082

Correlation coefficient (r), coefficient of determination (r^2), intercept (a), regression coefficient (b), CI: Confidence intervals, standard error (S.E.), *** $P < 0.001$, $^{n.s}$ $P > 0.05$.

as a mean (±S.D) as shown in Table 1. Samples of male *O. mossambicus* ranged from 13.20 to 18.10 cm with a mean of 15.96 (±1.25) in total length and from 10.10 to 14.20 cm with a mean of 12.49 (±1.03) in standard length.

The result for logarithmic relationship between total length (TL) and body weight (W) is described for male *O. mossambicus* in Table 2. Regressions were highly significant ($r = 0.958$; $P < 0.001$) with coefficients of determination, $r^2 = 0.918$ (Table 2).

Morphometric characters, that is, standard length (SL), head length (HL), head width (HW), pectoral fin length (PtFL), pelvic fin length (PvFL), anal fin base (AFB) and caudal fin length (CFL) indicated high significance, while dorsal fin length (DFL) indicated least significance correlation with increasing size (total length and body weight). Body girth (BG) was found to be highly significant with body weight and significant with total length. Dorsal fin base (DFB) was to be found least significant with total length and non-significant with body weight. Pectoral fin base (PtFB), pelvic fin base (PvFB), anal fin length (AFL) and caudal fin width (CFW) were found to be insignificant with increasing size (Tables 2 and 3).

Condition factor (K) remained constant with total length and body weight (Tables 2 and 3).

DISCUSSION

In the present study, the estimates of parameter b were found to be 2.93 (95% CI of *b* 2.65 to 3.21), within the range for fish which was suggested by Carlander (1969) and presented for 1773 marine and freshwater species by Froese (2006), thus, the result can be considered to be an adequate estimation of the length-weight relationships. According to Ricker (1963), if the specific gravity and form of fish remain unchanged during its life time, the value of the regression coefficient 'b' would be exactly 3.0, in the relation $W = aL^b$ (Begenal and Tesche, 1978; Wootton, 1990). According to their study, growth in many cases tends to be isometric, since b = 3.0 for isometric growth. Regression slope showed isometric growth (close to 3), indicating that the small specimens have the same form and probably same condition as large specimens (Froese, 2006; Percin and Akyol, 2009).

The value of slope (b) of *O. mossambicus* is compared with those reported by other investigators for other fish species. The results of LWR are in general agreement with that of Arslan et al. (2004) in *Salmo trutta* and Naeem et al. (2011b) in female *O. mossambicus.* Furthermore, to compare our estimates, the log a vs b graph (Froese, 2006) in FishBase (Froese and Pauly,

Table 3. Descriptive statistics and regression parameters of body weight (W, g) with condition factor and different morphometrics for male *O. mossambicus*.

Equation	Relationship parameters		95% CI	95% CI	r	r^2
	a	b	of a	of b		
K = a + b W	0.1764	0.06	0.0040 to 0.3489	-0.03 -0.15	0.208 ^{ns}	0.043
SL = a + b W	0.5175	0.30	0.4254 to 0.6096	0.26 -0.35	0.897***	0.805
HL = a + b W	-0.0133	0.34	-0.1656 to 0.1391	0.25 - 0.42	0.804***	0.646
HW = a + b W	-0.3839	0.29	-0.6223 to -0.1456	0.17 - 0.42	0.602***	0.363
BG = a + b W	0.5402	0.29	0.3948 to 0.6856	0.21 - 0.36	0.770***	0.593
DFL = a + b W	-0.0409	0.32	-0.6416 to 0.5599	-0.0001 - 0.63	0.308*	0.095
DFB = a + b W	0.3595	0.17	-0.8564 to 1.5755	-0.47 - 0.81	0.085 ^{ns}	0.007
PtFL = a + b W	0.0055	0.30	-0.1933 to 0.2044	0.19 - 0.40	0.678***	0.460
PtFB = a + b W	0.4605	-0.35	-0.8905 to 1.8116	-1.06 - 0.37	0.155 ^{ns}	0.024
PvFL = a + b W	-0.0530	0.34	-0.2441 to 0.1382	0.24 - 0.44	0.734***	0.538
PvFB = a + b W	0.0633	0.25	-0.5439 to 0.6704	-0.07 - 0.57	0.245 ^{ns}	0.060
AFL = a + b W	0.1089	0.16	-0.3548 to 0.5727	-0.09 - 0.40	0.205 ^{ns}	0.042
AFB = a + b W	-0.0729	0.27	-0.2747 to 0.1290	0.16 - 0.37	0.633***	0.401
CFL = a + b W	-0.1747	0.37	-0.4847 to 0.1352	0.21 - 0.54	0.597***	0.356
CFW = a + b W	0.3718	0.16	0.0129 to 0.7307	-0.03 - 0.35	0.260 ^{ns}	0.068

Correlation coefficient (r), coefficient of determination (r^2), intercept (a), regression coefficient (b), CI: confidence intervals, standard error (S.E.), *** $P < 0.001$, * $P < 0.05$, $^{n.s}$ $P > 0.05$.

2011) was applied and found to be close to those existing for *O. mossambicus*. However, slope value is quite different from the other closely related species of this genus, *O. niloticus*, (b = 2.72) as purported by Naeem et al. (2010a) and from other species reported by Yousaf et al. (2009), Naeem et al. (2010b, 2011a, c, d). The variation may be due to the fact that length-weight relationship in fish is affected by a number of factors including biological and environmental condition, geographical, temporal and sampling factor (Begenal and Tesch, 1978; Froese, 2006).

Isometric growth was observed in SL, HL, DFB and PvFL with increasing total length (b = 1) and in HL, DFL, PtFB and PvFL with body weight (b = 0.33) of the fish. This indicated a proportional growth in these morphometric characters with an increase in total length or body weight. While other studied morphometric characters showed allometric growth with increasing body size of the fish and hence no common trend was found in morphometric characters.

Similar to the present study, Naeem et al. (2010b) have also found condition factor to remain constant with increasing length or weight in farmed hybrid (*Catla catla* ♂ x *Labeo rohita* ♀). Whereas, Naeem et al. (2011d) using hatchery reared *Tor putitora* found the condition factor to decrease with an increase in length and no influence with the increase in weight. When the value of b = 3.0, then the K would remain constant without any change. If, however, the weight increases more rapidly than the cube length, the condition factor would increase with increase in length. And when weight increase is less than the cube of length then, K would tend to decrease with the growth of fish (Carlander et al., 1952).

The results present contribute to the knowledge on the length-weight and other morphometric relationships of male *O. mossambicus* and will be useful to the fisheries biologist, aquaculturists and other researchers. However, further studies are recommended with a larger sample size from the same and different habitats to validate these results.

REFERENCES

Arslan M, Yildirim A, Bektas S (2004). Length-Weight Relationship of Brown Trout, *Salmo trutta* L., Inhabiting Kan Stream, Çoruh Basin, North-Eastern Turkey. Turk. J. Fish. Aquat. Sci. 4: 45-48.

Barnhoorn IEJ (2001). Selected enzymes and heat shock protein 70 as biomarkers of pollution in the reproductive organs of freshwater fish. PhD-thesis, Rand Afrikaans Uni. South Africa.

Begenal TB, Tesch FW (1978). Age and growth. In Begenal T (ed) Methods for assessment of fish production in fresh waters, 3rd Edn. IBP Handbook Blackwell Sci. Pub. Oxford. 3: 101-136.

Bister TJ, Willis DW, Brown ML, Jordan SM, Neumann RM, Quist MC, Guy CS (2000). Proposed standard weight (Ws) equation and standard length categories for 18 warm water nongame and riverine fish species. North Am. J. Fish. Manage. 20: 570–574.

Blackwell BG, Brown ML, Willis DW (2000). Relative weight (Wr) status and current use in fisheries assessment and management. Rev. Fish. Sci. 8: 1–44.

Canonico GC, Arthington A, McCrary JK, Thieme ML (2005). The effects of introduced tilapias on native biodiversity. Aquat. Conserv. 15: 463–483.

Carlander KD (1969). Handbook of freshwater fishery biology. The Iowa State Uni. Press, Ames. IA. 1: p. 752.

Carlander KD, Lewis WM, Ruhr CE, Cleary RE (1952). Abundance, growth and condition of yellow bass. *Morone interrupta.* Gill in Clear Lake, lowa, 1941-1951. Trans. Am. Fish. Soc. 82: 91-103.

De Silva SS, Subasinghe RP, Bartley DM, Lowther A (2004). Tilapias as alien aquatics in Asia and the Pacific: a review. FAO Tech. p. 453.

Doup´e RG, Knott MJ (2010). Rapid digestion of fish prey by the highly invasive 'detritivore' *Oreochromis mossambicus,* J. Fish. Biol. 76: 1019–1024.

Froese R (2006). Cube law, condition factor and weight length relationship: history, meta-analysis and recommendations. J. Appl. Ichthyol., 22: 241–253.

Froese R, Pauly D, Editors (2011). FishBase. World wide web electronic publication. http://www.fishbase.org. 06: 2011.

Huxley JS (1932). Problems of relative growth. Methven., London.

LeCren ED (1951). The length-weight relationship and seasonal cycle in gonad weight and condition in the perch, *Perca fluviatilis*. J. Anim. Ecol. 20: 201-219.

Lowe S, Browne M, Boudjelas S, De Poorter M (2000). 100 of the World's Worst Invasive Alien Species – A Selection from the Global Invasive Species Database. Gland: Invasive Species Specialist Group (ISSG), World Conservation Union (IUCN). Available at http://www.issg.org/database/species/reference files/100English.pdf

Luff RM, Bailey GN (2000). Analysis of size changes and incremental growth structures in African catfish *Synodontis schall* (Schall) from Tell el-Amarna, Middle Egypt. J. Arch. Sci. 27: 821– 835.

Mirza MR (1990). Fresh water fishes of Pakistan (Urdu Eds.), Urdu Science Board, 299 Upper Mall, Lahore.

Moutopoulos DK, Stergiou KI (2002). Length-weight and length-length relationships of fish species from Aegean Sea (Greece). J. Appl. Ichthyol. 18: 200-2003.

Naeem M, Salam A, Gillani Q, Ishtiaq A (2010a). Length-weight relationships of *Notopterus notopterus* and introduced *Oreochromis niloticus* from the Indus River, southern Punjab, Pakistan. J. Appl. Ichthyol. 26: p. 620.

Naeem M, Salam A, Ishtiaq A, Shafique S (2010b). Length- weight and condition factor relationship of farmed hybrid (*Catla catla* ♂ x *Labeo rohita* ♀) from Multan, Pakistan. Sindh Univ. Res. J. (Sci. Ser). 42(2): 35-38.

Naeem M, Salam A, Baby R, Ishtiaq A, Rasool SA (2011a). Study of Body Composition of Female Population of Farmed *Oreochromis mossambicus* in relation to Body Size and Condition Factor from Pakistan. International Conference on Bioscience, Biochemistry and Bioinformatics (ICBBB). 26-28, February, Singapore, pp. 360-363.

Naeem M, Salam A, Ashraf M, Baby R, Ali M, Ishtiaq A (2011b). Length–Weight Relationship of Female Population of Farmed *Oreochromis mossambicus* in Relation to Body Size and Condition Factor from Pakistan, International Conference on Bioinformatics and Biomedical Engineering, Amsterdam, The Netherlands, July 13-15, World Acad. Sci. Eng. Technol. 78: 1149-1153.

Naeem M, Salam A, Ishtiaq A (2011c). Length-weight relationships of wild and farmed *Tor putitora* from Pakistan. J. Appl. Ichthyol. 27(4): 1133-1134.

Naeem M, Salam A, Ashraf M, Khalid M, Ishtiaq A (2011d). External morphometric study of hatchery reared mahseer (*Tor putitora*) in relation to body size and condition factor. Afr. J. Biotechnol. 10(36): 7071-7077.

Okgerman H (2005). Seasonal variation of the length weight and condition factor of rudd (*Scardinius erythrophthalmus* L.) in Spanca Lake. Int. J. Zool. Res. 1: 6–10.

Percin F, Akyol O (2009). Length–weight and length–length relationships of the bluefin tuna, *Thunnus thynnusL*., in the Turkish part of the eastern Mediterranean Sea. J. Appl. Ichthyol. 25: 782-784.

Pullin RSV, Lowe-McConnell RH (1982). The biology and culture of tilapias. Int. Cen. Livest. Aq. Res. Man. Manila. 7: p. 432.

Richter TJ (2007). Development and evaluation of standard weight equations for bridgelip sucker and large scale suckers. North Am. J. Fish. Manage. 27: 936–939.

Ricker WE (1963). Big effects from small causes: two examples from fish population dynamics. J. Fish. Res. Board Can. 20: 257-264.

Rypel AL, Richter TJ (2008). Empirical percentile standard weight equation for the blacktail redhorse. North Am. J. Fish. Manage. 28: 1843–1846.

Salam A, Ali M, Anas M (2001). Body composition of *Oreochromis mossambicus* in relation to body size and condition factor. Pakistan. J. R. Sci. 12(1): 89-96.

Seymore T (1994). Bioaccumulation of metals in Barbus marequensis from the Olifants River, Kruger National Park and lethal levels of manganese to juvenile *Oreochromis mossambicus*. M.Sc. thesis, Rand Afrikaan University, South Africa.

Shearer KD (1994). Factors affecting the proximate composition of cultured fishes with emphasis on salmonids. Aquaculture, 119: 63–88.

Skelton P (1993). Volledige Gids tot die Vars-watervisse van Suider-Afrika. Southern Publishers, Halfway house. p. 387.

Stevenson RD, Woods WA (2006). Condition indices for conservation: new uses for evolving tools. Integr. Comp. Biol. 46: 1169–1190.

Webster M (2006). Introduction to Geometric Morphometrics. Department of the Geophysical Sciences, Univ. Chicago.

Wootton RJ (1990). Ecology of Teleost fishes. Chapman and Hall, London. p. 118.

Yousaf M, Salam A, Naeem M (2009). Length–weight relationships of *Wallago attu* and *Sperata sarwari* from the Indus River, southern Punjab, Pakistan. J. Appl. Ichthyol. 25(5): 614-615.

Zakaria MZ, Jalal KCA, Ambak MA (2000). Length weight relationship and relative condition factor of Sebarau, *Hampala macrolepidota* (Van Hasselt) in Kenyir Lake, Malaysia. Pak. J. Biol. Sci. 3: 721–724.