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Morphometry and length weight relationship of the Catfishes *Arius caelatus* (Valenciennes, 1840) and *Arius thalassinus* (Ruppell, 1837) off Mumbai, Veraval and Vishakhapatanam coasts

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Abstract

The catfishes, *Arius caelatus* and *Arius thalassinus* have been compared morphometrically for seven characters with reference to fork length from Mumbai, Veraval, Vishakhapatnam and Veraval coasts respectively. For *Arius caelatus*, significant differences were found between the sexes at the same locality, within the same sexes at different localities and between both sexes combined from Mumbai and Veraval four out of seven characters were investigated. Similarly, for *Arius thalassinus*, significant differences were noticed between and within the sexes at the same locality and when the sexes were combined, almost all the characters showed highly significant differences between the Veraval and Vishakhapatnam populations, which have been attributed to separation of stocks. The sex specific length weight relationships between the sexes as well as locations were not significant for *A. caelatus*, hence a relation common to both sexes and regions was established. But *A. thalassinus* showed highly significant differences, in respect of sexes as well as locations. Therefore, separate relationships were obtained for sexes and locations for the latter.

Introduction

Exploitation of marine fishes demands studies directed towards understanding the identity and distribution of the exploited stocks in space and time. A stock is a subset of a species showing distinct morphometric characters, inhabiting a particular geographical area in which, its vital stock parameters of growth and mortality are homogeneous (Sparre and Venema 1998). If fisheries on different coasts are supported by a single stock, an extensive exploitation even at one place may lead to depletion of catches elsewhere (Tandon 1964; Kothare and Bal 1976 and Subba Rao 1982).

Among marine catfishes, the engraved catfish (*Arius caelatus*, Ariidae) and the

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giant catfish (*Arius thalassinus*, Ariidae) are the two major species from the west and east coasts of India. Growth, mortality, recruitment and maximum sustainable yield of the engraved catfish has been studied by Chakraborty et al. (1997) from Maharashtra. Available information on its biology is mainly due to the work of Sekharan and Mojumdar (1973) from Vishakhapatanam, Menon (1984) and Menon and Muthiah (1987) from Mandapam and Raje (2006) from Mumbai. The giant catfish occupies a prominent position in the catfish fishery in the east coast, where it constitutes 38.2% of the catfish catch (Sekharan 1968). Some aspects of the biology of the species with respect to food habits and length weight relationship have been worked out by Mojumder (1969, 1971). The distribution and abundance of this catfish along the Andhra-Orissa coast have been studied by Sekharan (1968, 1973). There have been relatively few studies in the seas around India, and in fact, tropical waters, directed toward identification of exploited stocks of catfishes Dutt and Rao (1981). Detailed raciation studies on populations of catfishes, especially for the engraved and giant catfish are scarce. Therefore, the present paper attempts to compare morphometrically, seven characters with reference to fork length from Mumbai, Veraval, Vishakhapatnam and Veraval coasts respectively for the above two species of catfish. Length weight relationship was also established for the two species from the four locations.

Materials and Methods

The material for this investigation was collected during 1985-99 from two regions separately for *A. caelatus and A. thalassinus.* For *A. caelatus*, 134 specimens (77 males, 57 females) were collected from New Ferry Wharf and Versova landing centres of Mumbai from April 1989 to June 1999 and from Veraval from July 1985 to December 1986. For *A. thalassinus*, 361 specimens (251 males, 110 females) were collected from trawl catches of the Fishery and the Oceanographic Research Vessel, Sagar Sampada (Department Of Ocean Development), during cruise no. 58 on 8 February 1989, at 62 meters depth, 19.19º N, 85.15º E, off Vishakhapatnam, on the east coast and from the commercial trawl at Veraval on the west coast between April 1985 and February 1987.

Morphometric studies

Fresh specimens were measured for morphometric characters to the nearest millimeter using a divider and a measuring board. Eight morphometric characters were studied following Apparao (1966) and Dwivedi and Menezes (1974). The significance of the difference between regressions of each morphometric character on fork length was considered at 5% and 1% probability level:

1. Total length (TL): Distance from the tip of the snout to the tip of longest caudal ray of the upper lobe when the upper lobe is laid back parallel to the scale.

2. Standard length (SL): Distance from the tip of the snout to the end of the vertebral column (structural base of caudal rays).
3. Fork length (FL): Distance from the tip of the snout to the end of the middle ray of the caudal fork.
4. Length of head (HL): Distance from the tip of the snout to the outer edge of the operculum.
5. Height (depth) of Body (BD): Depth of the fish taken at the origin of dorsal fin.
6. Snout to origin of first dorsal fin (S-1d): Distance from the tip of the snout to the origin of the first dorsal fin.
7. Snout to origin of adipose dorsal fin (S-Ad): Distance from the tip of the snout to the origin of the adipose fin.
8. Snout to origin of anal fin (S-A): Distance from the tip of the snout to the origin of the anal fin.

The range, mode, standard deviations, mean, coefficient of correlation (r) were calculated and the relationships were analysed using a standard linear regression expression: Y = a +bX, where 'Y' is the dependent variable, 'X' is the independent variable (fork length), 'a' is the constant (Y intercept) and 'b' (slope) is the regression coefficient, were fitted for all the variables for different localities. The goodness of fit of the relationship between the variables was derived from the coefficient of correlation. Regressions of different morphometric characters were compared for sexes and localities by the analysis of covariance (Snedecor and Cochran 1967).

Length-weight relationship

For length-weight relationship, the total length was measured to the nearest millimeter from the tip of the snout to the tip of the longest caudal fin ray of the lower lobe and then weighed to the nearest gram. The allometric relationship between length (L) and weight (W) was calculated by the formula:

$$W = a L^{b}$$

where, W = weight of an individual fish in gram ; L = Length of an individual fish in millimeter ; a and b are constants.

The data of total length and weight were analyzed by the least square method using the equation of Le Cren (1951) given as : Log W = Log a + b Log L

where a and b are constants estimated by linear regression of the log transformed variates. Length weight relationship was determined separately, for both sexes of *A. caelatus* and *A. thalassinus* from their respective locations and pooled.

Results

The size range of size of *A. caelatus* from Mumbai and Veraval and *A. thalassinus* from Vishakhapatnam and Veraval varied between 178-452 mm and 115-590 mm in fork length and 174-554 mm and 132-710 mm in total length, respectively. All the morphometric relations between the variables were linear over the range of the fork length. The coefficients of correlation (r) for various characters ranged from 0.81-0.99 for *A. caelatus* and 0.88-0.99 for *A. thalassinus*, indicating a very high degree of interdependence of the characters. (Tables 1-4).

Table 1: Regression values of various morphometric characteristics (y) as a function of fork length (x) of *A. caelatus* from Mumbai

Morphometric characters	Intercept (a)	Slope (b)	Correlation (r)
FL & TL			
Male	8.2083	1.109513	0.977678
Female	13.07578	1.09469	0.978673
FL & SL			
Male	-10.9151	0.982337	0.988857
Female	-19.4958	1.003353	0.97862
FL & BD			
Male	-19.925	0.272899	0.806165
Female	-17.1561	0.25319	0.882227
FL & 1st dorsal			
Male	-12.3523	0.385367	0.942606
Female	-0.62165	0.339279	0.960095
FL & S-Adip dorsal			
Male	-21.5331	0.767823	0.871074
Female	10.91339	0.66564	0.942651
FL & S-Anal			
Male	-11.2009	0.683861	0.918949
Female	-11.5383	0.68985	0.938036
FL & HL			
Male	-0.26881	0.265502	0.812885
Female	-8.79604	0.289389	0.932211

Table 2 : Regression values of various morphometric characteristics (y) as a function of fork length (x) of *A. caelatus* from Veraval

Morphometric characters	Intercept (a)	Slope (b)	Correlation (r)
FL & TL			
Male	6.562608	1.102372	0.941647
Female	-0.37537	1.139796	0.973332
FL & SL			
Male	6.482913	0.903227	0.868033
Female	17.54399	0.855847	0.92522
FL & BD			
Male	-6.60956	0.221469	0.840381
Female	-3.66639	0.206615	0.846028
FL & 1st dorsal			
Male	-8.47654	0.376606	0.975859
Female	-11.1997	0.376258	0.935183
FL & S-Adip dorsal			
Male	-32.4529	0.81961	0.932951
Female	-23.1351	0.788239	0.969496
FL & S-Anal			
Male	-27.834	0.768391	0.971999
Female	-21.7392	0.743953	0.953767
FL & HL			
Male	-16.4565	0.330557	0.974607
Female	-11.6061	0.295923	0.964467

Table 3: Regression values of various morphometric characteristics (y) as a function of fork length (x) of *A. thalassinus* from Vishakhapatnam.

Morphometric characters	Intercept (a)	Slope (b)	Correlation (r)
FL & TL			
Male	-4.56954	1.250326	0.963397
Female	11.88504	1.197606	0.981805
FL & SL			
Male	1.497717	0.945999	0.949681
Female	6.565891	0.938712	0.950292
FL & BD			
Male	-11.5918	0.239528	0.898813
Female	-17.5788	0.257893	0.888101
FL & 1st dorsal			
Male	-15.9724	0.425619	0.96408
Female	-8.4445	0.395695	0.978681
FL & S-Adip dorsal			
Male	-32.3179	0.876748	0.909596
Female	-8.66401	0.808783	0.981355
FL & S-Anal			
Male	-14.3883	0.328164	0.977816
Female	-13.8145	0.760384	0.97395
FL & HL			
Male	-14.3883	0.328164	0.977816
Female	-8.05964	0.298917	0.964005

Table 4 : Regression values of various morphometric characteristics (y) as a function of fork length (x) of *A. caelatus* from Veraval

Morphometric characters	Intercept (a)	Slope (b)	Correlation (r)
FL & TL			
Male	18.53338	1.162363	0.941709
Female	17.52083	1.16741	0.982941
FL & SL			
Male	0.578873	0.933593	0.963449
Female	-4.78618	0.954272	0.994198
FL & BD			
Male	-6.58057	0.209304	0.775923
Female	-7.50904	0.240525	0.766897

FL & 1st dorsal			
Male	-1.03687	0.383765	0.917905
Female	-0.10264	0.373024	0.961651
FL & S-Adip dorsal			
Male	-11.4181	0.811	0.864395
Female	2.434603	0.786603	0.976357
FL & S-Anal			
Male	-11.5441	0.768917	0.939591
Female	1.961395	0.729802	0.984708
FL & HL			
Male	-6.13429	0.310688	0.90844
Female	2.72218	0.269265	0.95939

Among all the characters compared with fork length for *A. caelatus*, TL and SL showed maximum increase while BD showed least change, as indicated by the steepness and flatness of the lines at both Mumbai and Veraval. (Figs.1-4).

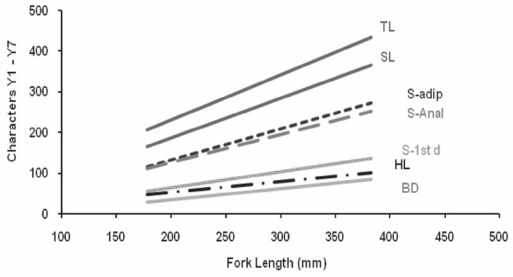

Figure 1. Regressions of different characters on fork length of *A. caelatus* male from Mumbai.

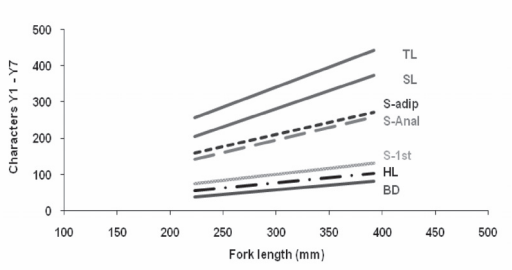

Figure 2. Regressions of different characters on fork length of *A. caelatus* female from Mumbai.

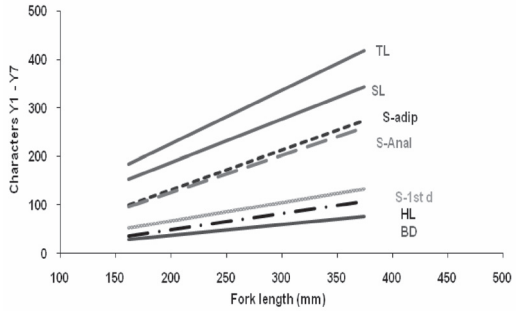

Figure 3. Regressions of different characters on fork length of *A. caelatus* male from Veraval.

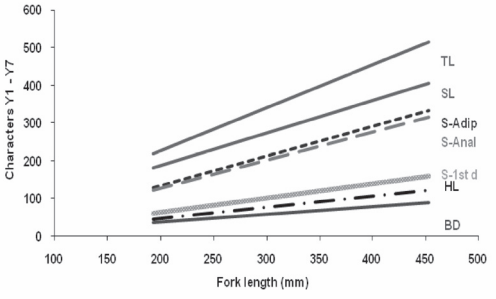

Figure 4. Regressions of different characters on fork length of *A. caelatus* female from Veraval.

Similarly, for *A. thalassinus*, TL and SL showed maximum increase while BD showed least change at both Vishakhapatnam and Veraval (Figs.5-8).

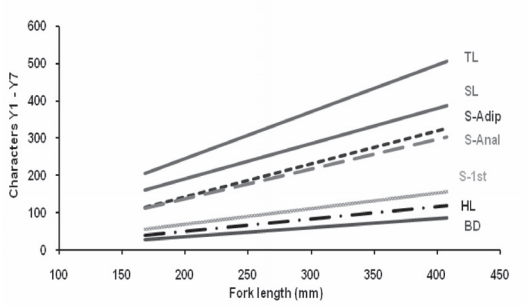

Figure 5. Regressions of different characters on fork length of *A. thalassinus* male from Vishakhapatnam

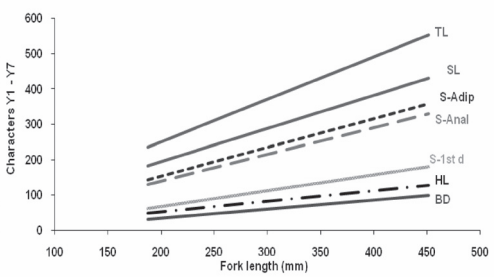

Figure 6. Regressions of different characters on fork length of *A. thalassinus* female from Vishakhapatnam

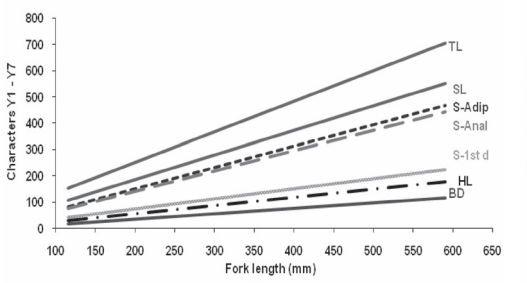

Figure 7. Regressions of different characters on fork length of *A. thalassinus* male from Veraval.

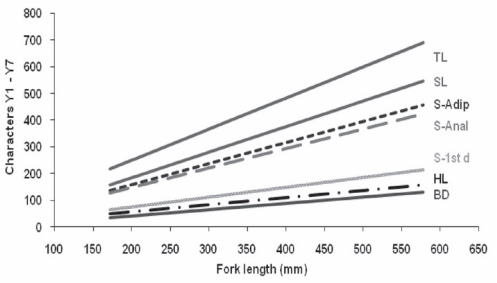

Figure 8. Regressions of different characters on fork length of *A. thalassinus* female from Veraval.

Among all the relationships, BD showed least variation in all locations for both species.

Comparison between sexes

Comparison of regressions of the characters between males and females showed significant differences in four out of seven characters, *viz*, TL, SL, S-1d and S-Ad at Mumbai and S-1d, S-Ad, S-A and HL at Veraval, in *A. caelatus*, out of which highly significant differences existed at 1% level in two characters for male and female samples from Mumbai and three characters for male and female samples from Veraval (Table 5).These differences were more distinct for *A. thalassinus*, where except for BD and S-1d at Vishakhapatnam and for BD at Veraval (which did not show any difference), regressions of all other characters differed highly at 1% level at both locations (Table 6).

Table 5: Summary of results of analysis of covariance in respect of regressions of morphometric measurements of *A. caelatus* from Mumbai and Veraval.

Details of comparisons	FL & TL	FL & SL	Fl & BD	FL & S-1d	FL & S-Ad	FL & S-A	FL & HL
(between sexes)							
Mumbai male & Mumbai	**	*	NS	**	*	NS	NS
female	(9)	(6.9)	(3.1)	(17)	(6.5)	(2.4)	(0.04)
Veraval male & Veraval	NS	NS	NS	**	*	**	*
female	(2.9)	(2.7)	(3.9)	(8.8)	(5.3)	(10.2)	(14.8)
(within sexes)							
Mumbai male & Veraval	NS	NS	NS	NS	NS	**	*
male	(0.5)	(0.1)	(2.5)	(0.13)	(1.4)	(5.2)	(13.3)
Mumbai female &	NS	NS	NS	*	**	NS	NS
Veraval female	(3.5)	(1.1)	(2.4)	(6)	(12.3)	(1.8)	(2.4)
(between localities)							
Malefemale Mumbai &	NS	NS	NS	*	**	**	**
Malefemale Veraval	(3.8)	(0.08)	(1.76)	(6.5)	(8.4)	(9.8)	16.4

Table 6. Summary of results of analysis of covariance in respect of regressions of morphometric measurements of *A. thalassinus* from Vishakhapatnam and Veraval.

Details of comparisons	FL & TL	FL & SL	FL & BD	FL & S-1d	FL & S-Ad	FL & S-A	FL & HL
(between sexes)							
Visag male &	**	**	NS	NS	**	**	**
Visag female	(21.4)	(8.7)	(0.2)	(4.4)	(10.3)	(31)	(54)
Veraval male &	**	**	NS	**	**	**	**
Veraval female	(13.9)	(13.8)	(2)	(13.9)	(10)	(22.2)	(24.3)
(within sexes)							
Visag male &	**	NS	**	**	*	*	**
Veraval male	(12)	(4.9)	(13.1)	(14.8)	(7.9)	(6.2)	(8.5)
Visag female &	**	*	**	**	**	**	**
Veraval female	(17.8)	(7.1)	(10.3)	(12.4)	(17)	(25)	(27)
(between localities)							
Malefemale Visag &	**	*	**	**	**	**	**
Malefemale Veraval	(18)	(8)	(12.2)	(25.3)	(10.5)	(10.4)	(15.1)

Significant at 5% level but not at 1% level.

** Significant at 1% level (Highly significant).

NS Not significant.

Comparison within sexes

In *A. caelatus*, significant difference at 1% level was observed between males from Mumbai and Veraval for the character, HL only. Similarly, females from the two locations showed significant differences at 5% and 1% for two characters, S-1d and S-Ad (Table 5). However, in case of *A. thalassinus* males, all the characters except SL from Vishakhapatnam and Veraval, show significant differences. In females, all the seven characters showed highly significant differences (Table 6).

Comparison between localities

In *A. caelatus*, the character, S-1d differed significantly at 5% and the characters, S-Ad, S-A and HL showed highly significant differences at 1% when compared between localities without segregating sexes (Table 5). Comparison of samples of *A. thalassinus* without segregation of the sexes with respect to localities, showed significant differences in all seven characters out of which all six characters besides SL showed highly significant differences at 1% (Table 6).

Length-weight relationship

The extent of association between length and weight, separately for the males and the females, was assessed from the coefficient of correlation (r).

For *A. caelatus* from Mumbai, the r for males was 0.979559 and for females 0.911744, indicating a fairly close relationship.

Log W= -5.42954 + 3.173407 Log L (male); Log W= -5.84139 + 3.335444 Log L (female)

The equations when subjected to ANOCOVA (Snedecor, 1967) revealed that there was no significant difference between the sexes in Mumbai. So a common equation for length-weight relationship was obtained for both sexes as follows:

Log W= -5.6042 + 3.243076 Log L (r = 95291).

The coefficient of correlation r value for males and females of *A. caelatus* from Veraval were 0.980365 and 0.964624, indicating a close relationship.

Log W= -5.28943 + 3.114438 Log L (male); Log W= -5.26077 + 3.0985 Log L (female)

No significant difference existed between the LW relationships between the sexes. Hence, a LW relationship common to both the sexes of *A. caelatus* from Veraval obtained is as follows:

Log W= -5.25377 + 3.09831 Log L (r = 975685).

No significant difference was found when length-weight relationships for the sexes of *A. caelatus* were combined for the two locations. Hence, a common length-weight

relationship formula with respect to sexes and locations was fitted: Log W= -5.41295 + 3.164498 Log L (r = 96769). (Figure 9)

In case of *A. thalassinus* from Vishakhapatnam, the r for males was 0.955902 and for females 0.98632, which were close to 1, indicating a close relationship However, significant difference existed between the sexes. Therefore, length weight equations were obtained separately for the sexes as:

Log W= -6.76303 + 3.625556 Log L (male) (Figure 10)

Log W= -7.63788 + 3.965118 Log L (female) (Fig. 11)

For *A. thalassinus* from Veraval, the coefficient of correlation (r) for males was 0.952813 and for females 0.747487, indicating a possible variation in the relationship. Highly significant differences between the sexes and locations existed for the species. Therefore, separate LW equations were obtained for the sexes as:

Log W= -5.12893 + 3.029225 Log L (male) (Fig. 12)

Log W= -5.10804 + 3.04644 Log L (female) (Fig. 13)

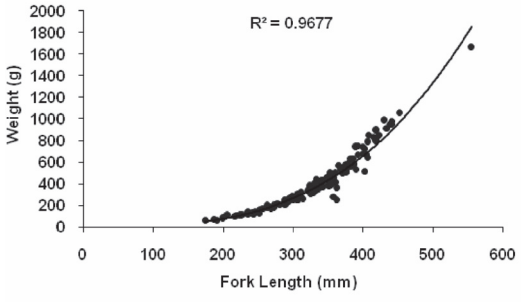

Figure 9. Length weight relationship of *A. caelatus*

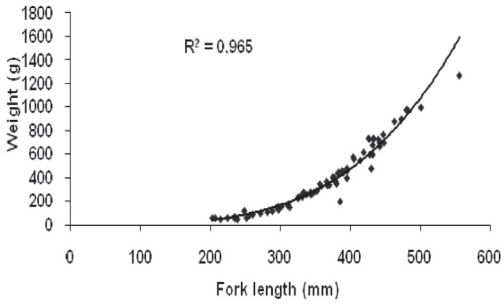

Figure 10. Length weight relationship of *A. thalassinus* male from Visakhapatnam.

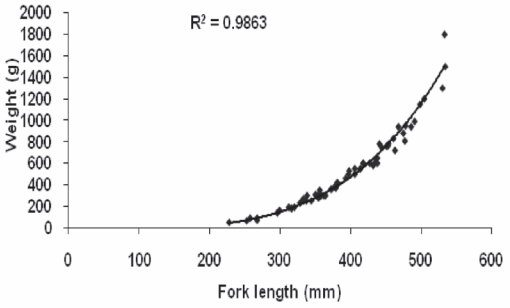

Figure 11. Length weight relationship of *A. thalassinus* female from Vishakhapatnam

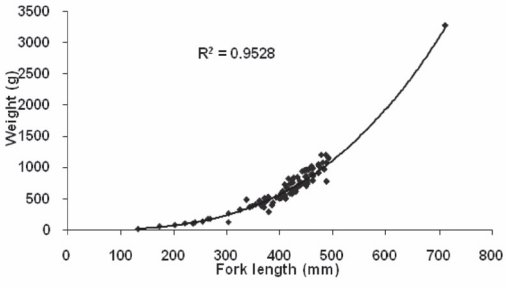

Fig 12: Length weight relationship of *A. thalassinus* male from Veraval

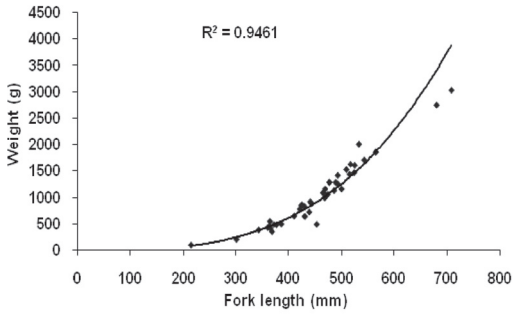

Fig 13: Length weight relationship of A. *thalassinus* female from Veraval

Discussion

The results obtained for morphometric measurements in the present study are comparable with those of earlier workers (Day 1878; Bal and Rao 1984; FAO/SIDP 2000). Among all the relationships, body depth showed variation at all locations in both catfishes, probably due to the variations in the degree of fullness of stomach, as comparable with the inference by Jaiswar and Devaraj (1989) in *Megalaspis cordyla*.

Identification of different stocks of a given species presents some problems. Firstly, fishing is largely confined to coastal and territorial waters and samples are not available from different localities in the area over which a stock may be distributed. Secondly, tagging experiments do not guarantee the recapture of tagged fish for further research. Thirdly, the terms, stocks, races and demes have been indiscriminately used, although as pointed out by Dutt (1962), the terms refer to distinct kinds of biological units (Dutt and Rao 1981).

It has been observed by De Sylva et. al. (1956), Berdegue (1958), Prasad (1958), Royce (1964) that populations resemble each other more if the distribution is closer to one another and differ more if distance becomes greater, as a consequence of geographical isolation resulting from dissimilarity in ecological and environmental conditions. The same has been recorded by Tandon (1964) and Rao (1982) in case of *Selaroides leptolepis* (Cuvier and Valenciennes) and *Saurida tumbil* (Bloch) from Indian waters. The present study on the two Indian catfishes, also shows this trend, as can be seen from the closer resemblance between Mumbai and Veraval samples of the engraved catfish (four out of seven characters do not show any significant difference even at 1% level) than those between Vishakhapatnam and Veraval samples of the giant catfish (all the characters differ from each other significantly out of which six characters show highly significant differences).

In catfishes, differences in length and weight between the sexes may arise out of the fact that during spawning season (which may differ by locations and coastlines), a

large number of starving, gestating males are available. In case of the giant catfish, sexual dimorphism also exists, resulting in significant differences in regressions of morphometric characters and length –weight relationship in the two sexes, at both locations from east and west coasts respectively.

Conclusion

The studies on comparison of morphometric characters and length-weight relationship of the engraved and giant catfishes from two sets of locations help to conclude that populations of the giant catfish, *A. thalassinus* from Vishakhapatnam on the east coast and Veraval on the west coast of India may belong to separate stocks. Morphometic studies need to be supplemented by studies at the genetic level so as to confirm whether the populations belong to different races or demes.

Acknowledgement

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References

Appa Rao, T. 1966. On some aspects of biology of *Lactarius lactarius* (Schn). Indian Journal of Fisheries 13:334-349.

Bal, D.V. and K. V. Rao 1984. Marine Fisheries of India: Tata Mc-Graw Hill Publishing Company Limited, New Delhi, 212pp.

Berdegue, J. A. 1958. Biometric comparison of the anchoveta, Cetengraulis mysticetus (Gunther), from ten localities of the Eastern Tropical Pacific Ocean. Inter-American Tropical Tuna Commission Bulletin 3:1-53.

Chakraborty, S. K., V. D. Deshmukh, M.Z. Khan, Kuber Vidyasagar and S.G. Raje. 1997. Estimates of growth, mortality, recruitment pattern and maximum sustainable yield of important fishery resources of Maharashtra coast. Indian Journal of Marine Science 26: 53-56.

Day, F. 1878. The fishes of India. Vol. 1.2, Reprinted 1958. William Dawson and Sons Ltd. London.pp. 210-215.

De Sylva, D. P. H. B. Stearns and D. C. Tabb. 1956. Populations of the black mullet (*Mugil cephalus* L.). Florida State Board Cons Techical Series 19: 1-45.

Dutt, S. 1962. Populations and races in fishes. Proc. First All-India Congress Zoology (1959), pt. III, 3-7.

Dutt, S and B. V. Seshagiri Rao. 1981. Biometric comparison of samples of the clupeid fish, *Escualosa thoracata* (Val. 1847) from two localities. Matsya 7:50-63.

Dwivedi S. N. and M. R. Menezes. 1974. A note on morphometry and ecology of *Brachiunius orientalis* (Bloch & Schenider) in the estuary of Goa. Geobios 1: 80-83.

FAO /SIDP 2000. Species Identification Sheet : *Arius caelatus. Arius thalassinus*. Fisheries global information system (FIGIS), Food and Agricultural Organization of the United Nations, Rome.

Fisher, R. A. and Frank Yates. 1963. Statistical Tables for Biological, Agricultural and Medical Research. Sixth Edi. Oliver & Boyd, Longman Group Ltd. U. K. 53,55 pp.

Jaiswar, A. K. and M. Devaraj. 1989. Morphometric study of *Megalaspis cordyla* (Linnaeus, 1758) along the northwest coast of India. Journal of the Indian Fisheries Association 19: 1-6.

Kothare, P. V. and D. V. Bal. 1976. Morphometric study of *Sphyraena obtusata* (Cuv. and Val.) off Ratnagiri and Janjira. Journal of Biological Science 19 (2): 66-70.

Le Cren, E. D.1951. The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). Journal of Animal Ecology 20: 201-219.

Menon, N. G. 1984. Observations on the intraovarian ova of a few Tachysurids from Indian waters. Indian Journal of Fisheries 32 (2): 250-256.

Menon, N. G. and C. Muthiah. 1987. Marine Cat fish Resource of India. Biology of the important species of catfish. Bulletin of Central Marine Fisheries Research Institute, Kochi 40. 60-69.

Mojumder, P. 1969. Food of the catfish, *Tachysurus thalassinus* (Rupell). Indian Journal of Fisheries 16 (1&2): 161-169.

Mojumder, P. 1971. Length weight relationship in the catfish *Tachysurus thalassinus* (Rupell). Indian Journal of Fisheries 18 (1&2): 179-182.

Prasad, R. R. 1958. Racial analysis of *Clavelandia ios* (Jordan and Gilbert) in California waters. America Midland Naturae 59: 465-476.

Raje, S. G. 2006. Some aspects of biology of catfishes *Tachysaurus caelatus* (Valenciennes) and *Osteogeneiosus militaris* (Linnaeus) from Mumbai. Indian Journal of Fisheries 53 (3): 333-340.

Rao, K. Venkata Subba. 1982. Studies on the populations of *Saurida tumbil* (Bloch) from Indian waters. Indian Journal of Fisheries 29 (1&2): 8 -19.

Royce, W. F. 1964. A morphometric study of yellowfin tuna *Thunnus albacores* (Bonnaterre). U. S. Fisheries and Wildlife Service Fish Bulletin 63(2): 395-443.

Sekharan, K. V. 1968. The catfish resources of the coasts of Andhra Pradesh, Orissa and West Bengal. Proceedings Symposium on Living Resources of the seas around India Central Marine Fisheries Research Institute. pp. 517-536.

Sekharan, K. V. 1973. The depth distribution of catfishes T. thalassinus (Ruppell) and T. tenuispinis (Day) in the north-western Bay of Bengal. Indian Journal of Fisheries 20 (1): 193-202.

Sekharan, K. V. and P. Mojumdar. 1973. On the size of eggs found in the mouth of two males of catfish, *Tachysurus caelatus* (Val.). Jounal of Marine Boilogical Association of India 15 (1): 431-433.

Snedecor, G. W. and W.G. Cochran. 1967. Statistical Methods, sixth Edition. Oxford and IBH publishing Co, New Delhi. 593 pp.

Sparre, P. and S.C. Venema. Introduction to tropical fish stock assessment. Part 1. Manual. FAO Fisheries Technical Paper. No. 306. 1, Rev. 2. Rome. 27 pp.

Tandon, K. K. 1964. Biology and fishery of 'Choo Parai'–*Selaroides leptolepis* (Cuvier and Valenciennes) Part III. Population Studies. Indian Journal of Fisheries 9 (1): 10-36.

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