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Biometric studies on *Johnieops sina* (Cuvier, 1830) along Ratnagiri coast of Maharashtra

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ABSTRACT

Length-weight relationship, morphometric and meristic characters of *Johnieops sina* (Cuvier, 1830) from Ratnagiri waters were studied by examination of 874 (454 male and 420 female) specimens collected during December 2009 - November 2011. The male fishes ranged from 100 to 195 mm in length and 8.2 to 80.1g in weight and females ranged from 105 to 232 mm in length and 9.4 to 128.2 g in weight . The length-weight relationship was established as $W= 0.000006092 L^{3.13429563}$ for male, $W=0.000005234 L^{3.169965}$ for female and $W= 0.000005029 L^{3.175118}$ for pooled, indicating positive allometric relationships. The deviations in the growth rate in present study from that of earlier findings may be result of the influence of the difference in environmental conditions in other geographical areas, apart from difference in the stocks. Correlation coefficient (r) was highest for standard length and total length (0.9841) and lowest for eye diameter and head length (0.7527). Based on the findings of the present investigation on meristic characters, the fin formula can be written as B_{7}, D 9-11/1/$_{26-31}$, P $_{16-18}$, V 1/$_{5}$, A 2/$_{7-8}$, and C $_{17-18.}$ Number of gill rakers on the first left gill arch ranged from 13 to 15.

Keywords: *Johnieops sina*, Length-weight relationship, Meristic, Morphometric, Ratnagiri, Sciaenids

Introduction

Morphometric and meristic parameters have been most frequently used to delineate stocks of a variety of exploited fish species (Murta, 2000; Silva, 2003; O'Reilly and Horn, 2004; Turan, 2004). Morphometric characters are continuous characters describing aspects of body shape. Meristic characters are the number of discrete, serially repeated, and countable structures that are fixed during embryonic or during larval stages. Studies of morphological variation between populations continue to have an important role to play in stock identification, while stable differences in shape between groups of fish may reveal different growth, mortality or reproductive rates that are relevant for the definition of stocks (Swain and Foote, 1999; Cadrin, 2000). Morphometric and meristic features have been commonly used to distinguish the species taxonomically, to identify stocks of fish, and to separate different morphotypes (Lourie *et al*., 1999; Doherty and McCarthy, 2004; Jayasankar *et al*., 2004). Similarly, length-weight relationship of fishes are important in fisheries biology because they allow the estimation of the average weight of the fish of a given length group by establishing a mathematical relation between the two (Beyer, 1987). Besides this, the length-weight relationship can also be used in setting yield equations for estimating the number of fish landed and for comparing the population in space and time (Beverton and Holt, 1957). It also provides useful data for stock assessment and population dynamics studies such as growth estimation, length (Kolher *et al*., 1995) and age structures, and allow scientists to compare different populations of the same species in different environments with respect to morphological aspects (Goncalves *et al.,* 1997).

The family Sciaenidae is represented by approximately 70 genera and 270 species (Schwarzhans, 1993; Nelson, 2006) that are distributed in Indian, Pacific and Atlantic Oceans (Longhurst and Pauly, 1987; Sasaki, 1996). There are 48 species of sciaenids belonging to 27 genera in Indian Ocean (Lal Mohan, 1991). These demersal resources are abundant in 50 to 70 m depth along both the coasts of India, supporting fishery almost round the year contributing around 1.66 lakh to the total marine landings of the country (Anon, 2011). Studies on morphometric, meristic and length-weight relationship of sciaenids carried out in India include that of Gandhi (1982) on *Pennahia aneus* from Porto Novo waters, Jayasankar (1989) on *Nibea maculata* from Mandapam waters, Chakraborty (1992) on *Otolithes cuvieri, Johnius macrorhynus* and *Johnius vogleri* from Bombay waters, Bhuyan (2003) on *Johnius carutta*, *Pennahia macrophthalmus* and *Otolithes ruber* from Orissa coast and Manojkumar (2007, 2011) on *Johnieops sina* and *O. cuvieri* along the Malabar coast and off Veraval.

One of the important species, *Johnieops sina,* commonly known as 'sin croaker' is landed as by-catch of commercial shrimp trawl operations along the west coast. It forms about 8.4% (Anon, 2011) of total sciaenid catch in Maharashtra. There is no report on morphometry and length-weight relationship from Ratnagiri (Maharashtra) waters till now. Therefore an attempt was made to investigate the morphometry and length-weight relationship of *J. sina* from Ratnagiri waters.

Materials and methods

During the present study, 874 specimens of *J. sina* ranging from 100 to 232 mm in total length and 8.2 to 128.2 g in weight were collected from Mirkarwada Landing Centre of Maharashtra from December 2009 to November 2011. The morphometric characters (mm), meristic counts and weight (g) were measured in laboratory using standard methods as described by Lagler *et al.* (1962), Laevastu (1965), Lowe-McConnel (1971), Dwivedi and Menezes (1974) and Grant and Spain (1977). The morphometric characters measured were total length (TL), standard length (SL), pre-dorsal length (PDL), caudal peduncle length (CPL), pre-anal length (PAL), pre-pelvic length (PPL), pre-pectoral length (PPEL), head length (HL), body depth (BD), caudal depth (CD), snout length (SNL), inter - orbital length (IOL) and eye diameter (ED).

The meristic characters include number of spines and rays in dorsal, pectoral, anal and caudal fins, gill rakers on first gill arch and branchiostegal rays. Scattergram of morphometric characters were plotted and the linear regression equation was fitted using least square method described by Laevastu (1965) and Snedecor and Cochran (1967). The relationships were represented by the equation:

$$Y = a + b X$$

where, "Y"- a dependent variable, "X"- an independent variable, "a"- a constant (intercept) and "b"- the regression coefficient (slope). The "a" and "b" were determined as follows.

$$a = \overline{y} - \overline{bx} \text{ and } b = [n\Sigma xy - \Sigma x\Sigma y] / [n\Sigma x^2 - (\Sigma x)^2]$$

The correlation coefficient (r) is usually calculated to express the degree of linear association or interdependence of two variables as:

$$r = [n\Sigma xy - \Sigma x\Sigma y] / \sqrt{[n\Sigma x^2 - (\Sigma x)^2] [n\Sigma y^2 - (\Sigma y)^2]}$$

Length-weight relationship

The length-weight relationship was established separately for male and female using the formula given by LeCren (1951):

$$W = a L^b$$

The relationship was expressed in the logarithmic form as:

$$\text{Log } W = \text{Log } a + b \text{ Log } L$$

where, W = weight of fish in g, L = length of fish in mm, "a" and "b" are intercept and regression coefficient, respectively. The coefficient of correlation "r" was determined in order to know the relationship between the two variables.

The analysis of covariance was attempted in order to determine variation in 'b' values among the sexes at 1% and 5% level of significance, following Snedecor and Cochran (1967). To test deviation of "b" value from that of "3", student's t-test was employed.

$$t = (b-3)/S_b$$

where, S_b= Standard error of 'b' = and $S_b = \sqrt{(1/(n-2))*[(Sy/Sx)^2-b^2]}$,

S_x and S_y are the standard deviations of x and y respectively. The t-value was compared with t-table value for (n-2) degrees of freedom at 5% and 1% level of significance.

Results and discussion

Measurements of various morphometric characters of *J. sina*, their range, mean, median, standard error, standard deviation and coefficient of correlation are presented in Table 1. Snout length showed a maximum coefficient of variation (16.83 %) while eye diameter showed minimum variation (12.22 %). Regression of standard length, pre-anal length, pre-pelvic length, head length, pre-pectoral length, caudal length, pre-dorsal length, body depth against total length and eye diameter, post-orbital length, snout length, inter-orbital length against head length and also caudal depth against body depth revealed positive allometric growth pattern. High degree of correlation between compared characters is evident from 'r' values those ranged from 0.7527 to 0.9841. Standard length showed maximum degree of correlation (0.9841) with total length while caudal length showed minimum (0.9003). The coefficient of correlation of head length against compared characters ranged from minimum of 0.7527 for eye diameter to maximum of 0.9629 for post-orbital length, while correlation between caudal depth against body depth was found to be 0.8925 (Fig. 1 and 2).

The results of statistical analysis of various meristic characters is presented in Table 2. Coefficient of variation of anal fin rays was the maximum (5.54) followed by gill rakers (4.95) and pectoral fin rays (3.49). An analysis of meristic characters indicated that *J. sina* possess 9 to 11 spines in its first dorsal fin followed by a deep notch and second fin with 1 spine and 26 to 31 soft rays. Pelvic fin has 1 spine followed by 5 rays and anal fin 2 spines and

Table 1. Statistical estimate of various morphometric characters of *Johnieops sina*

Morphometric characters	Range (mm)		Mean (mm)	Median (mm)	Standard error	Standard deviation	Coefficient of variation (%)
	Min.	Max.					
Total length	100	232	155.28	155	0.65	19.23	12.39
Standard length	75	186	125.65	125	0.56	16.69	13.28
Pre-anal length	32	147	87.1	87	0.44	12.94	14.85
Pre-dorsal length	25.8	65.1	41.03	40.8	0.19	5.76	14.03
Pre-pectoral length	24.3	60.7	38.43	38.3	0.18	5.36	13.94
Pre-pelvic length	21.7	92.5	39.91	39.8	0.2	5.86	14.68
Body depth	25.2	82	38.32	37.8	0.2	5.83	15.21
Head length	20.5	57.8	37.86	37.9	0.18	5.22	13.78
Caudal peduncle length	9.6	29.3	18.38	18.2	0.1	3.00	16.29
Caudal depth	6.6	17.5	11.38	11.37	0.05	1.58	13.88
Post-orbital length	13.2	35.1	22.14	22	0.11	3.13	14.14
Inter-orbital length	6	18.8	11.37	11.3	0.05	1.56	13.69
Snout length	5	14.5	8.66	8.6	0.05	1.46	16.83
Eye diameter	5.1	13	8.58	8.6	0.04	1.05	12.22

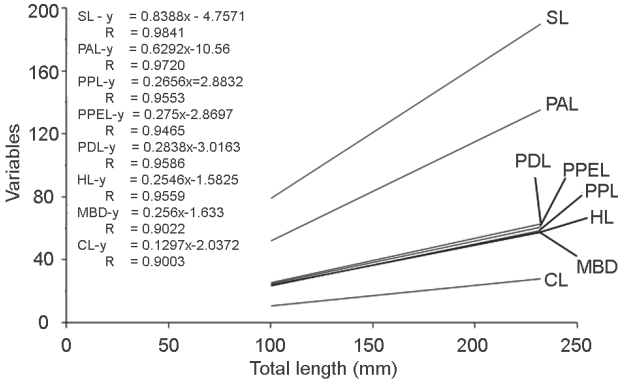

Fig. 1. Relationship of morphometric characters with total length in *J. sina*

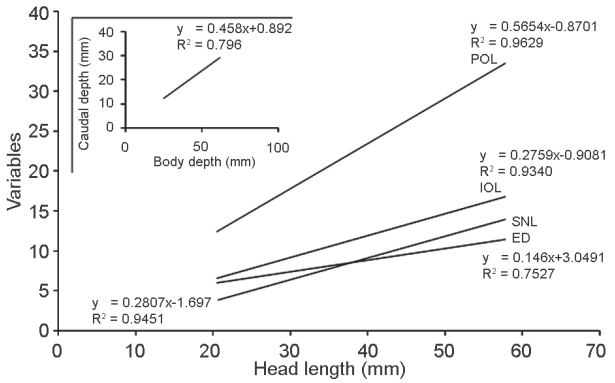

Fig. 2. Relationship of morphometric characters with head length and caudal depth against body depth in *J. sina*

7 to 8 soft rays. Rays on pectoral fin ranged from 16 to 18, caudal fin 17 to 18 but the branchiostegal rays were found to be constant. Number of gill rakers on their first gill arch of left side varied from 13 to 15. A comparison of meristic characters of *J. sina* with findings of earlier workers is presented in Table 3. Though most of the characters can be compared with that of earlier studies, the only difference is the presence of 11 dorsal spines. It ranged from 9-11 in the

Table 2. Statistical estimates of various meristic characters of *Johnieops sina*

Meristic characters	Range (mm)		Mean	Median	Mode	Standard error	Standard deviation	Coefficient of variation (%)
	Min.	Max.						
Dorsal fin spine	9	11	9.96	10	10	0.01	0.27	2.76
Dorsal fin rays	26	31	27.85	28	28	0.04	0.74	2.65
Pectoral fin rays	16	18	17.45	18	18	0.03	0.61	3.49
Pelvic fin rays	5	5	5	5	5	-	-	-
Anal fin spine	2	2	2	2	2	-	-	-
Anal fin rays	7	8	7.76	8	8	0.02	0.43	5.54
Caudal fin rays	17	18	17.54	18	18	0.03	0.50	2.85
Gill rakers	13	15	13.74	14	14	0.04	0.68	4.95
Branchiostegal rays	7	7	7	7	7	-	-	-

Table 3. Comparison of meristic characters of *Johnieops sina* with earlier reports

Authors	Location	Dorsal fin spine	Dorsal fin rays	Pectoral fin rays	Pelvic fin rays	Anal fin rays	Caudal fin rays	Branchi-ostegal rays	Gill rakers
Jayaprakash (1974)	Mumbai waters	10	27	-	-	7	-	-	-
Trewavas (1977)	Indo-West Pacific	9-10	26-29						12-15
Mohan (1981)	India	-	26-31	-	-	-	-	-	10-15
Talwar and Kacker (1984)	India	9-10	27-31	-	-	7	-	-	13-15
Fischer and Bianchi (1984)	Western Indian Ocean	9-10	26-29	-	-	7	-	-	13-15
Munro (2000)	Ceylon	10	27-29			7			9-18
Anon (2002)	Karnataka	-	27-29	-	-	-	-	-	-
Sivakami (2003)	Kakinada	-	-	-	-	-	-	-	14-15
Mishra (2003)	India and Pakistan	-	26-29	17	5	7-8	17	-	-
Telvekar (2006)	Mumbai waters	9-10	26-31	17	5	7-8	17-18	7	-
Day(2007)	India	10	27-29	17	5	7-8	17	7	-
Present study (2012)	Ratnagiri waters	9-11	26-31	16-18	5	7-8	17-18	7	13-15

present study whereas it is reported as 9-10 by others. However, only in one specimen the dorsal spine was counted as 11. Based on the results from the present study, the fin formula for *J. sina* from Ratnagiri waters could be written as: B $_{7}$, D 9-11/1/$_{26-31}$, P $_{16-18}$, V 1/$_{5}$, A 2/$_{7-8}$ and C $_{17-18}$. Number of gill rakers on the first left gill arch ranged from 13 to 15. Analysis of the various morphometric and meristic characteristics of *J. sina* collected from the Ratnagiri Landing Centre did not indicate any variation within the population.

The length-weight relationship was established as: $W = 0.000005234L^{3.169965}$ for female and $W = 0.000006092 L^{3.13429563}$ for male.

The same is represented in logarithmic form: Log W = -5.2811 + 3.17 Log L, ($R^2 = 0.9336$) for female and Log W = - 5.2152 + 3.1343Log L ($R^2 = 0.9413$) for male.

Power relationship of *J. sina* (male, female and pooled) is depicted in Fig. 3 (a, b and c). The analysis of covariance did not show significant difference (at 1 % and 5% levels) between sexes and therefore a common equation was derived as $W = 0.000005029 L^{3.175118}$ and in logarithmic form as Log = - 5.2985 + 3.1751 Log L ($R^2 = 0.9394$).

Student's t-test was performed to test whether the length-weight relationship follows the isometric pattern. The value of 't' was found to be significant at 5% level at 872 degrees of freedom indicating positive allometric growth.

The earlier investigations on length-weight relationship of the species carried out from different locations of India include those of Jayasankar (1994) from Mandapam, Chakraborty *et al.* (2000) from Cochin, Telvekar (2006) from Mumbai and Manojkumar (2011)

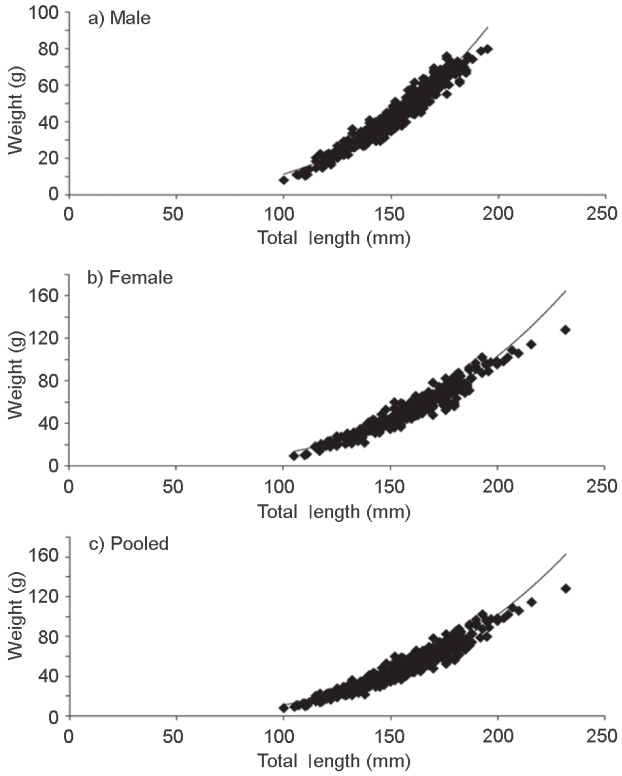

Fig. 3. Power length-weight relationship of *J. sina*

along Malabar coast. Comparison of the findings of present investigation (b =3.17) with that of other locations of India indicates similarity with Mandapam (b=3.26) (Jayasankar, 1994) and Mumbai coast (b= 3.23) (Telvekar, 2006) (Table 4). Normally the regression coefficient value (b) =3 for length-weight relationship indicates that the fish grows symmetrically or isometrically (provided its specific gravity remains constant). Values other than three indicate

Table 4. Comparison of length-weight relationship of *Johnieops sina* with earlier reports

Author	Location	Sex	Sample size	Intercept (a)	Slope (b)	Correlation coefficient (r^2)
Jayasankar (1994)	Mandapam coast	Male	374		3.2285	0.96
		Female	274		3.3064	0.98
		Combined	648		3.2616	0.97
Chakraborty *et al*. (2000)	Cochin waters	Male			2.4187	
		Female	-		2.7575	
Telvekar (2006)	Mumbai waters	Male	204	0.000003413	3.2582	0.9167
		Female	338	0.000005299	3.1769	0.9510
		Combined	542	0.000003893	3.2352	0.9442
Manojkumar (2011)	Malabar coast	Male	1151	0.000045005	2.8215	0.9465
		Female	1100	0.000047472	2.8514	0.9512
		Combined	2251	0.000046658	2.8313	0.9494
Present Study (2012)	Ratnagiri waters	Male	454	0.000006092	3.1342	0.9413
		Female	420	0.000005234	3.1699	0.9335
		Combined	874	0.000005029	3.1751	0.9393

allometric growth. Fish having b value as 3 maintain their specific body shape throughout their life (Day, 2007; Bal and Rao, 1984). Variation in the relative growth (b) of the species reported from different places suggests regional difference in length-weight relationship of the fish. Geographical variation, in this respect, has already been documented by other workers for different fishes (Sparee *et al.,* 1989) and molluscs (Jaiswar and Kulkarni, 2002). Some investigators correlated this fact with ecological variations of the habitats or variation in the physiology of the animal, or both (Bhattacharya and Acharya, 1984; Jaiswar and Kulkarni, 2002). Therefore the variations observed in the length-weight relationship of *J. sina* at different places may be attributed to geographical and ecological differences which lead to difference in water quality parameters and food availability which are directly responsible for growth of the fish (Mommsen, 1998).

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