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COMPARATIVE STUDIES ON *SETIPINNA GODAVARIENSIS* RAO (PISCES : ENGRAULIDAE) FROM GODAVARI AND HOOGHLY ESTUARIES

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INTRODUCTION

Setipinna godavariensis Rao has been first reported from Godavari estuary (East Coast of India) as *S. godavari* (Babu Rao, 1962, syntypes deposited in the National Collections of Zoological Survey of India, Reg. No. F 2607/2). However, according to the International Code of Zoological Nomenclature adopted by the XV International Congress of Zoology (1961), a species' name based on a geographical name should be an adjective derived from the geographical name and ending in a suitable suffix, such as—*ensis* or—*iensis* (Rec. 22, p. 109). Consequently the specific name has been changed from *godavari* to *godavariensis*.

Subsequently it was observed by the authors that among the species of *Setipinna* occurring in Hooghly estuary, *S. godavariensis* also contributes for a good *Setipinna* fishery of Hooghly estuary. Samples of this species which were brought from the Diamond Harbour fish landing centres, were obtained from Calcutta markets during November 1966 to January 1967, during which period it formed a major constituent of *Setipinna* fishery along with *S. taty*. Further it was found that from December onwards *S. phasa* appears in the catches and gradually dominates the *Setipinna* fishery from January onwards (cf. Jones & Menon 1951).

Certain observations on biology were made on this species both from Godavari and Hooghly estuaries (Fig. 1). In the following account, while comparing the populations of the two estuaries in meristic characters and body measurements, the biological data have also been presented in a comparative manner. A note on the systematics of the species of this genus is also added, bringing out a distinct gradation in the three species in certain of the morphological and meristic characters.

SYSTEMATIC NOTES

Till now four species of the genus *Setipinna, viz., S. breviceps* (Cantor), *S. taty* (Valenciennes), *S. phasa* (Hamilton Buchanan) and *S. godavariensis* Rao have been described from India. From Godavari estuary two species, *viz. S. taty* and *S. godavariensis* have been recorded along with their descriptions (Babu Rao

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op. cit.). Apart from the above two, one more species, *S. phasa* has been obtained by the authors from the Hooghly estuary (Plate I). The life history, bionomics and fishery of this species from Hooghly estuary has already been studied (Nair 1940, Mookherjee and Mookherjee 1950, Jones and Menon 1950, 1951). Though mor-

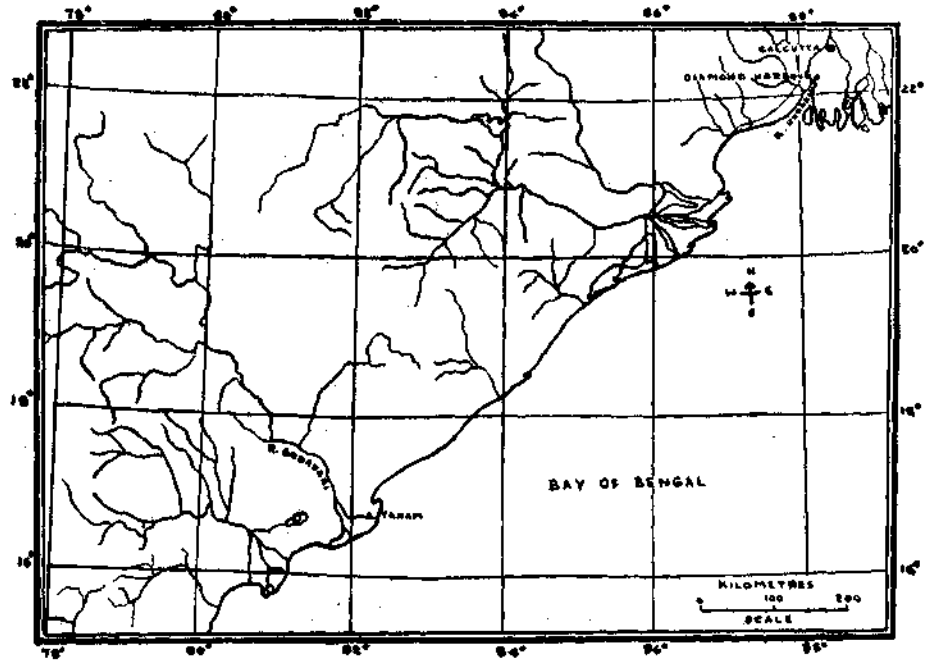

FIG. 1. North East Coast of India showing Godavari and Hooghly Estuaries.

phological descriptions were given by the earlier authors (Day 1878, Fowler 1941 etc.) a brief account of *S. phasa* based on the specimens collected by us has also been given here with special reference to meristic characters and body measurements.

Description of S. phasa :

Based on three specimens of standard lengths 146 mm., 153 mm., and 157 mm. Body elongate and laterally compressed. Dorsal profile convex, sharply ascending from snout to dorsal fin from whence gradually descending to caudal base. Ventral profile relatively much less convex. Lateral line is slightly curved towards the dorsal profile. Mouth terminal, cleft extends far behind eye. Maxilla extends nearly upto the opercular edge. Nostrils situated on the antero-dorsal margin of the eyes.

Eyes are laterally situated in the anterior quarter of head. Scales deciduous. Elongated axillary scale at pectoral base. Teeth villiform and in a single row in each jaw. Pectorals situated near the gill opening ; the uppermost ray is much elongated than the rest and reaches the posterior half of the anal fin. A free spine is present before the dorsal fin. Anal origin is distinctly before dorsal origin. Colour greenish black on back ; sides silvery. Dorsal and caudal fins are yellow with a black margin. Pectorals and anal are more or less colourless.

In percentages of standard length : body depth 24.5-24.8, head length 19.1-19.8, eye 3.4-3.9, upto pectoral base 19.1-19.6, base of dorsal 10.2-11.7, upto dorsal 40.7-42.8, base of anal 54.4-55.5, upto anal 39.8-40.0, length of pectoral (longest ray) 54.4-57.5.

P. 13-14, V. 7, D. I+15-16, A. 75-77, Scutes (13-15)+7, G.R. (14-15)+(18-19).

S. taty, *S. phasa* and *S. godavariensis* :

There are distinct gradations noticeable among the three species in certain morphological as well as some meristic characters. Thus the uppermost pectoral fin ray is very robust and extends upto the posterior one-fourth of the anal fin in *S. taty* ; it is moderately robust and extends upto the second half of the anal fin in *S. phasa* and it is relatively slender and extends only upto the anterior one-fourth of the anal fin in *S. godavariensis* (Plate I). Dorsal profile is highly convex in *S. godavariensis*, less convex in *S. phasa* and more or less straight in *S. taty*. Similarly, anal origin is distinctly before dorsal origin in *S. phasa* ; and dorsal origins more or less fall in a straight line in *S. godavariensis* ; anal and anal origin is distinctly behind dorsal origin in *S. taty*.

With regard to anal fin rays, *S. phasa* has the highest number (75-77), *S. taty* has the lowest (50-52) and *S. godavariensis* falls in between the two (max. no. of specimens at 52-55). Similarly *S. taty* has the highest number of preventral scutes (20-24), next comes *S. godavariensis* (max. no. of specimens at 18-21) and finally *S. phasa* has the lowest number (13-15).

Comparison of Samples of *S. GODAVARIENSIS* from Godavari and Hooghly Estuaries

S. godavariensis is a euryhaline species and is found to occur from the mouth of the river Godavari upto about 20 kilometres up the river. It has been recorded to occur at a minimum salinity of 8.68°/$_{oo}$ and a maximum salinity of 33°/$_{oo}$ in Godavari estuary (Babu Rao, 1962). Similarly in Hooghly estuary it extends at least upto Diamond Harbour, where the salinity during November-January period is less than 10°/$_{oo}$ (Bose, 1956). In Godavari estuary there is no regular pattern with regard to the occurrence of this species. Its intermittent occurrence is dependent on the migration of prawns like *Leander*, *Acetes*, etc. which form major food of this species. Samples were obtained from Balusutippa and Neellapalli (Babu Rao, 1965, Fig. 1, p. 90). In Hooghly estuary samples which were brought from Diamond Harbour (Bose, *op. cit.* Fig. 1, p. 102) were purchased at Calcutta markets during November 1966 to January 1967.

Length-weight data were obtained in the fresh condition and morphometric and meristic data were obtained in preserved condition.

The data of the samples from the two estuaries which have been studied in a comparative manner are : meristic characters, body measurements, length-weight relationship and fecundity.

Meristic characters :

The following meristic characters were taken for comparison of the samples from the two estuaries :

(i) Pectoral fin rays,

(ii) Dorsal fin rays,

(iii) Anal fin rays,

(iv) Preventral scutes,

(v) Postventral scutes, and

(vi) Gillrakers on lower arm.

The above meristic characters were taken for over 75 specimens from Hooghly estuary and were compared with those of Godavari estuary (Table I), the latter data being taken from Babu Rao (1962). Uniformly in all cases, fin rays counts were taken for the pectoral fin, on the left side, and the gill rakers count of the first gill arch on the left side. Care was taken to include in the count the small anterior rays of dorsal and anal fins.

Chi-square test (Bailey, 1959) has been applied to the two frequencies in each meristic character. The results have shown that in the case of dorsal fin rays, pre-

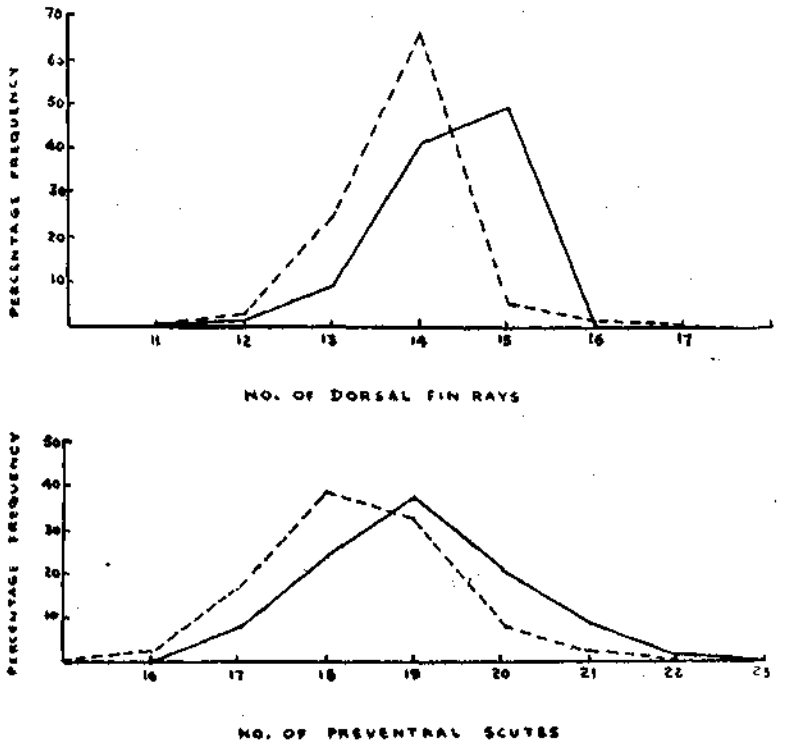

FIG. 2. Percentage frequency polygons of No. of dorsal fin rays (upper graph) and No. of preventral scutes (lower graph) of *S. Godavariensis* from Godavari (straight line) and Hooghly (broken line) estuaries.

ventral scutes, postventral scutes and gillrakers on the lower arm, the two populations differ significantly (Table II). Godavari estuary forms are having a significantly higher number of dorsal fin rays, preventral scutes and gillrakers on lower arm than Hooghly estuary forms, while the number of postventral scutes are significantly higher in Hooghly forms than in Godavari forms (Figs. 2 and 3).

TABLE I

Frequency distribution of the meristic characters of Setipinna godavariensis *from Godavari and Hooghly estuaries. Data for Godavari specimens from Babu Rao (1962, Table-I)*

(A) *Pectoral fin rays*

Locality	..	11	12	13	14	n
Godavari	..	8	75	17		100
Hooghly	..	3	67	17	1	88

(B) *Dorsal fin rays*

Locality	..	12	13	14	15	16	n
Godavari	..	1	9	41	49		100
Hooghly	..	2	20	53	4	1	80

(C) *Anal fin rays*

Locality	..	49	50	51	52	53	54	55	56	57	58	n
Godavari	..	1	3	7	12	18	25	19	7	6	2	100
Hooghly	..	1	1	7	9	12	18	23	5	2		78

(D) *Preventral scutes*

Locality	..	16	17	18	19	20	21	22	n
Godavari	..		8	24	37	21	9	1	100
Hooghly	..	2	14	32	27	7	2		84

(E) *Postventral scutes*

Locality	..	6	7	8	9	10	n
Godavari	..	5	84	10	1		100
Hooghly	..	2	54	17	2	1	76

(F) *Gillrakers (Lower arm)*

Locality	..	13	14	15	16	n
Godavari	..	4	62	33	1	100
Hooghly	..	4	73	0		87

Body measurements :

The following body measurements were taken from the preserved specimens of the two localities :

(i) Standard length,
(ii) Body depth,
(iii) Head length, and
(iv) Diameter of eye.

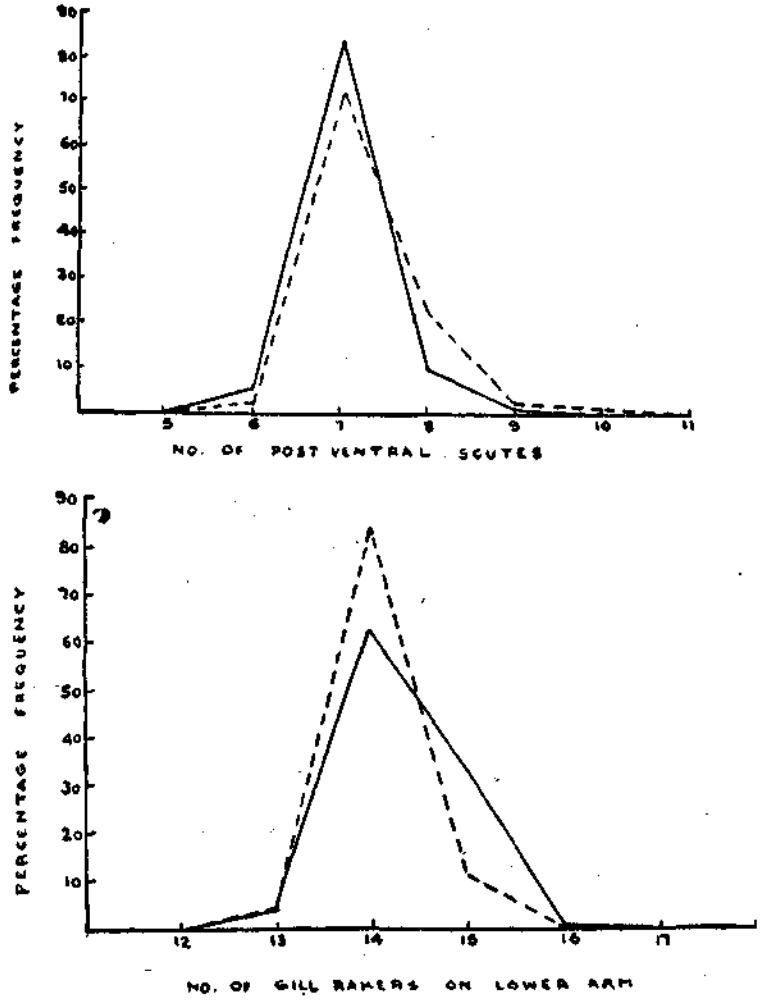

FIG. 3. Percentage frequency polygons of No. of postventral scutes (upper graph) and No. of gillrakers on lower arm (lower graph) of *S. Godavariensis* from Godavari (straight line) and Hooghly (broken line) estuaries.

The number of specimens taken, the length range of the specimens, and the means for the two localities are presented in Table III. Multiple regression analysis, following Rao (1952), has been applied to this data to test the significance of the

difference between the populations of the two estuaries. The various statistics required for the test were calculated and tabulated (Tables IV A-F), and the analysis of variance table is set up (Table IV G). The ' F ' value is significant even at 0.1% level, indicating a highly significant distance between the populations of the two estuaries, with regard to these body measurements. To ascertain in which particular characters the two populations differ, individual regression coefficients of the three body measurements, on standard length, along with their respective standard errors were calculated (Goulden, 1939) and the difference in the regression coefficients of the populations of the two estuaries is tested for significance (by means of the ' t ' test) in each character (Table V). The results have shown that in two of the body measurements, *viz.*, body depth and eye diameter, the two populations differ significantly. The rate of growth of body depth in relation to standard length is significantly higher in Godavari forms than the Hooghly forms while the rate of growth of eye diameter is significantly higher in Hooghly forms than in Godavari forms (Fig. 4).

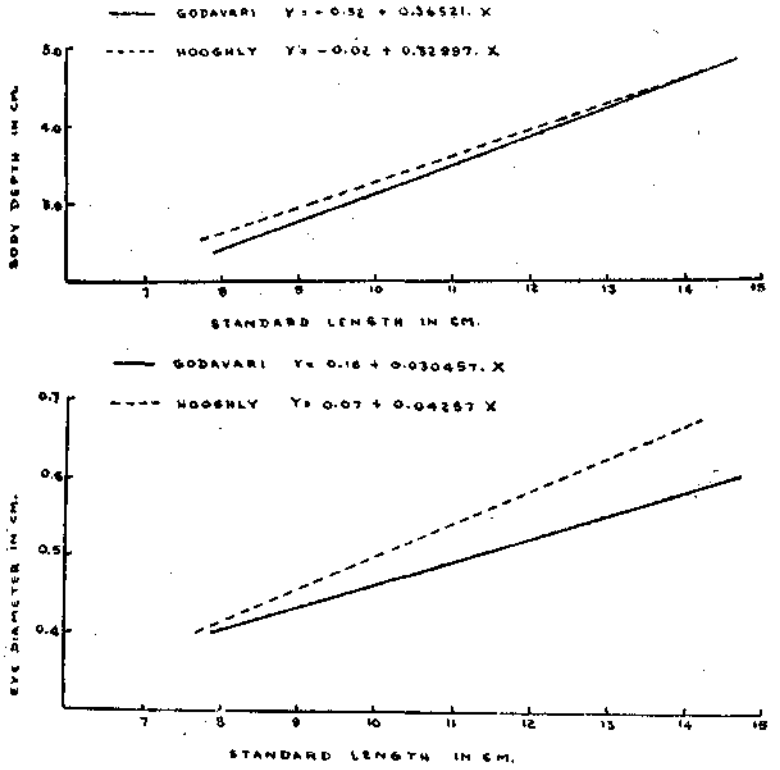

FIG. 4. Regression lines of body depth (upper graph) and eye diameter (lower graph) on standard length of *S. Godavariensis* from Godavari (straight line) and Hooghly (broken line) estuaries.

Length-weight relationship :

The total length and total weight data were obtained from 226 specimens, ranging in length from 6.0 cm. to 18.8 cm., from Godavari estuary and from 90 specimens

TABLE II

Chi-square test applied to the meristic data of Setipinna godavariensis *specimens from Godavari and Hooghly estuaries*

S. No.	Character	Obs. X^2	d.f.	P	Significance	Remarks
1.	Pectoral fin rays. ..	0.176	1	> 0.05	Not significant.	Classes 11 and 12 and 13 and 14 are bracketed. 2×2 contingency table test with Yates' correction is applied.
2.	Dorsal fin rays. ..	40.158	2	< 0.001	Highly significant.	Classes 12 and 13 and 15 and 16 are bracketed.
3.	Anal fin rays. ..	3.587	5	> 0.05	Not significant.	Classes 49 to 51 and 56 to 58 are bracketed.
4.	Preventral scutes ..	20.930	3	< 0.001	Highly significant.	Classes 16 and 17 and 20 to 22 are bracketed.
5.	Postventral scutes. ..	5.967	1	< 0.05	significant.	Classes 6 and 7 and 8 to 10 are bracketed. 2×2 contingency table test with Yates' correction is applied.
6.	Gillrakers (lower arm) ..	11.880	1	< 0.001	Highly significant.	Classes 13 and 14 and 15 and 16 are bracketed. 2×2 contingency table test with Yates' correction is applied.

TABLE III

Ranges and means of the body measurements of the specimens from the two localities

Body measurement	Godavari estuary	n=48	Hooghly estuary	n=50
	Range	Mean	Range	Mean
1. Standard length ..	7.90 cm. - 14.70 cm.	11.3531	7.70 cm. - 14.20 cm.	10.9100
2. Body depth ..	2.30 cm. - 5.05 cm.	3.6323	2.40 cm. - 4.55 cm.	3.5770
3. Head length ..	1.75 cm. - 3.00 cm.	2.4113	1.70 cm. - 3.00 cm.	2.4900
4. Diameter of eye ..	0.38 cm. - 0.65 cm.	0.5125	0.40 cm. - 0.65 cm.	0.5310

ranging in length from 7.1 cm. to 17.2 cm. from Hooghly estuary. Averages were obtained for 0.5 cm. groups and the scatter diagrams were obtained. Considering the trend of relationship obtained in both cases, three equations *viz.*, (i) $W=CL^n$, (ii) $W=Ae^b L$ and (iii) $W=a+b.L^3$ have been applied to the data and the sum of squared deviations of the observed weights from the calculated weights were calculated in each equation for the two localities (Table VI). It was found that the

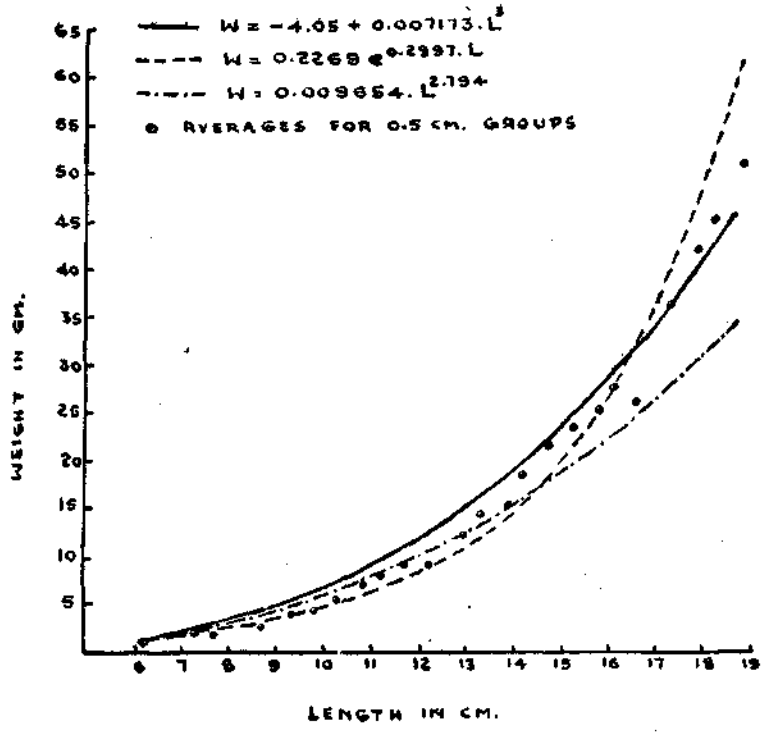

FIG. 5. Length-weight relationship of the samples from Godavari estuary (*S. Godavariensis*).

equation $W=a+b.L^3$ has the lowest sum of squared deviations in both localities and hence is the best fitting curve for the length-weight data of the two populations (Figs. 5 & 6).

TABLE IV

MULTIPLE REGRESSION ANALYSIS

(A) *Corrected sums of products matrix of Godavari estuary forms*

	X1	X2	X3
X1	16.2629	7.8961	1.1951
X2	7.8961	4.4983	0.7063
X3	1.1951	0.7063	0.1831

TABLE IV (*contd.*)

(B) *Corrected sums of products matrix of Hooghly estuary forms*

	X1	X2	X3
X1	6.9471	2.8860	0.8931
X2	2.8860	2.3800	0.5175
X3	0.8931	0.5175	0.1695

(C) *Corrected sums of products matrix of the pooled data*

	X1	X2	X3
X1	23.2689	10.6755	2.0633
X2	10.6755	7.0404	1.2575
X3	2.0633	1.2575	0.3610

(D) *Corrected sums of products of Xi's with 'Y' for Godavari estuary, Hooghly estuary and pooled samples*

Xi	Godavari	Hooghly	Pooled
X1	43.2627	19.9565	64.0192
X2	22.6363	11.5050	33.2868
X3	3.6076	2.5745	5.9814

In the above four tables (A-D) the notation is as follows :—
Y=Standard length; X1=body depth; X2=head length; X3=eye diameter; Xi=X1, X2, or X3.

(E) *Corrected sums of squares of the dependent variable (standard length) for Godavari estuary, Hooghly estuary and pooled samples*

Godavari estuary	..	118.4471
Hooghly estuary	..	60.4800
Pooled data	..	183.8209

(F) *Estimates of regression coefficients for Godavari estuary, Hooghly estuary and pooled samples*

i	Godavari	Hooghly	Pooled
1.	2.88162	2.56451	1.60518
2.	—0.70851	4.04634	2.11503
3.	1.66807	—10.67910	—1.98194

TABLE IV (*contd.*)

(G) *Analysis of variance for testing equality of regression coefficients*

Residual due to	D. F.	S. S.	Mean Square	F.	P.	Significance
Deviation from hypothesis ..	(p) 4	($R1^2$-Ro^2) 17.7887	4.4472	84.5797	< 0.001	Highly significant
Separate ..	(n+n'-2p)	(Ro^2)				
regression ..	90	4.7221	0.05258			
Common ..	(n+n'-p)	($R1^2$)				
regression ..	94	22.5108				

The notations used in this table are from Rao (1952 : Table 3 f. 3.4 page 113), p=no. of variables.

TABLE V

Test of significance of the difference of regression coefficients of body measurements on standard length—samples from Godavari estuary and Hooghly estuary

Body Measurements	Godavari estuary	n : 48	Hooghly estuary	n : 50			
	Regression coefficient b1	Standard error of regression coefficient S1	Regression coefficient b2	Standard error of regression coefficient S2	Standard error of difference S1-2	t	p
Body depth ..	0.36521	0.008874	0.32997	0.009908	0.01330	2.650	<0.01***
Head length ..	0.19111	0.005626	0.19023	0.008123	0.009881	0.089	>0.50*
Eye diameter ..	0.030457	0.003664	0.042568	0.004542	0.005837	2.075	<0.05**

* Not significant ; ** significant ; *** highly significant.

TABLE VI

Sums of squared differences of the observed weights and calculated weights for the length-weight data of Godavari and Hooghly estuaries

Equations	$\Sigma(Wo-Wc)^2$	
	Godavari	Hooghly
$W=C.L.^n$	767.0514	89.8146
$W=Ae^{bL}$	268.2598	282.8239
$W=a+b.L^3$	139.4324	18.5041

TABLE VII

Test of significance of the difference between regression coefficients of weight on total length of Godavari and Hooghly estuary forms (Equation $W=a+bL^n$. The notation is adopted from Goulden (1939, p. 56)

Statistics	Godavari	Hooghly
n (Averages)	24	20
$\Sigma(X-\bar{x})^2$	8,67,57,000	3,53,23,669
$\Sigma(X-\bar{x})(Y-\bar{y})$	6,22,295.50	2,53,836.58
b	0.007173	0.007186
S.E.	0.0002703	0.0001618
S1-2	0.0003151	
t	0.004126	
d.f	40	
P	>0.50	
Significance	Not significant	

The equations expressing the length-weight relationship of the samples from the two localities are :

$$\text{Godavari}: \quad W = -4.05+0.007173.\ L^3$$

$$\text{Hooghly}: \quad W = -0.92+0.007186.\ L^3$$

Since the length-weight relationship is expressed by the same type of equation in both the populations, it was felt worth the while to see whether the samples from the two estuaries belong to a homogeneous population with regard to the rate of increase in weight in relation to increase in length. This has been done by testing, the difference in regression coefficients of the length-weight data of the two populations, for significance, by means of the ' t ' test (Table 7). The result has shown that the ' t ' value is not significant even at 50% level indicating that as far as rate of increase in weight, in relation to length, is concerned the samples from the two estuaries are homogeneous (Fig. 7).

Fecundity :

Fecundity for 19 mature specimens from Godavari estuary and 18 mature specimens from Hooghly estuary have been estimated. The relationship between total weight of the fish and fecundity expressed in thousands of eggs, is found to be

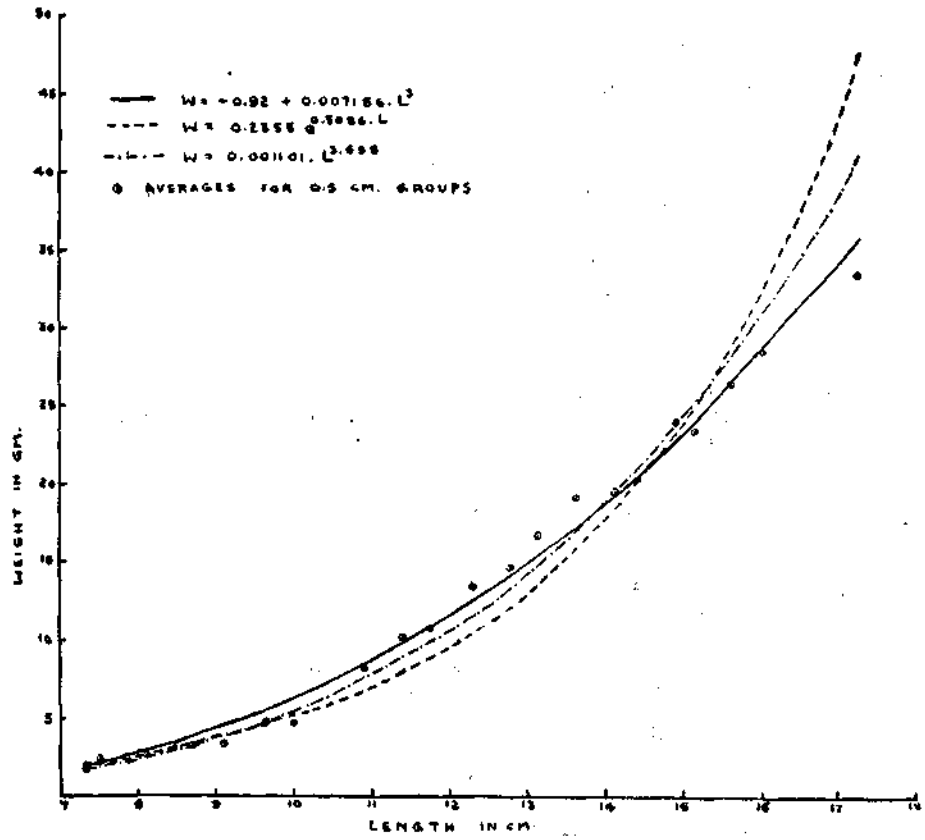

FIG. 6. Length-weight relationship of *S. Godavariensis* for Hooghly estuary forms.

a linear regression in Hooghly estuary forms (Fig. 8 a) and can be expressed by the equation :

$$F = -1.268 + 0.1957.\ W$$

Since the relationship between the length and weight of the fish is found to be a cube equation (*vide* above) and the relationship between weight of fish and fecundity is straight line, the relationship between length of fish and fecundity would be a cube equation (Fig. 8b). The equations that express the length of fish and fecundity relationship of the two populations are :

Godavari estuary : $F = -0.75 + 0.001213.\ L^3$

Hooghly estuary : $F = -1.78 + 0.001567.\ L^3$

To see whether these three equations really express the relationship of the different variables or not, the respective regression coefficients have been tested for

TABLE VIII

Test of significance of the regressions of fecundity on one hand and weight and total length of the fish on the other, in the samples from Godavari and Hooghly estuaries. W=Weight of fish in gms. ; L=Total length in cms. ; F=Fecundity in 1000 *S of eggs.*

	Godavari estuary	Hooghly estuary	
	T. L. Vs. Fecundity	Wt. Vs. Fecundity	T. L. Vs. Fecundity
Equation	$F = -0.75 + 0.001213 . L^3$	$F = -1.268 + 0.1957 . W$	$F = -1.780 + 0.001567 . L^3$
n	19	18	18
Standard error of estimate	0.7982	1.344	1.240
t	5.839	3.080	3.736
p	<0.001	<0.01	<0.002
Significance	Highly significant	Highly significant	Highly significant

significance (Bailey, 1959, p. 97). In all the three cases the degree of association is found to be highly significant (Table VIII).

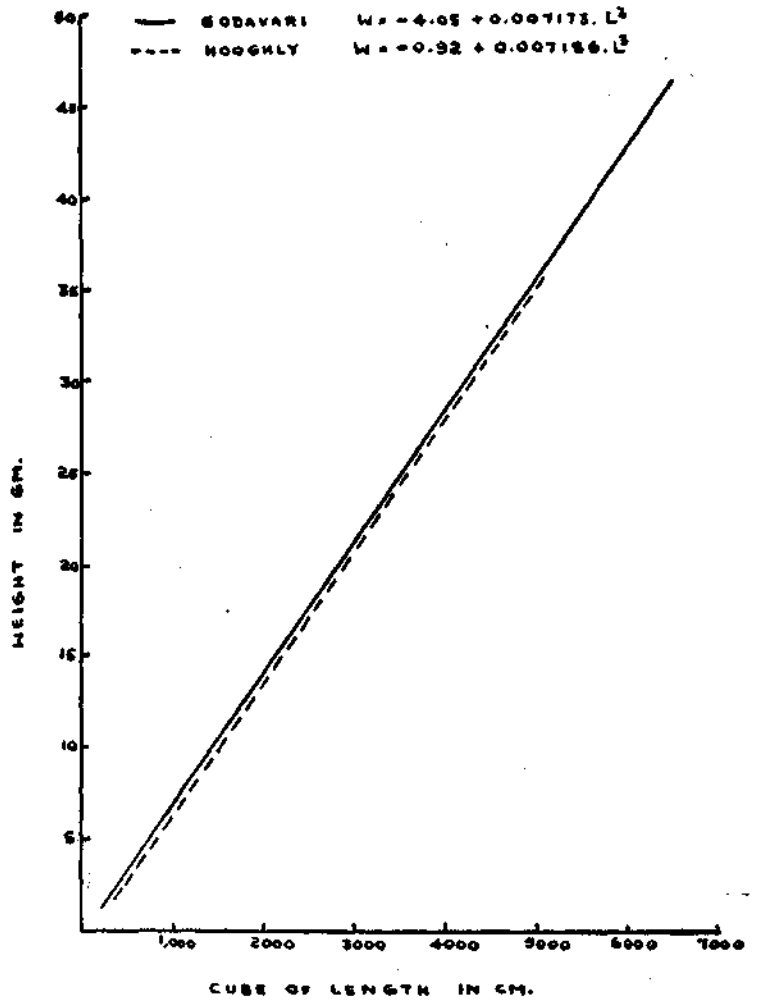

FIG. 7. Regression lines of cube of length-weight relationship of *S. Godavariensis* from Godavari (straight line) and Hooghly (broken line) estuaries.

The rates of increase of the fecundity with the length of fish in the two populations have been compared by testing the difference of regression coefficients, expressing the rate of increase of fecundity in relation to length of fish, by the 't' test (Bailey, *op. cit.* p. 99). The 't' value is found to be not significant even at 10% level indicating that with regard to length of fish-fecundity relationship the samples from both the estuaries are homogeneous (Table IX).

TABLE IX

Test of significance of the difference between regression coefficients of fecundity on total length of Godavari and Hooghly estuary forms (Equation $F=a+b.L^3$). t-test for small samples is applied, following Bailey (1959, *P.* 99)

Statistics	Godavari	Hooghly
n	19	18
$\Sigma (X-\bar{x})^2$	1,47,68,353	87,33,137.2
$\Sigma (X-\bar{x})(Y-\bar{y})$	17,914.89	13,680.75
b	0.001213	0.001567
Standard error of estimate	0.7982	1.240
S1-2	1.036	
t	0.801	
d.f	33	
P	>0.10	
Significance	Not significant	

GUT CONTENT ANALYSIS

The constituents of food of this species have been studied for Godavari estuary forms. The gut contents were examined whenever adequate samples of this species could be obtained in the estuary. The ' occurrence method ' described by Pillay (1952) has been adopted for the present study. The percentage frequency of guts containing the various food organisms (Table X) show that this species feeds on the following items, given in the order of preference : Prawns, copepods, crustacean larvae, molluscs, fish and diatoms. It is clear that *S. godavariensis* is predominantly a zooplankton feeder. Of the prawns, *Acetes*, *Leander* and *Peneaus* were most represented. Among the copepods commonly encountered are *Paracalanus*, *Centropages*, *Undinula*, *Temora*, *Labidocera*, *Pontella*, *Eucalanus*, *Acartia*, *Coryceus* etc. Of crustacean larvae *Lucifer* were most common. A few forms had ingested young gastropods, bivalves and juveniles of fishes like *Gobius* spp. and *Stolephorus* spp. Diatoms like *Nitzchia*, *Pleurosigma*, *Gyrosigma* and *Coscinodiscus* were observed in a very small number of forms.

OVA DIAMETER MEASUREMENT STUDIES

Measurements of diameters of ova of different maturing stages of females of Godavari forms were taken. The percentage frequencies of the diameters of ova are plotted for stage I of maturity to stage VI of maturity, when the ova are fully ripe (Fig. 9). From the figure it is evident that in stage I the maximum number of ova occur at about 0.09 mm., in stage II at about 0.20 mm., in stage III at about 0.33 mm., in stage IV at about 0.58 mm., in stage V at about 0.66 mm. (and also at 0.33 mm.) and in stage VI at about 0.80 mm. The second batch of smaller ova start appearing from stage III onwards (Fig. 9). The fully mature ovarian ovum of this species will be of an approximate size of 0.80 mm. The presence of a second smaller mode

TABLE X

Monthly frequencies of the stomachs containing the listed food components from Godavari samples of S. godavariensis

Name of the food item	Nov. 1959	Dec. 1959	Feb. 1960	April 1960	May 1960	Aug. 1960	Spt. 1960	Oct. 1960	Feb. 1961	March 1961	April 1961	May 1961	Average percentage for the observation period
Prawns	42.8	40.6	45.5	79.2	8.9	6.5	100	95	23.5	96	100	72	59
Copepods	21.4	25	4.5	30	1.1	35	6	10	50	56	24	20	23.6
Crustacean larvae	—	21.9	—	1.3	3.3	15	6	15	19.6	44	20	—	12.2
Molluscs	—	—	—	15.6	1.1	—	—	5	—	24	8	—	4.5
Fish	7.1	—	4.5	1.3	2.2	4.5	—	2.5	10.9	4	4	8	4.1
Diatoms & Din flagellates	—	—	—	1.3	—	—	—	—	8.7	—	—	8	1.5

in the percentage frequency curves might indicate that the species may spawn more than once in an year.

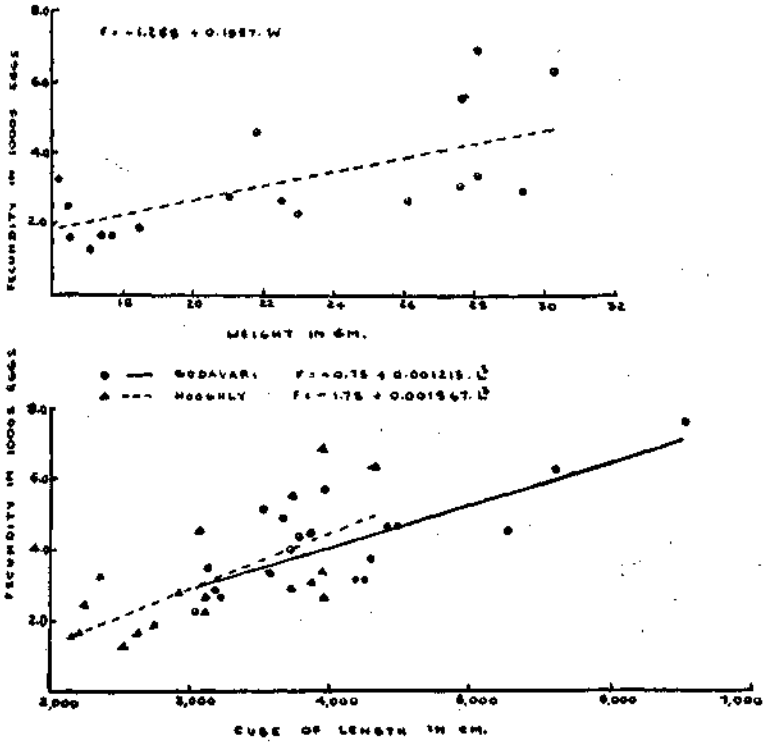

FIG. 8. Weight of fish-fecundity relationship in Hooghly samples (upper graph) and cube of length-fecundity relationship in Godavari (straight line) and Hooghly (broken line) samples (lower graph) of *S. Godavariensis*.

SUMMARY AND CONCLUSIONS

Three species of the genus *Setipinna* Swainson *viz. S. taty* (val.) *S. phasa* (Buch.-Ham.) and *S. godavariensis* Rao were found to occur in Hooghly estuary. The three species show gradations in some of the morphological and meristic characters.

Samples of *S. godavariensis* from Godavari estuary were compared with those from Hooghly estuary in meristic characters, body measurements, length-weight relationship and total length-fecundity relationship. Samples from the two localities were found to differ significantly in dorsal fin rays, preventral scutes, post-ventral scutes, gillrakers on lower arm, body depth and eye diameter on standard length (Table XI). It may be concluded that the samples from the two estuaries constitute two distinct populations in view of these differences.

The best fit equation expressing the length-weight relationship of the samples from both estuaries is found to be $W=a+b.\ L^3$. The relationship of weight of fish and fecundity can be expressed by a linear equation, $F=a+b.\ W$ and the relationship between total length and fecundity can be expressed by the equation

$F=a+b.\ L^3$. With reference to length-weight relationship and total length-fecundity relationship the populations do not differ significantly indicating that these relationships are less variable than meristic characters or body measurements.

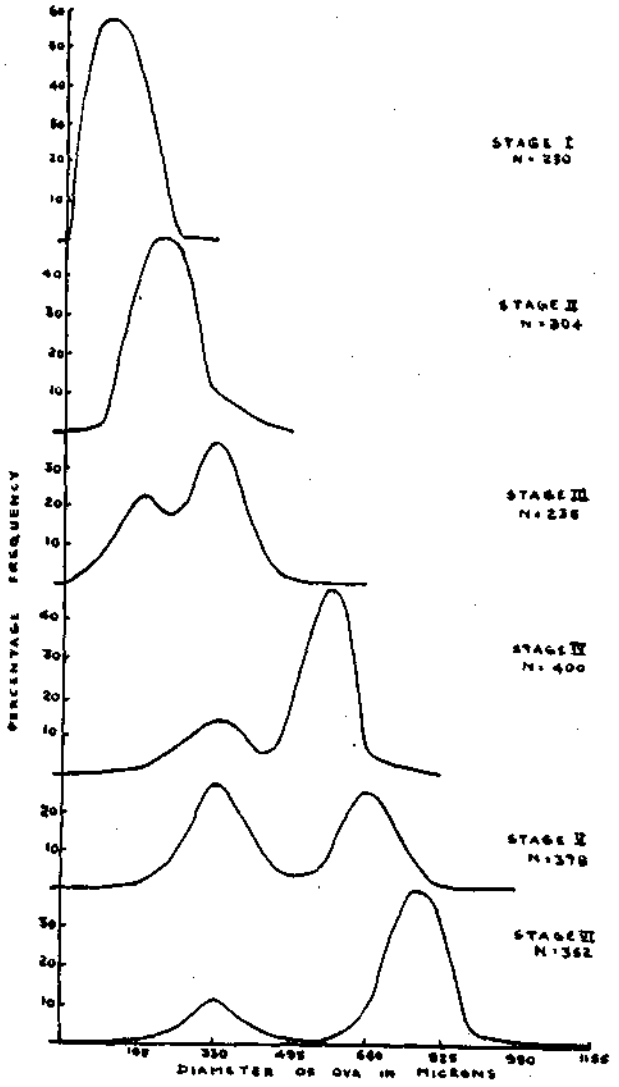

FIG. 9. Percentage frequency curves of the diameter of ova in different stages of maturity of *S. godavariensis* of Godavari.

The gut content analysis of Godavari estuary samples has revealed that the food preference of the species is in the following order : prawns, copepods, crustacean larvae, molluscs, fish and diatoms.

The ova-diameter measurement studies have shown that the size of the mature ova in this species is about 0.80 mm. and that from stage III onwards a second batch

PLATE 1 : The three *Setipinna* species from Hooghly estuary, *S. godavariensis* Rao (above), *S. phasa* (Ham-Buch.) (middle) and *S. taty* (Val.) (below) showing gradations in some of the morphological characters like dorsal profile and length of first pectoral fin ray.

of ova start appearing to mature, indicating that the species might spawn a second time in the same year.

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TABLE XI

Characters of Setipinna godavariensis, *from Godavari estuary and Hooghly estuary, tested for homogeneity*

S.No.	Character	Significance
1.	Pectoral fin rays.	Not significant.
2.	Dorsal fin rays.	Highly significant.
3.	Anal fin rays.	Not significant.
4.	Preventral scutes.	Highly significant.
5.	Postventral scutes.	Significant.
6.	Gillrakers (lower arm).	Highly significant.
7.	Body depth on standard length.	Highly significant.
8.	Head length on standard length.	Not significant.
9.	Eye diameter on standard length.	Significant.
10.	Length-weight relationship.	Not significant.
11.	Total length-fecundity relationship.	Not significant.

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