

A COMPARISON OF MERISTIC CHARACTERS OF
THE MALABAR SOLE *CYNOGLOSSUS SEMIFASCIATUS* DAY FROM
DIFFERENT CENTRES OF THE WEST COAST OF INDIA

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ABSTRACT

Samples of *Cynoglossus semifasciatus* Day taken between January 1980 and January 1982 from different places of the west coast (Viz. Malpe, Mangalore, Cannanore, Calicut and Cochin) were statistically analysed for selected characters for inter-regional comparison of the populations. Meristic characters such as dorsal finrays, anal finrays, caudal finrays, cephalic scales of the lateral line, post-cephalic scales of the lateral line, and the transverse rows of scales between the lateral lines, were used in this comparative study. Both variance analysis and the "Student's" t-test have been used in the statistical analysis.

The study indicates some variability in the meristic characters among the different centres, the samples of Cochin perhaps belonging to a stock rather different from the other centres which (on the basis of these characters) seem to belong to a common stock though with variations from place to place.

INTRODUCTION

A COMPARATIVE study of the Malabar sole *Cynoglossus semifasciatus* Day, from different centres of the west coast was undertaken by the authors during 1980-82. These studies involved mainly selected morphometric and meristic characters and a few biological characters; the morphometric data are included in a separate paper (Chakrapani and Seshappa, 1982). Some other aspects of the study have been partly published (Seshappa and Chakrapani, 1983, 1984), but partly awaiting publication (Seshappa and Chakrapani, MS). The present paper records the results of comparison of the meristic characters.

Meristic characters counted in fishes for comparison of samples often include the vertebrae, various finrays as well as the various categories of scales and scutes that are gener-

ally used in taxonomy. Among the more recent papers using such meristic counts for comparative studies may be mentioned those of Jayaram (1960, 1962) on *Rita chrysea* and *Ailichthys punctata*, of Ramakrishnaiah (1972) on *Hilsa ilisha*, of Babu Rao and Joglekar (1967) on *Setipinna godavariensis*, of Venkatasubba Rao (1977) on the lizard fishes, and of Dutt and Seshagiri Rao (1981) on the clupeoid *Escualosa thoracata*. The main earlier papers on morphometric and meristic studies in different fishes will be found mentioned in the above papers and also partly in the other papers of the present authors mentioned earlier. In the case of the Malabar sole, Seshappa (1970) has made an interspecific comparison of selected morphometric characters, while Seshappa (1976) has made a comparative study of this species with a few others from Cannanore, but without any statistical computations in the latter case.

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TABLE 1. *Details of samples of C. semifasciatus examined for their meristic characters for comparison*

Place	Date	Total number examined	Mean total length (cm)
Mangalore	23-2-1980	44-47	11.89
-do-	14-3-1980	56-66	12.01
Malpe	15-3-1980	44-49	12.02
Mangalore	28-3-1980	48-51	10.92
Calicut	23-4-1980	16-36	11.86
-do-	30-4-1980	38-49	11.43
-do-	25-5-1980	40-48	11.38
Cannanore	28-5-1980	31-47	11.82
Calicut	10-5-1980	42-49	11.55
Cannanore	8-5-1980	23-41	11.69
Mangalore	5-5-1980	49-54	11.37
-do-	22-5-1980	46-51	12.27
-do-	15-5-1980	46-51	10.51
Cannanore	6-10-1980	33-35	12.35
Calicut	23-10-1980	53-55	11.58
-do-	21-10-1980	47-54	13.96
-do-	30-10-1980	49-51	11.07
-do-	31-10-1980	47-51	13.72
-do-	28-11-1980	48-50	8.45
-do-	1-12-1980	49-52	11.34
-do-	13-12-1980 (i)	51-54	11.94
-do-	13-12-1980 (ii)	51-55	8.43
Cannanore	14-12-1980	50-51	10.81
-do-	28-12-1980	48-52	11.57
Calicut	29-12-1980	47-52	10.22
-do-	15-1-1981	38-53	12.12
-do-	28-1-1981	39-50	11.57
Cochin	8-1-1982	61-64	12.00
-do-	13-1-1982	66-68	11.33

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TABLE 2. Sample-wise mean values of various meristic counts in *C. semifasciatus* from different centres during February 1980 to January 1982

Place	Dorsal finrays	Anal finrays	Caudal finrays	L. 1. scales (cephalic)	L. 1. scales (postcephalic)	Scales between L. 1s.
Mangalore	101.65	79.57	10.04	11.19	86.96	14.49
-do-	103.32	79.93	10.00	11.02	89.27	14.58
Malpe	102.85	79.89	10.05	11.02	90.17	14.63
Mangalore	102.55	79.67	9.98	11.04	90.29	14.68
Calicut	100.78	79.31	10.10	10.81	91.50	14.96
-do-	104.79	79.95	9.95	10.86	90.69	15.24
-do-	104.68	79.51	9.90	11.00	91.83	15.12
Cannanore	105.13	79.73	10.24	10.97	92.55	14.93
Calicut	104.98	79.63	10.02	10.95	92.71	15.18
Cannanore	105.14	79.90	9.92	11.00	93.17	14.93
Mangalore	105.04	80.22	9.86	10.91	90.70	15.11
-do-	105.02	80.63	9.91	10.98	90.88	15.00
-do-	104.73	80.39	9.98	11.02	89.42	15.00
cannanore	104.24	79.71	9.91	11.09	90.91	14.86
Calicut	104.56	79.47	9.91	11.00	87.35	14.74
-do-	104.96	79.94	9.94	11.01	89.39	15.19
-do-	104.86	80.08	10.02	10.98	87.65	14.47
-do-	104.51	79.70	9.96	11.18	89.36	15.02
-do-	104.40	80.35	9.92	10.94	90.46	15.35
-do-	104.78	80.12	9.96	10.86	87.99	14.65
-do-	104.27	79.67	10.04	11.00	88.39	14.89
-do-	105.11	80.20	9.96	11.00	90.65	15.35
Cannanore	104.76	80.24	9.94	10.92	89.92	14.90
-do-	104.59	80.06	9.92	10.92	92.10	14.88
Calicut	105.76	81.33	9.96	11.00	90.02	15.29
-do-	104.56	79.96	9.98	10.96	88.16	14.75
-do-	104.28	78.98	9.95	10.86	90.13	14.64
Cochin,	105.49	80.25	9.97	10.98	91.91	15.17
-do-	106.01	80.75	10.01	10.87	92.33	15.25
Overall Mean values	104.40	79.97	9.98	10.98	90.24	14.94
Standard Deviations	1.155	0.463	0.074	0.086	1.672	0.258
Standard Errors	0.2146	0.0860	0.0138	0.0160	0.3105	0.0480
Coefficient of variation	1.1067	0.5791	0.7438	0.7834	1.8530	1.7290

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total length of the fish in each sample are detailed in Table 1. It was not possible to take the samples either simultaneously at all the centres or in the same numbers at all the centres, because of practical difficulties. 29 samples were taken and analysed in all in the work.

The meristic characters counted were : (1) dorsal finrays, (2) anal finrays, (3) caudal finrays, (4) cephalic lateral line scales, (5) post-cephalic lateral line scales and (6) the numbers

TABLE 3. *Frequency distribution of dorsal finrays in C. semifasciatus (pooled data) from different centres of the west coast (Figures in brackets indicate percentages)*

Centres	Numbers of dorsal finrays									Total fish	Mean rays
	94-5	96-7	98-9	100-1	102-3	104-5	106-7	108-9	110-11		
Cochin	0	0	0	0	9 (3.20)	37 (29.60)	64 (51.20)	20 (16.00)	0	125	106.10
Calicut	1 (0.14)	7 (0.95)	11 (1.49)	10 (1.36)	81 (11.01)	371 (50.41)	215 (29.21)	39 (5.30)	1 (0.14)	736	104.85
Cannanore	0	0	2 (0.86)	6 (2.59)	22 (9.48)	115 (49.57)	72 (31.03)	15 (6.47)	0	232	105.03
Mangalore	0	1 (0.32)	12 (3.80)	32 (10.13)	64 (20.25)	145 (45.89)	50 (15.82)	12 (3.80)	0	316	103.91
Malpe	0	0	1 (2.04)	9 (18.37)	15 (30.24)	22 (44.90)	2 (4.08)	0	0	49	103.11

vation and transport of the fish samples from the west coast.

MATERIAL AND METHODS

Samples of the Malabar sole were collected at the various centres, preserved and despatched rolled in formalin-soaked cotton to Bangalore where they were stored and studied. The dates of sampling at the different centres along with the numbers of the fish used for each character from the samples and the average

of scales in the transverse rows between the lateral lines. The counts were all taken in the usual way. Comparisons of the mean values between pairs of centres were made by means of the "Student's" t-test (Snedecor and Cochran, 1967; Bailey, 1959; Simpson and Roe, 1939).

RESULTS

Table 2 shows the sample mean values of all the six meristic characters chosen for the

TABLE 4. Frequency distribution of anal finrays in *C. semifasciatus* (pooled data) from different centres of the west coast (Figures in brackets indicate percentages)

Centres	Numbers of finrays											Total fish	Mean rays	
	74	75	76	77	78	79	80	81	82	83	84			85
Cochin	0	0	3 (2.29)	5 (3.82)	9 (6.87)	12 (9.16)	35 (26.72)	30 (22.90)	22 (16.79)	12 (9.16)	2 (1.30)	1 (0.76)	131	80.50
Calicut	2 (0.28)	2 (0.28)	14 (1.95)	32 (4.46)	110 (15.32)	131 (18.25)	157 (21.87)	135 (18.89)	104 (14.48)	19 (2.65)	10 (1.39)	2 (0.28)	718	79.90
Cannanore	0	1 (0.44)	1 (0.44)	13 (5.75)	25 (11.06)	50 (22.12)	57 (25.22)	33 (14.60)	42 (18.58)	4 (1.77)	0	0	226	79.92
Mangalore	0	1 (0.33)	2 (0.65)	12 (3.91)	18 (5.86)	63 (20.52)	101 (32.90)	61 (19.87)	42 (13.68)	6 (1.95)	1 (0.33)	0	307	80.06
Malpe	0	0	0	1 (2.08)	6 (12.50)	11 (22.92)	10 (20.82)	18 (37.50)	2 (4.17)	0	0	0	48	79.92

study. Tables 3 to 6 show the frequency distribution of the dorsal finrays, anal finrays, postcephalic lateral line scales and the transverse rows of scales between the lateral lines respectively for the different centres from the pooled data of the entire period. Table 7 shows the results of variance analysis made with the pooled data of all the centres for the characters (excluding Cochin and the cephalic lateral line scales, while Table 8 shows results of t-test comparisons.

DISCUSSION AND CONCLUSIONS

The analysis of variance for five meristic criteria among the different centres north of Cochin showed highly significant results in the case of (1) dorsal finrays ($F=26.65$ and $P < 0.01$), (2) post-cephalic lateral line scales ($F= 6.35$ and $P < 0.01$) and (3) the transverse rows of scales between the lateral lines ($F = 17.74$ and $P < 0.01$); the anal and caudal finrays showed only non-significant differences ($F=0.38$ and 0.91 respectively and $P > 0.05$ in both cases). Between the premonsoon and post-monsoon seasons in the pooled data, the dorsal finrays, anal finrays and the postcephalic lateral line scales again showed highly significant differences ($F= 7.17, 9.93$ and 79.95 respectively with $P < 0.01$ in all cases); the caudal finray counts had significant differences at the 5% level of P , while the differences in the transverse rows of scales between the lateral lines were non-significant.

The results of the t-test comparisons shown in Table 8 have the following features: (1) The caudal finrays and cephalic scales of the lateral line show non-significant results in all comparisons except between Mangalore and Malpe in former case, and Cochin and Mangalore in latter case; (2) the dorsal finrays show highly significant differences (8 out of 10) in all comparisons except between Calicut and Cannanore ($P > 0.05$) and between Mangalore and Malpe ($P < 0.005$); (3) post-cephalic lateral line scales show highly significant differences in

six out of ten comparisons, the results being non-significant between Calicut and Mangalore, Calicut and Malpe, Cannanore and Malpe, and Mangalore and Malpe; (4) the anal finrays show differences significant at the 5% level of P in all comparisons between Cochin and the other centres, while among the remain-

cephalic lateral line scales (all SS), numbers of scales between lateral lines (3 SS and one S), and the anal finrays (all differences being significant at the 5% level of P). While the caudal finrays and the cephalic lateral line scales have non-significant differences in all comparisons generally, the anal finrays show a 5% signifi-

TABLE 5. Frequency distribution of post-cephalic lateral line scales in *C. semifasciatus* from different centres of the west coast (Figures in brackets indicate percentages)

Centres	Cochin	Calicut	Cannanore	Mangalore	Malpe
Numbers of scales					
79-80	0	6 (0.86)	2 (1.11)	0	0
81-82	0	9 (1.29)	0	3 (0.99)	1 (2.04)
83-84	1 (0.76)	33 (4.74)	0	12 (3.96)	0
85-86	0	101 (14.51)	13 (7.22)	34 (11.22)	3 (6.12)
87-88	13 (9.85)	86 (12.36)	22 (12.22)	59 (19.47)	7 (14.29)
89-90	12 (9.09)	130 (18.68)	39 (21.67)	64 (21.12)	16 (32.65)
91-92	20 (15.15)	140 (20.11)	37 (20.56)	68 (22.44)	17 (34.69)
93-94	46 (34.85)	130 (18.68)	53 (29.44)	47 (15.51)	4 (8.16)
95-96	28 (21.21)	46 (6.61)	12 (6.67)	12 (3.96)	1 (2.04)
97-98	10 (7.58)	11 (1.58)	1 (0.56)	2 (0.66)	0
99-100	2 (1.52)	4 (0.57)	1 (0.56)	1 (0.33)	
101-102	0	0	0	1 (0.33)	
Total fish	132	696	180	303	49
Mean number of scales	92.98	89.93	90.94	89.78	89.95

ing four centres all the paired comparisons show only non-significant differences.

In general, the Cochin samples seem to differ quite considerably from all the other centres in the case of the dorsal finrays (all SS), post-

cance in the comparisons with Cochin and non-significant values in all other comparisons. The counts of the postcephalic lateral line scales and of the dorsal finrays are notably on the higher side in the Cochin samples.

The study thus indicates a high range of variability in the meristic characters of the species at the different centres, the samples of Cochin indicating their probable origin from a stock

quite different from the other centres (which seem to have a common stock though with marked variations within the stock).

TABLE 6. Frequency of scales in the transverse rows between the lateral lines in *C. semifasciatus* from different centres of the west coast (pooled data) (Figures in brackets indicate percentages)

Centres	Numbers of scales in transverse rows					Total fish	Mean of transverse row scales
	13	14	15	16	17		
Cochin	0 (0.00)	18 (13.64)	70 (53.03)	42 (31.82)	2 (1.52)	132	15.21
Calicut	24 (3.13)	159 (20.76)	394 (51.44)	173 (22.58)	16 (2.09)	766	15.00
Cannanore	4 (1.83)	48 (21.92)	134 (61.19)	32 (14.61)	1 (0.46)	219	14.90
Mangalore	4 (1.29)	89 (28.62)	179 (57.56)	37 (11.90)	2 (0.64)	311	14.82
Malpe	1 (2.08)	19 (39.58)	25 (52.08)	3 (6.25)	0	48	14.63

TABLE 7. Results of variance analysis of five categories of meristic counts from pooled data on *C. semifasciatus* of different centres together (Cochin excluded)

Characters compared	Between Centres		Between seasons	
	F-value	Significance	F-value	Significance
Dorsal finrays	26.65	Highly significant	7.17	Highly significant
Anal finrays	0.38	Not significant	9.53	Highly significant
Caudal finrays	0.91	Not significant	6.09	Significant at the 5% level of P
Post-cephalic lateral line scales	6.35	Highly significant	79.95	Highly significant
Scales (transverse rows) between lateral lines.	17.74	Highly significant	3.26	Not significant

TABLE 8. *Results of paired t-test comparisons of meristic counts in C. semifasciatus among different centres of west coast (pooled data)*

Centres		Dorsal finrays	Anal finrays	Caudal finrays	Cephalic L-1. scales	Post-cephalic L.1. scales	Scales between L. lines	Total N. S. result
Cochin & Calicut	t:	6.4460	3.2441	0.6185	0.6197	8.0017	2.9108	2
	P:	<0.001	<0.005	>0.50	>0.50	<0.001	>0.05	
	R:	SS	S	NS	NS	SS	S	
Cochin & Cannanore	t:	5.3730	3.1939	0.1797	1.1259	4.7991	4.1789	2
	P:	<0.001	<0.005	>0.50	>0.02	<0.001	<0.001	
	R:	SS	S	NS	NS	SS	SS	
Cochin & Mangalore	t:	10.0805	2.7911	1.1451	2.8856	9.2166	5.7106	1
	P:	<0.001	<0.010	>0.40	>0.005	<0.001	<0.005	
	R:	SS	S	NS	S	SS	SS	
Cochin & Malpe	t:	11.4868	2.2221	0.9158	1.8075	5.3378	5.1545	2
	P:	<0.001	<0.010	>0.40	>0.05	<0.001	<0.001	
	R:	SS	S	NS	NS	SS	SS	
Calicut & Cannanore	t:	1.5091	0.1843	0.5394	0.0953	3.6037	3.5052	4
	P:	>0.05	>0.50	>0.50	>0.50	<0.001	<0.001	
	R:	NS	NS	NS	NS	SS	SS	
Calicut & Mangalore	t:	6.0580	1.6901	0.0006	1.2795	0.8689	6.1701	4
	P:	<0.001	>0.05	>0.50	>0.05	>0.05	<0.001	
	R:	SS	NS	NS	NS	NS	SS	
Calicut & Malpe	t:	5.8731	0.3037	1.3759	0.5589	1.0594	5.3056	4
	P:	<0.001	>0.50	>0.05	>0.05	>0.05	<0.001	
	R:	SS	NS	NS	NS	NS	SS	
Cannanore & Mangalore	t:	6.2997	0.9371	0.8603	1.8142	4.4983	1.5117	4
	P:	<0.001	>0.20	>0.20	>0.05	<0.001	>0.05	
	R:	SS	NS	NS	NS	SS	NS	
Cannanore & Malpe	t:	6.7877	0.2286	0.8703	1.0467	1.6476	2.4736	4
	P:	<0.001	>0.50	>0.20	>0.20	>0.05	<0.05	
	R:	SS	NS	NS	NS	NS	S	
Mangalore & Malpe	t:	2.7573	0.7997	3.0488	0.0375	1.0950	1.7780	4
	P:	<0.005	>0.10	<0.005	>0.50	>0.50	>0.05	
	R:	S	NS	S	NS	NS	NS	
Total non-significant results		1	6	9	9	4	2	

REFERENCES

- BABU RAO, M. AND ASHA JOGLEKAR 1967. Comparative studies on *Setipinna godavariensis* Rao (Pisces: Engraulidae) from Godavari and Hooghly Estuaries. *J. mar. biol. Ass. India*, 9 (1): 39 - 60.
- BAILEY, N. T. J. 1959. *Statistical Methods in Biology*. English Language Book Society and English Universities Press Ltd., 200 pp.
- B. K. CHAKRAPANI AND G. SESHAPPA 1982. A morphometric comparison of the Malabar sole *Cynoglossus semifasciatus* Day from different parts of the west coast. *J. mar. biol. Ass. India*, 24 (1 & 2): 72-79.
- AND B. V. SESHAGIRI RAO 1981. Biometric comparison of samples of the Clupeoid fish *Escualosa thoracata* (Val., 1847) from two localities. *Matsya*, 7: 50 - 63.
- JAYARAM, K. C. 1960. Racial analysis of *Rita chrysea* Day inhabiting the Mahanadi River. *J. Zool. Soc. India*, 12 (1): 85 - 103.
- 1962. Systematic status of *Ailichthys punctata* Day and its relationship with *Aitta coilia* (Hamilton) (Siluroidea: Schilbeidae). *Ibid.*, 14 (1 & 2): 244-248.
- RAMAKRISHNAIAH, M. 1972. Biology of *Hilsa ilisha* (Hamilton) from the Chilka Lake with an account on its racial status. *Indian J. Fish.*, 19 (1 & 2): 35 - 53.
- SESHAPPA, G. 1970. Some morphometric studies on five species of *Cynoglossus* (Family: *Cynoglossidae*, Order: Heterosomata) from the west coast. *Ibid.*, 17 (1 & 2): 149 - 158.
- 1976. Report on a collection of tongue soles (*Cynoglossus* spp.) from Moplah Bay with a description of *C. lida* (Bleeker). *Ibid.*, 23 (1 & 2): 160 - 173.
- 1984. A scalimetric comparison of the Malabar sole *Cynoglossus semifasciatus* Day from different parts of the west coast. *Ibid.*, 31 (1): 82 - 89.
- AND B. K. CHAKRAPANI 1983. On the length frequency distribution in *Cynoglossus semifasciatus* Day on the west coast during 1980 - 81. *Ibid.*, 30 (1): 74 - 86.
- AND ————— (MS). On the length-weight relationships in *Cynoglossus semifasciatus* Day from the west coast of India.
- SIMPSON, G. G. AND ANNE ROE 1939. *Quantitative Zoology*. McGraw-Hill Book Coy. Inc., New York & London, 14 pp.
- SNEDECOR, G. W. AND W. G. COCHRAN 1967. *Statistical Methods*. Oxford and IBH Publishing Co., 593 pp.