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RESEARCH ARTICLE.........

Morphometry, length-weight relationship and relative condition factor of marine catfish, *Osteogeneiosus militaris* (Linn., 1758) of Mumbai waters

P.K. PARIDA, B.K. KHUNTIA, **B.K. PATI** AND B. SAHU

ABSTRACT...... The meristic and morphometric characters as well as the length-weight relationship and condition factor of the marine cat fish, *Osteogeneiosus militaris* (Linn.,1758) off Mumbai waters was investigated. Based on the meristic characters, the fin formula can be written as; $D_{I, 7}$, $P_{I, 10-11}$, V_6, A_{18-22}, C_{17-19}. The morphometric characters of indicated high degree of correlation among the compared characters. The length-weight relationship of the species is given as, $W = 0.000006\ L^{3.05}$ for females, $W = 0.000008\ L^{3.01}$ for males and $W = 0.000007\ L^{3.03}$ for pooled sexes which implies that the species found off Mumbai waters has isometric growth. The co-efficient of co-rrelation between length and weight was found to be very high ($r = 0.981$, 0.962 and 0.977) for females, males and sexes pooled, respectively. The condition factor was found to be higher for females than those of the males. This indicates that females are in better condition compared to males. The seasonal variation observed in the condition factor for both the sexes could be related to reproductive cycle and feeding.

KEY WORDS...... Morphometry, Length-weight relationship, Relative condition factor, *Osteogeneiosus militaris*

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INTRODUCTION..

The study of the biology and population characteristics of any species of fish is a prerequisite for developing all possible scientific resource management and conservation strategies (Mojekwu and Anumudu, 2015) as well as for formulating necessary stock enhancement programmes (Shaklee and Bentzen, 1998). All these are necessary to achieve sustainable yield, avoid recruitment failures, rebuild overfished stocks, as well as to conserve threatened and endangered species (Sajina *et al*., 2011). The basic requirement for the development and management of a particular fishery resource is its stock identification which is required for its reliable stock assessment (Cadrin, 2005). An important tool for the study of the biology of fishes in general and stock identification in particular, is morphometry (Hussain *et al.*, 2012). In spite of the advent of modern biochemical and molecular genetic techniques for the identification of fish stocks, these have always been supported by traditional morphometry which is still being used widely due to its high reliability and operational simplicity.

Among all the stock identification methods available, the analysis of morphometric characters is one of the most commonly used methods (Sajina *et al*., 2011). Morphometry (Gk: *morphe* : shape or form; *metria* : measurement) which refers to quantitative analysis of forms, *i.e*., size and shape (Anonymous, 2015a) has been used in fisheries not only to differentiate taxonomic units (Ambily and Bijoy Nandan, 2010) but also to differentiate fish populations (Mir *et al*., 2013). It is defined as a more or less interwoven set of largely statistical procedures for analyzing variability in size and shape of an organism or parts of its body (Mojekwu and Anumudu, 2015). Morphometric differences among the stocks of a fish species are recognised as important for evaluating the population structure and as a basis for identifying stocks (Cadrin and Friedland, 1999). Morphometric characterization may also be able to provide conceptual links between morphology and the genetic, developmental, and evolutionary processes and factors that influence it (Sajina *et al*., 2011). It can also be used to quantify a trait of evolutionary significance and by detecting changes in the shape, deduce something of their ontogeny, function or evolutionary relationships (Anonymous, 2015a).

Another important parameter used for the characterization of fish stocks is length-weight relationship (Hussain *et al*., 2012). Huxley (1924), for the first time, described the relationship between length and weight. The power function, suggested by him, has proved to be a useful model for weight as function of length (Anderson and Gutreuter, 1983). As length measurements are quicker and can be carried out in a range of circumstances than weight measurements, a limited number of weight observations are often used to construct a length-weight relationship (Gerritsen and McGrath, 2007). This relationship can be used to convert length distribution into weight distribution for biomass estimation so as to obtain information for stock assessment of a particular species (Gonzalez *et al*., 2004). It is also used to evaluate the relative condition of fish among populations (Lai and Helser, 2004) and to understand the biological changes in fish stocks (Le Cren, 1951). Its other applications include conversion of length-growth equivalents (*i.e*., length-at-age to weight-at-age) in yield per recruit and related models (Beverton and Holt, 1957); interspecific and inter-populational morphometric comparison of fish species and populations (King, 1996) and prediction of the condition, reproductive history and life history of fish species (Wootton, 1992).

The third parameter used for the characterization of fish stocks is condition factor which is used as an index of fitness or well-being of an individual fish or a stock. Thus, it is a reliable indicator of the energy reserves in fish. The use of condition factor is based on the assumption that heavier fish of a given length are in better condition (Bolger and Connolly, 1989). Poor condition is usually associated with poor feeding, reproductive cycle and/or adverse environment conditions. A fish is said to be in better condition when the value of condition factor is more than 1 and in worse condition than an average individual of the same length, when its value is less than 1 (Le Cren, 1951). There are three types of condition factors, namely, Fulton's condition factor (Fulton, 1904), relative condition factor (Le Cren, 1951) and relative weight (Wege and Anderson, 1978). A number of negative features can be associated with an individual fish or a fish stock showing poor condition factor as a result of poor environmental conditions. Some of these manifestations may be reduction in somatic growth potential of fish (Danzmann *et al*., 1988) as well as reductions in reproductive success because of lower fecundity, poor quality eggs and sperms (Rakitin *et al*., 1999).

The marine cat fish, *Osteogeneiosus militaris* (Linnaeus, 1758) belonging to family Tachysuridae constitutes an important component of catfish resources exploited along both the coasts of India. Marine catfish, in general, is one of the important demersal species of Indian waters. Its catch contributed to about 1.92 per cent of the total marine production and 7.11 per cent of total demersal landings of India during 2014 (Anonymous, 2015b). *O. militaris* contributes around 18 per cent of the total marine catfish landings at Mumbai. Although several studies have been conducted on the morphometry, length-weight relationship and condition factor of freshwater fishes (Alam *et al*., 2013; Uneke, 2013 and Alhassan *et al*., 2015), brackish water fishes (Renjini and Bijoy Nandan, 2011and Lawson *et al*., 2013) and marine fishes (Ambily and Bijoy Nandan, 2010; Dutta *et al*., 2012 and Mahapatra *et al*., 2015), no information is available on these aspects for the marine catfish, *O. militaris*. Therefore, the present investigation was undertaken for a detailed study on the morphometry, length-weight relationship and condition factor of this species caught off Mumbai waters.

RESEARCH METHODS...................................

A total sample of 405 fishes ranging between 154-408 mm of total length (TL) and 30-590 g of total weight (TW) was collected at weekly intervals from New Ferry Wharf and Sassoon Dock landing centres of Mumbai from September 2002 to August 2004. Standard procedure adopted by Dwivedi and Menezes (1974) was followed to study morphometric features. Relationship among the various morphometric parameters was worked out using standard linear regression analysis technique. The meristics characters studied were the number of rays on pectoral, dorsal, ventral, anal and caudal fins. Meristic characters were subjected to standard statistical analysis including range, mean, mode, median, standard deviation, standard error and sample variance.

Sample collection and preparation :

A total number of 405 specimens of the marine catfish, *O. militaris* (Linnaeus,1758), was collected at weekly intervals from New Ferry Wharf, Versova and Sassoon Dock landing centers of Mumbai from September to August except the month of July during which there was ban on fishing. The landings in these places were only those caught off Mumbai waters. The total length (TL) of the samples was between 154 mm and 408 mm and total weight (TW) between 30 g and 590 g. Care was taken to use only fresh specimens for the study.

Meristic and morphometric study :

Standard procedure adopted by Dwivedi and Menezes (1974) was followed to study the meristic and morphometric features. The meristics characters studied were the number of rays on pectoral, dorsal, ventral, anal and caudal fins. The mortphometric features studied included length and weight of the specimens. The total length of the specimens was measured using an ichthyometer (Lloret *et al*., 2014) which has a horizontal graduated platform to keep the fish along its length and a vertical wall at the zero end to which the tip of the snout of the fish was touched during measurement of its length. The total length of the fish was taken from the tip of the snout to the end of the caudal fin and measured to the nearest millimeter. Other length measurements such as standard length, fork length, pre-dorsal length, pre-pectoral length, pre-ventral length, pre-anal length, snout length and eye diameter were taken with the help of a divider and scale. Weight was recorded by an electronic balance and measured to the nearest gram. Before weighing, each fish was properly wiped with blotting paper to ensure removal of as much moisture as possible from its body surface so that it did not interfere with actual weight of the fish.

Length weight relationship :

The length-weight (L-W) relationship was calculated in the exponential form separately for males, females and sexes pooled, following the formula given by Le Cren (1951) as given below :

$$W = aL^b$$

where,

W= Weight of fish in grams,

L= Length of fish in centimeters,

a = Co-efficient related to body form and

b = An exponent indicating isometric/ allometric growth.

The length-weight relationship obtained in the exponential form as above was transformed to linear logarithmic form by taking the logarithm of the values on both the sides of the above equation. The equation was derived as follows :

$$W = a\,L^b$$
$$\Rightarrow \log W = \log (a\,L^b)$$
$$\Rightarrow \log W = \log a + b \log L$$

Condition factor :

The relationship between length and weight for individual trout were used to calculate Fulton's condition factor index (K) was estimated using the following equation given by Le Cren (1951).

$$K = \frac{W}{L^3} x100$$

where,

K = Condition factor

L = Length of fish in centimeters

W = Weight in g .

Statistical analysis :

Relationships between the various body

measurements to the total length and head length were calculated. Statistical parameters like range, mean, median, standard deviations and co-efficient of co-rrelation (r) were estimated for the characters under study. The relationship between the various morphometric measurements was determined by linear regression formula, Y = a + b X. In order to test the significance of difference in 'b' values in male and female, ANACOVA as per Snedecor and Cochran (1967) was used.

RESEARCH FINDINGS AND ANALYSIS...........

A comparison of the meristic characters of *O. militaris* reported earlier and those obtained in the present study is given in Table 1. It can be observed that, the meristic characters obtained in the present study has high resemblance to those reported earlier by Day (1878); FAO (1984); Talwar and Kacker (1984) and Talwar and Jhingran (1991) for the species caught in Indian waters and by Munro (1955) for those obtained in the waters of Cylone. Based on the observations of the present study the fin formula can be written as follows :

$\mathbf{D_{1,\,7}, P_{1,\,10\text{-}11}, V_{6}, A_{18\text{-}22}, C_{17\text{-}19}}$

where,
D = Dorsal fin,
P = Pectoral fin,
V = Ventral fin
A = Anal fin
C= Caudal fin and
Numerical subscripts = Number of fin rays in the respective fins.

Results of the study on the morphometry of *O. militaris* indicated that the co-efficient of co-rrelation (r) of total length against other morphometric characters were significantly high ranging from 0.808 to 0.995 while that of head length against the characters in head were also high varying between 0.801 and 0.974. Similar observations have been made by Shah *et al.* (2011) in farmed rainbow trout in which they observed the values to range from 0.8262 to 0.9979 and from 0.8436 to 0.9648, respectively. The statistical analysis like range, co-rrelation co-efficient and standard error of estimate of various morphometric characters and their relationship to total length and head length were also determined. From linear regression analysis, the relationship between total length and other parameters were found as : total length and fork length : Y= - 8.61 + 0.947 X; total length and standard length: Y = - 4.43 + 0.875 X, total length and pre-dorsal length: Y= - 11.07 + 0.361 X, total length and pre-pectoral length: Y = - 10.86 + 0.248 X, total length and pre-ventral length : Y = -9.181+0.467 X and total length and pre-anal length: Y = -12.16 + 0.636 X. Similarly, the relationship between head length other parameters were found as: head length and snout length: Y = 4.877 + 0.247 X and head length and eye diameter : Y = 4.27+0.073 X. Similar studies have been done by Laidig *et al.* (1997) on lingcod (*Ophiodon elongates*) to establish relationship among total length, fork length and standard length. The linear relationship found between total length and fork length was Y=0.562 + 1.019 X, between total length and standard length was Y= - 0.286 + 1.145 X and between fork length and standard length was Y= - 0.942 + 1.124 X. Hussain *et al.* (2012) have also made similar investigations for the freshwater fish, *Xenentodon cancila* found in Bangladesh and derived linear regression equations of total length with respect to standard length, dorsal length, anal length, pectoral length and pelvic length. Similar results have also been made by in farmed rainbow trout (Shah *et al.*, 2011).

In the present investigation, the length-weight relationship, in the exponential form, worked out as follows:

Female : $W = 0.000006\ L^{3.05}$ (r = 0.981)
Male : $W = 0.000008\ L^{3.01}$ (r = 0.962)
Pooled : $W = 0.000007\ L^{3.03}$ (r = 0.977).

Transformation of the above equations in

Table 1: Comparison of meristic counts of *O. militaris* reported by various investigators

Investigators	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Pelvic fin rays	Caudal fin rays	Place
Day (1878)	1, 7	19-22	1, 10-11	6	17	India
Talwar and Kacker (1984)	7	19-22	10-11	-	-	India
FAO (1984)	1, 7	19-22	-	6	-	India
Munro (1955)	1, 7	19-21	9-10	-	-	Ceylon
Talwar and Jhingran (1991)	1, 7	19-22	1, 10-11	6	-	India
Present study	1, 7	18 -22	1, 10-11	6	17-19	India (Mumbai)

exponential from into linear logarithmic form resulted in the following equations :

Female: log W = -5.22185 + 3.05 log L

Male : log W = -5.09691 + 3.01 log L

Pooled : log W = -5.15490 + 3.03 log L.

The co-efficient of co-rrelation (r) between length and weight were found to be very high (0.981 for females, 0.962 for males and 0.977 for sexes pooled) which implies a very high degree of correlation between the two parameters. Such a result indicates that the species maintains its shape throughout its life (Dutta *et al.*, 2012). Very high correlation co-efficient (r = 0.992) have also been reported between length and weight of this species found in the northern Bay of Bengal (Dutta *et al.*, 2012). Similar high correlation co-efficient (r = 0.990, 0.991 and 0.987) have also been reported by them for three other marine fishes namely ilisha, king mackerel and silver pomfret, respectively, found in the northern Bay of Bengal (Dutta *et al.*, 2012).

The value of the exponent *b* in the length-weight equations was 3.05 for females, 3.01 for males and 3.03 for sexes pooled. None of these values differ very much from 3.00. The length-weight exponent (*b*) value for most animals fall roughly around 3.0 (Siegfried, 1980). Spencer (1864-67) described the growth of an organism through his 'cube law' which states that 'In similarly-shaped bodies, the masses and, therefore, the weights, vary as the cubes of the dimensions, *i.e.*, $W \alpha L^3$'. Accordingly, a fish which doubles its length increases by eight times in weight (Froese, 2006). The experimentally determined value of *b* in several species of fish has been shown to fluctuate around 3.0 (Ambily and Bijoy Nandan, 2010; Renjini and Bijoy Nandan, 2011). According to Pauly (1984) the value of *b* lies between 2.5 and 3.5, usually close to 3.0. When $b = 3$, growth is isometric in that it proceeds in the same dimension as the cube of length. When $b \neq 3$, growth is allometric in that it proceeds in different dimensions (differing from L^3). Allometric growth can be either positive ($b > 3$) or negative ($b < 3$). As the values in the present study are very close to 3.0, it delineates that, the species shows isometric growth. Dutta *et al.* (2012) observed that, out of the four species of marine fishes analysed from northern Bay of Bengal, ilisha showed isometric growth (b = 3.109) while the other three such as king mackerel, silver pomfret and soldier cat fish showed negative allometric growth (b = 2.894, 2.841 and 2.945, respectively). In contrast, the soldier cat fish, *O. militaris*, off Mumbai waters, in the present study showed isometric growth indicating the better growth of the species in off Mumbai waters which reflects better food availability and favourable environmental condition of these waters for this species. This corroborates well with the established fact that the Arabian Sea bordering the west coast of India to which off Mumbai belongs is more productive than the Bay of Bengal bordering east coast of which northern Bay of Bengal is a part (Vivekanandan and Krishnakumar, 2010). Sangun *et al.* (2007) analysed 39 species of marine fishes from north eastern Mediterranean coast of Turkey and found the growth to be isometric in 16, positive allometric in 9 and negative allometric in 14 species.

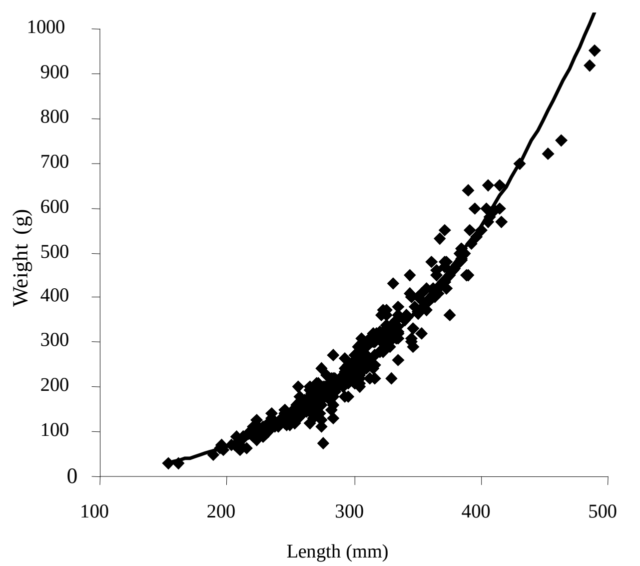

Fig. 1 : Length-weight relationship of *O. militaris* from Mumbai waters

No significance difference was found in the value of the exponent 'b' between the sexes at 5 per cent level of significance. This indicates that, the equation is valid irrespective of sex. This favours the fact that, in order to fit into this equation, it is not necessary to determine the sex of a specimen.

Study of condition factor (K) indicated high value in March (1.049) for male and May (1.080) for females. Minimum value was observed during October (0.95) for female and February (0.94) for male. Pooled month-wise condition factor varied between 0.95 (October) to 1.06 (May) (Fig.2). This behaviour may be result of protracted spawning where spawning season extended from

February to October. According to Le Cren (1951), K > 1 indicates good general condition of the fish whereas K< 1 denotes the reverse condition. High K values were recorded in *Labeo rohita* (1.0129) and *Catla catla* (0.9967) by Pandey and Sharma (1998). In the present study the highest value of K was found in the females (1.080) as compared to males (1.049). This indicates that females are in better condition compared to males. The values of K showed significant fluctuation in both males and females which may be due to difference in the weight of food contents in the stomach. This result corroborates well with those reported by Kader and Rahman (1978); Umesh *et al*. (1996) and Das *et al*. (1997). According to Pauly (1984), many factors such as sex, time of year, stage of maturity, stomach contents and others influence the magnitude of condition factor.

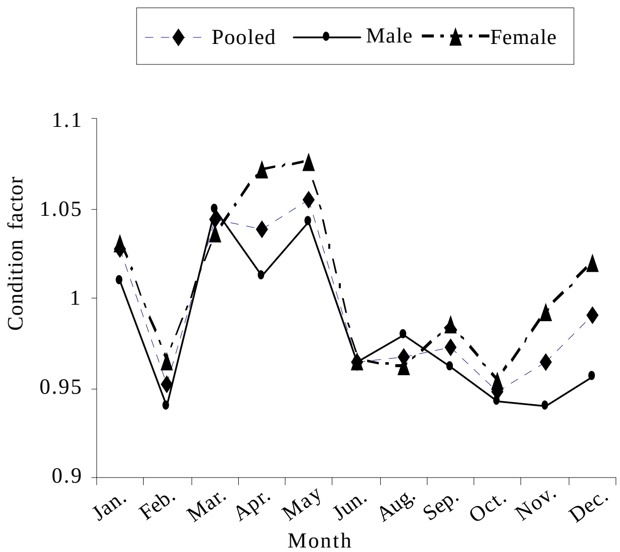

Fig. 2 : Month-wise condition factor in *O. militaris* from Mumbai waters

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