

STUDIES ON THE POPULATIONS OF *SAURIDA TUMBIL* (BLOCH) FROM INDIAN WATERS*

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ABSTRACT

A comparison of morphometric and meristic characters of *S. tumbil* respectively by means of analysis of covariance and analysis of variance indicated that there may be three populations of *S. tumbil* in Indian waters, confined to (1) Visakhapatnam-Kakinada, (2) Bombay-Mangalore, and (3) Tuticorin.

INTRODUCTION

In any fishery, a knowledge of the nature and composition of the exploited stocks is of utmost importance for rational exploitation and management. For this purpose, a stock may be defined as a population in which the vital parameters of recruitment, growth and mortality are homogenous. If the exploited species comes from one stock, the fishing intensity at any one place will have its effect at other places also. But, if the fishery is supported by more than one stock, the effect of overfishing on a stock at one place will not affect the fishery for the other stocks.

To know whether *S. tumbil* from Indian waters comprises one or more stocks, the present study has been taken up, by using the analysis of morphometric and meristic characters by statistical methods.

MATERIALS AND METHODS

Material for this study was collected from five localities, two on the west coast - Bombay (Lat. 18°55'N Long. 72°50'E) and Mangalore (Lat. 12°50'N Long. 74°50'E) — and three on the east coast — Visakhapatnam (Lat. 17°40'N long. 83°19' E), Kakinada (Lat. 16°55' N long. 82°20' E), and Tuticorin (Lat. 8°45' N long 78°10' E). A total number of 398 specimens were examined, 128

* Formed part of the author's thesis approved for the award of Ph.D. degree of the Banaras Hindu University.

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from Visakhapatnam, 56 from Kakinada, 69 from Tuticorin, 91 from Mangalore and 54 from Bombay. All the specimens were preserved in 5% formalin for about a month prior to measuring. At Visakhapatnam, samples of *S. tumbil* were collected in the years 1968 and 1970 while at the other places samples were collected in 1968 only.

Samples from different places were compared by the following methods:

- I. Comparison of the regressions of different body characters on the total length of the fish by the method of analysis of covariance.
- II. Comparison of the means of the samples for meristic characters by the method of analysis of variance.

Morphometric studies

The procedure of earlier workers, to compare the samples by comparing the ratios of different body parts in respect of the length of the fish, is of little value in view of the size-specific nature of most of the morphometric characters. It has been shown by Godsil (1948), Schaefer (1948), Schaefer and Walford (1950), and Marr (1955) that ratios of various body parts differ at different stages of the life history in fishes. To overcome this difficulty, the method of comparing the regressions of different body characters by the analysis of covariance was employed. In the present studies the total length of the fish was taken as an independent variable and the other lengths as dependent variables. The regressions of different body lengths on total length were found to be linear over the range of the independent variable (107 to 437 mm).

The method of comparison of regressions and the technique of analysis of covariance have been used by Godsil (1948), Schaefer (1948), Schaefer and Walford (1950), Roedel (1952), Pillay (1957), Sarojini (1957), Berdegue (1958), Prasad (1958), Tandon (1962), Royce (1964), Bapat (1970) and others for fish population studies.

Selection of characters: The following characters (Fig. 1) were selected for comparison, as they could be easily and accurately measured and were also likely to show possible differences.

1. *Total length:* 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. *Length of head:* Distance from the tip of the snout to the outer edge of the operculum.
3. *Length of pectoral fin:* Distance from the base of the pectoral fin to the tip of longest ray.
4. *Snout to origin of dorsal fin:* Distance from the tip of the snout to the origin of the dorsal fin.

5. *Snout to origin of adipose fin*: Distance from the tip of the snout to the origin of adipose fin.
6. *Tip of mandible to ventral fin*: Distance from the tip of the mandible to the origin of ventral fin.
7. *Tip of mandible to anal fin*: Distance from the tip of the mandible to the origin of anal fin.
8. *Height (depth) of body*: Depth of the fish taken at the origin of dorsal fin.

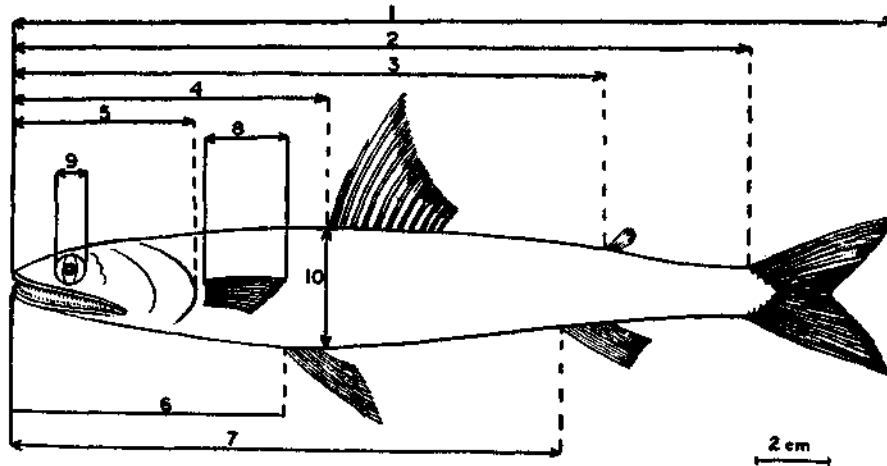


FIG. 1. Diagram of *S. tumbil* showing different morphometric measures (see text).

All the measurements except total length were taken to the nearest mm, with the help of dividers. The significance of the difference of regression of each morphometric character was considered at 5% and 1% level.

Meristic characters

The following meristic counts were studied:

- (1) Number of rays in the dorsal fin.
- (2) Number of rays in the anal fin.
- (3) Number of scales in the lateral line.
- (4) Number of predorsal scales.
- (5) Total number of vertebrae including the urostyle.

In *saurida tumbil* the last dorsal ray which branches very close to the base of the fin, but not completely split, is counted as one. For taking the vertebral count, the fish were kept in hot water (80-90°C) for about 20 minutes, the flesh was removed and the vertebral column was cleaned and dried. The total number of vertebrae including the urostyle were noted. In all, 398 specimens,

128 from Visakhapatnam, 56 from Kakinada, 69 from Tuticorin, 91 from Mangalore and 54 from Bombay, were used in this study. At Visakhapatnam samples were collected in 1968 and 1970 while at the other places samples were collected during 1968.

RESULTS

Morphometric characters

In the present study the range of size of the specimens from different localities varied between 107-437 mm in total length. Linear regression equations, given by the formula $Y = a + bX$ where 'Y' is the variable character, 'X' is the independent character (total length), 'a' is the constant (Y-intercept) and 'b' (slope) is regression coefficient, were fitted for all the variable for different localities.

Comparison between sexes: To find out whether there are differences in the regressions of different variables on total length between the two sexes, a sample of 76 fish (45 males and 31 females) was selected. The fish were separated according to sex and the various measurements recorded for individual fish. The analysis of covariance showed that except for the head length which was significant at 1% level, none of the other regressions were significant. Therefore, in subsequent analyses, samples were treated without reference to sexes.

Comparison between years: For testing the homogeneity or otherwise of the stocks at a centre in different years, samples from Visakhapatnam were collected in 1968 and 1970 and regressions of different variables on total length between these two years were compared. The results show that the samples collected in 1968 and 1970 at Visakhapatnam differed at 1% level in respect of two characters, namely, tip of mandible to ventral fin and height of body. It is interesting to note that the slopes in respect of the regressions of the characters, snout to origin of dorsal fin and snout to origin of adipose fin, were almost identical in 1968 and 1970 with the result that the sum of squares and mean square for the difference between the regressions is zero. As significant differences were observed in respect of only two characters out of seven, it appears that samples of *S. tumbil* collected at Visakhapatnam in 1968 and 1970 are drawn from a homogenous stock.

Variations between different localities: The samples collected at Visakhapatnam in 1968 and 1970 were pooled, assuming that they were homogenous, and compared with those collected at other places in 1968. Significant differences were observed at 1% level in respect of the regressions of all the characters except height of body which did not show significant difference at 5% level also. Next, comparisons of the regressions were made between samples of all possible pairs of localities in respect of the six characters (Table 1). The results of analyses are as follows:

Head length: Significant differences were observed between the samples of all pairs of localities except Visakhapatnam and Mangalore, and Kakinada and Bombay. Comparison of samples between Visakhapatnam and Kakinada, and Tuticorin and Bombay, showed significant difference at 5% level but not at 1% level, while between other pairs of places significant differences at 1% level were observed.

Length of pectoral fin: The comparisons of regressions revealed that the samples were significantly different at 1% level between Visakhapatnam and Tuticorin, Kakinada and Tuticorin, Tuticorin and Mangalore, and Tuticorin and Bombay. There were no significant differences between other pairs of places.

Snout to origin of dorsal fin: Significant differences at 1% level were observed between samples of Visakhapatnam and Bombay, Kakinada and Bombay, Tuticorin and Bombay, and Mangalore and Bombay. Mangalore samples differed from that of Tuticorin at 5% level but not at 1% level. Comparisons between samples of other pairs of localities did not reveal significant differences.

Snout to origin of adipose fin: The comparison of samples revealed significant differences between all pairs of places except Visakhapatnam and Kakinada, Visakhapatnam and Tuticorin, Kakinada and Mangalore, and Mangalore and Bombay. Tuticorin sample differed from that of Kakinada at 5% level but not at 1% level while the differences between other pairs of places were significant at 1% level.

Tip of mandible to ventral fin: Significant differences were observed between the samples of all pairs of localities except Kakinada and Tuticorin, Tuticorin and Mangalore, and Mangalore and Bombay. The differences between the samples of Visakhapatnam and Kakinada, Kakinada and Mangalore, and Tuticorin and Bombay were significant at 5% level but not at 1% level, while the differences between the samples of other pairs of localities were at 1% level.

Tip of mandible to anal fin: The comparison of the samples between Visakhapatnam and Kakinada, Visakhapatnam and Mangalore, Kakinada and Mangalore, Kakinada and Bombay, and Mangalore and Bombay, did not reveal significant differences while between the other pairs of places significant differences at 1% level were observed.

The results of the analysis of covariance may be summarised as follows (Table 1): Comparison of samples from all the localities revealed that of the seven regressions on total length, differences among six of them were highly significant (1% level). This indicates that the catches of *Saurida tumbil* from these places do not belong to a single stock. Further analyses between samples of all possible pairs of localities were done to see if the samples could be grouped conveniently.

TABLE 1. Summary of the results of the analysis of covariance in respect of regressions of morphometric measurements of *Saurida tumbil* between places.

Localities	Length of head	Length of Pectoral fin	Snout to dorsal fin	Snout to adipose fin	Mandible to ventral fin	Mandible to anal fin	Height of body
All localities	**	**	**	**	**	**	NS
Visakhapatnam Vs. Kakinada	*	NS	NS	NS	*	NS	
Visakhapatnam Vs. Tuticorin	**	**	NS	NS	**	**	
Visakhapatnam Vs. Mangalore	NS	NS	NS	**	**	NS	
Visakhapatnam Vs. Bombay	**	NS	**	**	**	**	
Kakinada Vs. Tuticorin	**	**	NS	*	NS	**	
Kakinada Vs. Mangalore	*	NS	NS	NS	*	NS	
Kakinada Vs. Bombay	NS	NS	**	**	**	NS	
Tuticorin Vs. Mangalore	**	**	*	**	NS	**	
Tuticorin Vs. Bombay	*	**	**	**	*	**	
Mangalore Vs. Bombay	**	NS	**	NS	NS	NS	

* Significant at 5% but not at 1% level

** Significant at 1% level

NS Not significant

Comparison of samples between Visakhapatnam and Kakinada, and Kakinada and Mangalore, did not reveal significant difference at 1% level in any of the characters, but at 5% level significant differences were observed in respect of two characters. Between Mangalore and Bombay, and Visakhapatnam and Mangalore samples, significant differences at 1% level were observed in respect of two characters. Comparison between Kakinada and Tuticorin, and Kakinada and Bombay samples revealed significant differences at 1% level in respect of three characters, while at 5% level they revealed significant differences

in four characters. Visakhapatnam sample differed from that of Tuticorin at 1% level in four characters. Tuticorin sample differed from that of Mangalore in four characters at 1% level and five characters at 5% level. Tuticorin sample differed from that of Bombay in respect of four characters at 1% level and all the characters at 5% level. Visakhapatnam sample differed from that of Bombay at 1% level in respect of five characters.

From the above analyses it would appear that:—

- (1) Visakhapatnam and Kakinada samples come from a single stock as they did not show significant difference (at 1% level) in any of the six characters.
- (2) Mangalore and Bombay samples are probably derived from a single stock or closely related stocks since significant differences at 1% level between them were observed in respect of two characters only.
- (3) Mangalore sample resembled more the distant Visakhapatnam and Kakinada samples rather than the nearer Tuticorin sample.
- (4) Bombay and Tuticorin samples differed much from Visakhapatnam and Kakinada samples.
- (5) Bombay and Tuticorin samples differed from each other to the maximum extent.

Meristic characters

In order to test whether the samples were drawn from a homogenous population at Visakhapatnam during different years (1968 and 1970) and from different places during the year 1968, the meristic characters were analysed by the method of analysis of variance. The frequency distribution of the different characters are given in Table 2.

Variations between years: The results of analyses show significant differences at 1% level in respect of two characters, namely, scales in lateral line and predorsal scales, while in respect of one character, viz., anal fin rays, the difference was significant at 5% level but not at 1% level. The other two counts (dorsal fin rays and vertebrae) did not show any significant difference. From this it appears that the samples collected in 1968 and 1970 at Visakhapatnam are not drawn from a homogenous population. So, for comparing with the other localities, the samples collected in 1968 at Visakhapatnam were used.

Variations between different localities: For comparing the meristic characters of the samples collected from different localities during the same year, i.e., samples collected in 1968 from different places, were used and the results of analysis show that the samples from the five localities differed significantly at 1% level in respect of all the five characters.

TABLE 2. *Frequency distribution of different meristic characters of Saurida tumbil from Visakhapatnam during 1968 and 1970, and Kakinada, Tuticorin, Mangalore and Bombay during 1968.*

<i>I. Dorsal fin rays</i>				
	N	Number of fish having dorsal fin ray counts of		
		11	12	13
Visakhapatnam (1968)	68	52	15	1
Visakhapatnam (1970)	60	41	19	—
Kakinada	56	35	21	—
Tuticorin	69	21	47	1
Mangalore	91	10	73	8
Bombay	54	5	47	2

<i>II. Anal fin rays</i>					
	N	Number of fish having anal fin ray counts of			
		10	11	12	13
Visakhapatnam (1968)	68	2	24	41	1
Visakhapatnam (1970)	60	2	35	23	—
Kakinada	56	2	38	16	—
Tuticorin	69	—	30	39	—
Mangalore	91	—	31	57	3
Bombay	54	—	10	43	1

<i>III. Scales in lateral line</i>							
	N	Number of fish having Ll. scale counts of					
		53	54	55	56	57	58
Visakhapatnam (1968)	68	3	20	24	14	6	1
Visakhapatnam (1970)	60	4	21	30	5	—	—
Kakinada	56	7	18	20	6	5	—
Tuticorin	69	3	20	27	14	5	—
Mangalore	91	11	40	28	12	—	—
Bombay	54	5	31	18	—	—	—

<i>IV. Predorsal scales</i>						
	N	Number of fish having predorsal scale counts of				
		18	19	20	21	22
Visakhapatnam (1968)	68	—	17	31	19	1
Visakhapatnam (1970)	60	3	25	29	3	—
Kakinada	56	16	28	9	3	—
Tuticorin	69	31	31	7	—	—
Mangalore	91	33	44	13	1	—
Bombay	54	15	34	5	—	—

V. <i>Vertebrae</i>	N	Number of fish having vertebral counts of				
		50	51	52	53	54
Visakhapatnam (1968)	66	4	15	41	6	—
Visakhapatnam (1970)	60	—	15	38	7	—
Kakinada	56	—	18	26	11	1
Tuticorin	69	10	23	10	25	1
Mangalore	91	13	50	28	—	—
Bombay	54	4	42	8	—	—

N = Number of fish

In order to determine which of the samples contribute to these variations, the analyses of variance between two localities at a time were made and the results are as follows:

Dorsal fin rays: Significant differences at 1% level were observed between all pairs of localities except Visakhapatnam and Kakinada, and Mangalore and Bombay. Comparison of samples between these pairs of localities did not reveal significant difference.

Anal fin rays: Comparison of samples between Visakhapatnam and Tuticorin, Visakhapatnam and Mangalore, Tuticorin and Mangalore, and Mangalore and Bombay did not reveal significant differences while between the other pairs of places significant differences were observed. The variation between Visakhapatnam and Bombay was at 5% level but not at 1% level while between the other pairs of places the differences were significant at 1% level.

Scales in lateral line: Comparison of samples between Visakhapatnam and Kakinada, Visakhapatnam and Tuticorin, Kakinada and Tuticorin, Kakinada and Mangalore, and Mangalore and Bombay did not reveal any significant difference while the other pairs of localities showed significant difference at 1% level.

Predorsal scales: Visakhapatnam sample, when compared with that of Kakinada, Tuticorin, Mangalore and Bombay, showed significant differences at 1% level. Kakinada sample differed from that of Tuticorin at 5% level but not at 1% level. Significant differences were not observed between samples of other pairs of places.

Vertebrae: Significant differences were not observed between samples of Visakhapatnam and Kakinada, Visakhapatnam and Tuticorin, Kakinada and Tuticorin, and Mangalore and Bombay, while between the other pairs of places the variations in the mean values showed significant differences at 1% level.

Table 3 gives a summary of the results of analysis of variance of the meristic counts. It can be seen that Mangalore and Bombay samples did not show any significant difference between them in respect of all the five characters, thereby suggesting that they are likely to be coming from a single stock. Visakhapatnam, Kakinada and Tuticorin samples differed from each other significantly at 1% level in respect of two characters. Bombay as well as Mangalore samples differed significantly from those of Visakhapatnam, Kakinada and Tuticorin at 1% level in respect of three or more characters. This suggests that the east-coast samples are probably derived from stocks independent of the west-coast stock. At 5% level, Tuticorin sample significantly differed from that of Kakinada as well as Mangalore in respect of three characters and, in view of the significant (1% level) differences between Tuticorin and Visakhapatnam samples in two characters, it appears likely that Tuticorin sample may be coming from a separate stock intermediate between the divergent west-coast and east-coast (Visakhapatnam-Kakinada) stocks.

TABLE 3. Summary of the results of the analysis of variance in respect of meristic counts of *Saurida tumbil* between places.

Localities	Dorsal fin rays	Anal fin rays	Scales in lateral line	Pre-dorsal scales	Vertebrae
Visakhapatnam Vs. Kakinada	**	**	**	**	**
Visakhapatnam Vs. Tuticorin	NS	**	NS	**	NS
Visakhapatnam Vs. Mangalore	**	NS	**	**	**
Visakhapatnam Vs. Bombay	**	*	**	**	**
Kakinada Vs. Tuticorin	**	**	NS	*	NS
Kakinada Vs. Mangalore	**	**	NS	NS	**
Kakinada Vs. Bombay	**	**	**	NS	**
Tuticorin Vs. Mangalore	**	NS	**	NS	**
Tuticorin Vs. Bombay	**	**	**	NS	**
Mangalore Vs. Bombay	NS	NS	NS	NS	NS

* Significant at 5% but not 1% level

** Significant at 1% level

NS Not significant

DISCUSSION

In the study it was noticed that the differences in respect of some characters were non-significant among samples obtained from places situated far apart while others were significant. Samples from closely situated places also differed significantly in some characters while in others they did not show any significant difference. In spite of these anomalies, an attempt is made here to arrange the samples into groups taking into consideration the number of characters showing significant difference. Those samples showing significant difference at

1% level are taken to be "highly significant" and indicative of greater separation between them than those showing significant difference at 5% level.

The fact that no significant difference at 1% level was observed between Visakhapatnam and Kakinada samples in respect of any of the six morphometric characters and only one out of the five meristic counts shows that Visakhapatnam and Kakinada samples belong to one stock. Similarly, the fact that Bombay and Mangalore samples did not show any significant difference between them at 1% level in any of the meristic characters and showed significant difference in respect of only two morphometric characters indicates that Bombay and Mangalore samples come from a single stock. The highly significant differences between Bombay and Visakhapatnam samples in 5 out of 6 morphometric characters and in all the meristic characters substantiate the view that Visakhapatnam and Kakinada samples on the east coast and Bombay and Mangalore samples on the west coast belong to different stocks.

Tuticorin sample differed significantly from Bombay sample in all the morphometric characters and 4 out of 5 meristic characters. Tuticorin sample differed significantly from Visakhapatnam and Kakinada samples in 4 morphometric and 2 or 3 meristic characters. This shows that Tuticorin sample is probably derived from a separate stock independent of those on the west coast but closer to the latter.

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, and differ more if the distance becomes greater. The present study also shows this trend as can be seen from the closer resemblance between Visakhapatnam and Kakinada, and Bombay and Mangalore samples than those between Bombay and Visakhapatnam or Visakhapatnam and Mangalore or Visakhapatnam and Tuticorin.

ACKNOWLEDGEMENTS

I am grateful to late Dr. K. V. Sekharan, Head of the Fishery Biology Division, Central Marine Fisheries Research Institute, Cochin, and Dr. J. P. Thapliyal, Professor of Zoology, Banaras Hindu University, for guidance and help. I am grateful to Dr. E. G. Silas, Director, Central Marine Fisheries Research Institute, for going through the manuscript critically and offering valuable suggestions for improving the same.

REFERENCES

- BAPAT, S. V. 1970. The Bombay duck, *Harpodon nehereus* (Ham.) *Bull. Cent. mar. Fish. Res. Inst.*, No. 21: 1-66.
- BERDEGUE, J. A. 1958. Biometric comparison of the anchoveta, *Cetengraulis mysticetus* (Gunther), from ten localities of the Eastern Tropical Pacific Ocean. *Inter-Amer. Trop. Tuna Comm. Bull.*, 3: 1-53.

- CUSHING, D. H. 1968. *Fisheries biology. A study in population dynamics*. The University of Wisconsin Press, London. pp. 200.
- DE SYLVA, D. P., H. B. STEARNS AND D. C. TABB. 1956. Population of the black mullet (*Mugil cephalus* L.) in Florida. *Florida Game Bd. Cons. Tech. Ser.*, 19: 1-45.
- GODDIL, H. C. 1948. A preliminary population study of the yellowfin tuna and the albacore. *Calif. Fish and Game, Fish. Bull.*, 70: 1-90.
- MARR, J. C. 1955. The use of morphometric data in Systematic, racial and relative growth studies in fishes. *Copeia* (1), 23-31.
- PILLAY, T. V. R. 1957. A morphometric study of the populations of hilsa, *Hilsa ilisha* (Ham.) of the river Hooghly and of the Chilka lake. *Indian J. Fish.*, 4: 344-386.
- PRASAD, R. R. 1958. Racial analysis of *Clavellandia ios* (Jordan and Gilbert) in California Waters. *Amer. Midl. Nat.*, 59: 465-476.
- ROEDEL, PHIL. M. 1952. A racial study of the Pacific mackerel, *Pneumatophorus diego*. *Calif. Fish and Game, Fish Bull.*, 84: 53 pp.
- ROYCE, W. F. 1964. A morphometric study of yellowfin tuna *Thunnus albacares* (Bonnatere). *U.S. Fish, Wildl. Ser. Fish Bull.*, 63(2): 395-443.
- SAROJINI, K. K. 1957. Biology and fisheries of the grey mullets of Bengal. I. Biology of *Mugil Parsia* Ham. with notes on its fishery in Bengal. *Indian J. Fish.*, 4(1): 160-207.
- SCHAEFER, M. B. 1948. Morphometric characteristics and relative growth of yellowfin tunas (*Neothunnus macropterus*) from Central America. *Pacific Sci.*, II (2): 114-120.
- SCHAEFER, M. B. AND L. A. WALFORD. 1950. Biometric comparison between yellowfin tunas (*Neothunnus*) of Angola and of the Pacific coast of Central America U.S. *Fish. Wildl. Ser. Fish. Bull.*, 51(56): 425-443.
- TANDON, K. K. 1962. Biology and fishery of 'Choo Parai' *Selaroides leptolepis* (Cuv. and Val.) Pt. III Population studies. *Indian J. Fish.*, 9A(1): 10-36.