ON SOME BIOLOGICAL, MERISTIC AND MORPHOMETRIC STUDIES ON THE MALABAR SOLE, *CYNOGLOSSUS SEMIFASCIATUS* DAY

G. SESHAPPA *

(Retired Scientist of Central Marine Fisheries Research Institute, Cochin)

ABSTRACT

29 samples of the Malabar Sole *Cynoglossus semifasciatus* collected from five centres of the west coast were studied statistically for selected biological, meristic and morphometric characters to assess the extent of homogeneity of this fish along the coast, the study being necessitated by some apparent variations noticed at Calicut earlier. Length frequency trends, sex-proportions and maturity trends, all revealed however, a high degree of agreement with the past findings on the species at Calicut by Seshappa and Bhimachar (1955). Counts of various finrays and of the longitudinal and transverse series of scales indicated a somewhat varying but yet similar trend, the Cochin samples being not different also. The morphometric characters studied both by the ratio method and by the regression and Co-variance analysis indicated a similar conclusion. A study of the length-weight relationships again revealed non-significant results from the different comparisons among centres though between seasons, there were expectable differences with statistical significance.

After a consideration of the results obtained by all these various tests it has been concluded that the Malabar sole (*C.semifasciatus*) of the west coast at the different centres is constituted by a single homogeneous stock only.

INTRODUCTION

THE MALABAR SOLE supports a commercial fishery of importance in this country, only along the south Karnataka and the north Kerala coasts. Some work was done on this fish from a fishery biological point of view by Seshappa and Bhimachar (1951, 1953 and 1955) and limited work on the same lines was continued by Seshappa subsequently (Seshappa 1964, 1968, 1970, 1976 and 1978). More recently Seshappa and Chakrapani worked on the same fish on the problem of variation (or 'raciation') utilising samples form Malpe, Mangalore, Cannanore, Calicut and Cochin (Seshappa and Chakrapani, 1982, 1984a, 1984b and 1987, and Chakrapani and Seshappa, 1987); these papers dealt with length frequencies, sex and maturity, scalimetry, meristic characters and morphometric characters; the weight length relationships have

Present address: 'SRI SAI NIVASA', 706, 2nd C-Cross Road, Basaveshwaranagar, III Stage III Block, Bangalore-560 079.

also been dealt with including the Cochin samples in a latter paper (1991 & MS). The present paper gives a summary view of the results included in the various above mentioned papers, on the raciation question i.e. the question of the homogeneity or otherwise of the stocks of this fish along the coast on the basis of the samples examined from four northern centres (Malpe, Mangalore, Cannanore and Calicut) during January 1980 - January 1981 and also from the southernmost centre in the series namely, Cochin Harbour, sampled in January 1982.

MATERIAL AND METHODS

Samples of the Malabar sole were collected at the various centres from commercial landings, preserved and transported to Bangalore for analysis during the period 1981 to 1982. While in general all the material was utilised for all aspects of the work, only 18 of the samples were used for the scale-ring counts, and the Cochin samples (collected in January 1982)

were examined separately for some aspects (e.g. length-weight relationship). Co-variance analysis has been done wherever convenient as for example, in morphometric comparisons by regression estimations and also the comparison of length-weight regressions; student's t-test has been utilised for comparison of ratios and meristic counts; and chi-square analysis has been done for sex-ratio studies (Bailey, 1965, Snedecor and Cochran, 1968).

Length - Frequency studies

Table 1 shows the dominant modal sizes noticed at Calicut during 1959-63 in comparison with the present data of 1980-82. The picture

years (Seshappa and Bhimachar 1955, Seshappa 1964, Seshappa and Chakrapani 1982). Some differences noticed in the modal sizes of new recruits of juveniles and an evident decrease in the modal sizes of the October - November season in 1980-81 as compared to the earlier years may be due to the increased trawling activity in the area of sampling almost round the year. The length-frequency trends in the other centres were also closely comparable to the condition noticed at Calicut, the main fishery season being the same. In the years of the earlier studies, the fishery was entirely dependent on indigenous gears (like the *Paithuvala* and *Veechuvala* or castnet at Calicut, and similar other nets like the *Kairampani* and

TABLE 1. *Range of dominant modal length groups of C. semifasciatus during 1959-63 and 1980-82*

Months	Years	Dominant modes (Range) in cm groups	Remarks
January	1959-63	6-6.9 to 13-13.9	Two age classes
-do-	1980-82	8.5-9.4 to 11.5-11.9	
February	1959-63	6-6.9 to 13.9	Two age classes
-do-	1980-82	7.5-7.9 to 11.5-11.9	
March	1959-63	5-5.9 to 13-13.9	Two age classes
-do-	1980-82	10-10.4 to 13-13.4	-do-
April	1959-63	6-6.9 to 13-13.9	Two age classes
-do-	1980-82	10-10.4 to 13-13.4	-do-
May	1959-63	7-7.9 to 13-13.9	Two age classes
-do-	1980-82	8-8.4 to 13.5 to 13.9	-do-
June : to August No (good) samples in both periods.			
September	1959-63	5-5.9 to 15-15.9	Two age classes
-do-	1980-82	No samples,	
October	1959-63	10-10.9 to 14-14.9	Two age classes
-do-	1980-82	7-7.4 to 13.5-13.9	-do-
November	1959-63	5-5.9 to 15-15.9	Two age classes
-do-	1980-82	8.5-8.9	
December	1959-63	5-5.9 to 14-14.9	Two age classes
-do-	1980-82	6-6.4 to 15-15.9	-do-

provided by the trends in the table agrees generally with the same trend for the earlier

Beesubale along the Karnataka coast). During the present study shrimp trawls had been

extensively in operation in both states and the Malabar sole was found to be an invariable component of the catches in both the areas. The pooled data of all the centres as well as the centre-wise data on length frequencies indicate a close biological similarity among the centres in the present study and also between the earlier and the present periods. The picture obtained is one of homogeneity of the stocks rather than of any heterogeneity of a marked nature.

SCALIMETRIC STUDIES

The occurrence of dependable growth-indicators in the scales of the Malabar sole in the form of monsoon rings was first reported by Seshappa and Bhimachar (1951) at Calicut. Similar and dependable growth rings in the scales of other species of *Cynoglossus* were also reported at Calicut (Seshappa, 1978). In the present work 18 samples of *C.semifasciatus* were examined in detail with measurements of different parts of the scales and statistical assessment of comparable features among different centres and seasons. Samples from Cochin were not available at that stage and

therefore left out. The scales examined mostly showed three growth checks (in the large fish) of which one or more could be easily recognised as false checks from the criteria defined by Bhimachar and Seshappa (1951, 1955); though the cause of these false checks within the regular three ring pattern was not known the phenomenon that occurred was utilised in a scalimetric study for comparison among the four northern centres. The parameters of the scales that examined were: total length, length from the focus, maximum width, and the distance from the focus to each of the growth rings (designated L_1, L_2 and L_3 corresponding to the first, second and third rings respectively). The annual mean values from the pooled data of the various parameters are compared by pairing the different centres among themselves, and using the Student's t-test. Table 2 shows the final results of this paired comparison of the different characters among centres. It will be noticed from this table that : (1) L_1 shows statistically significant difference while L_3 shows no difference at all in this sense among the different centres; (2) the difference in the L_2 values are also without statistical significance

TABLE 2. *Final results of paired comparison by student's t-test, of the scale parameters of the Malabar sole from different centres.*

Centres compared	Calicut Cannanore	Calicut Mangalore	Calicut Malpe	Cannanore Mangalore	Cannanore Malpe	Malpe Mangalore
Scale Length from focus	NS	S	S	NS	S	NS
Width of Scales:	SS	SS	NS	S	NS	NS
L_1 :	SS	SS	SS	S	SS	SS
L_2 :	NS	NS	SS	NS	SS	S
L_3 :	NS	NS	NS	NS	NS	NS

Explanations to abbreviations (used in different tables): L_1 = Distance from focus to first ring; L_2 = Distance from focus to 2nd ring; L_3 = Distance from focus to third ring; NS=Non-significant (P more than 5%); SS = highly significant (P less than 1%); S = significant only at 5% (P less than 5%) HL (i) = Head length to opercular angle; HL(ii) = Maximum Head length; TL = Total Length; SL = Standard length; MD = Maximum Depth; ED = Eye diameter; IOW = Inter-orbital width; Le.Am = Left Eye to angle of mouth; Am.Snt = Angle of mouth from end of Snout; Rh.Snt = Rostral hook from end of snout; Snt.L = Snout length; d.f. = degrees of freedom; Ht = Height; Sxy = Sum of xy; Sx^2 = Sum of x^2; Sy^2 = Sum of y^2; b = Regression co-efficient; L.l = Lateral line; L.tr. = Transverse rows of scales between Lateral lines.

except between Malpe and Calicut, there being however only one sample from Malpe while the largest number of 15 samples were represented at Calicut.

While the scale length from the focus as a character for comparison has not shown statistically signficant results in the various paired combinations, the width of the scales has shown a significant difference between Calicut and Cannanore, and also between Calicut and Mangalore, this being similar to the significant difference in the L_1 measurement itself, there being a relation between the two criteria in the growth pattern.

It may be concluded on the scale characters taken together, that the stock of the Malabar sole in the area was quite homogeneous. But the similar examination and comparison of the same parameters as between the premonsoon and postmonsoon pooled data of the region as a whole showed as expected, fully significant results at the 1% level of probability (the 5% level being ignored here in view of the known variability of the scale ring character for the purpose).

Sex proportions and maturity trends

Samples were examined from four northern centres *viz*. Malpe to Calicut inclusive, for the period February 1980 to January 1981, and two additional samples collected from Cochin Harbour in January 1982 were also studied separately, the latter samples resembling Calicut fish of January 1981 in general maturity trends of the females (and in size distribution). Only early immature and advanced spent and spent-recovering stages occurred in the Cochin samples, the intermediate stages from III to VI of maturity were completely unrepresented. In the pooled data of the other centres no immature juveniles in stage I occurred in the first and second quarters of the year while they were dominant in the fourth quarter. The occurrence

of latter indicated that the main spawning had taken place by the end of the third quarter and early in the fourth quarter in the entire area. Spawning and post-spawning stages (VI and recovering II) were completely absent in the second quarter but present in the first and fourth quarters; while stage VI was more frequent in the fourth quarter, stage II (the recovering spent) was more frequent in the first quarter.

Sex ratios were studied by X^2-distribution method for the monthly totals and for the overall totals for the four centres separately as well as pooled. Only samples of Cannanore showed an uneven and statistically significant difference in the numbers of the two sexes (in May 1980). High disparities in the numbers of the two sexes have been noticed in the past but on rare occasions *e.g.* during the spawning period (Seshappa and Bhimachar 1955). But for all the other centres and their totals together there was no peculiarity indicating stock differences, though the Cochin samples did show somewhat notable disparity in the numbers of the two sexes. The general biological picture, omitting such rare occurrences, has been one of a population constituted by a single stock or species along the coast.

Comparison of the meristic characters

All 29 samples (including the two from Cochin) were utilised for the data on meristic character comparisons. The characters selected were the numbers of dorsal finrays, anal finrays, caudal finrays, cephalic lateral line scales, post-cephalic lateral line scales, and the transverse rows of scales between the dorsal and mediolateral lines on the eyed side of the fish. Comparisons of the mean values of the numbers for pairs of centres were again made by the Student's t-test (Snedecor and Cochran, 1968). Table 3 shows in summary the final results of the t-test comparisons of these different characters.

TABLE 3. *Final results of paired comparisons of meristic counts in* C. semifasciatus *from different centres* (Pooled data)

Centres	Dorsal finrays	Anal finrays	Caudal finrays	Cephalic L1.Scale	Postcepahlic L1. Scales	L.tr.	Total of NS results
Cochin & Calicut	SS	S	NS	SS	SS	S	4
Cochin & Cannanore	SS	S	NS	NS	SS	SS	3
Cochin & Mangalore	SS	S	NS	S	SS	SS	3
Cochin & Malpe	SS	S	NS	NS	SS	SS	3
Calicut & Cannanore	S	NS	NS	NS	SS	SS	3
Calicut & Mangalore	SS	NS	NS	NS	NS	SS	4
Calicut & Malpe:	SS	NS	NS	NS	NS	SS	4
Cannanore & Mangalore	SS	NS	NS	NS	NS	NS	3
Cannanore & Malpe	SS	NS	NS	NS	NS	S	5
Mangalore & Malpe:	S	NS	S	NS	NS	NS	3

(For expansions of abbreviations see table 2)

A study of these characters has disclosed the following features:- (1) the dorsal finrays show significant differences (SS) in all except two comparisons *viz.* between Calicut and Cannanore, and between Malpe and Mangalore; (2) the anal finrays show non-significant differences in all comparisons at the 5% level of P (these being however significant at 1% level between Cochin and other centres in all the counts); (3) the caudal finrays and the cephalic scales of the mediolateral line show non-significant differences in all the comparisons except between Malpe and Mangalore for caudal finrays, and between Mangalore and Cochin for the cephalic lateral line scales; (4) highly significant differences were noticed in the post-cephalic lateral line scales in six of the ten comparisons (*viz.* between Calicut and Mangalore, Calicut and Malpe, Cannanore and Malpe, Mangalore and Malpe) (5) the transverse rows of scales on the eyed

side (L.tr.) between the two lateral lines showed highly significant differences in five out of ten comparisons at the 1% P while they showed significance at the 5% level in three comparisons and were clearly non-significant in the remaining two comparisons *viz.* between Malpe and Mangalore, and Cannanore and Mangalore.

ANALYSIS OF MORPHOMETRIC DATA

(a) Comparison of ratios of selected morphometric measurements:

While advanced statistical techniques are currently in vogue in many studies involving fish populations, in routine taxonomy, workers have to still depend largely on meristic counts and ratios and proportions of different body parts to one another. Hence in the present work both the ratio-comparisons, and direct regression estimations and their evaluations have been

tried to get a comparative picture of the fish under study by both methods. The following were the ratios studied for morphometry:- (1) Total length/head length (i & ii), (2) Standard length/head length (3) Total length/height of body, (4) Standard length/height of body, (5) Total length/Standard length. (6) Head length (i & ii)/height of body, (7) Head length (i & ii)/snout/eye diameter, (9) Head length (i & ii)/eye diameter and (10) Eye diameter/Interorbital width.

Results of paired t-tests:

In the intermonthly comparisons at Mangalore five of the fifteen ratios compared had non-significant results (or nearly so) while all the remaining ratios showed highly significant differences. In Calicut while snout length/eye diameter showed non-significant result the remaining 14 ratios differed significantly. At Cannanore all the ratios varied

In the between-centres comparisons (Table 6), Calicut and Cannanore differed highly significantly in $TL/HL_{(ii)}$, $HL_{(i)}$/Snout length, and $HL_{(i)}$/Eye diameter; other ratios such as TL/height, SL/height, Snout length/Eye diameter and Eye diameter/Interorbital width showed non-significant values. Between Calicut and Mangalore, the ratios TL/HL (i & ii), SL/HL (i & ii), HL (i & ii)/height were all different with high statistical significance; the difference in TL/height, TL/SL, SL/height and HL(i)/Snout length were clearly non-significant; the remaining two ratios differed significantly only at the 5% level of P. Between Calicut and Malpe SL/HL(i), SL/height, HL(i)/height and HL(i),/Eye diameter differed only non-significantly, TL/HL(i), SL/HL(ii) and Snout/Eye diameter showed significance at 5% level only, while the remaining four ratios showed highly significant differences.

Between Cannanore and Mangalore HL(i)/height, HL(i)/Snout, HL(i)/ED and

TABLE 4. *Abstract of results of regression comparisons among selected morphometric ratios by co-variance analysis (Pooled data)*

Regressions compared	Value of regression coefficient (b)	Significance
SL with TL	1.1205	NS
SL with HL(i)	0.2362	NS
SL with HL(ii)	0.2658	NS
SL with MD	0.2554	SS
SL with ED	0.0186	NS
SL with IOW	0.0141	NS
SL with Le.AM.	0.0151	SS
SL with Rh.Snt	0.0430	SS
SL with Am.Snt	0.01119	SS
SL with Snt.L	0.0685	NS

(For expansions of abbreviations, see table 2)

significantly among months, four of them at 5% level of *P* and all the rest at 1% level.

ED/IOW showed highly significant differences while TL/HL(i), SL/HL (ii) and Snout Length

/ED showed results significant at the 5% level of *P* only, and the other ratios were statistically non-significant, these including TL/height, SL/height and TL/SL ratios. Between Cannanore and Malpe height ratios showed non-significant results while HL(i)/ED gave a highly significant result and the remaining ratios differed at a *P* level of 5% only. Between Mangalore and Malpe only the HL(i) snout length and ED/IOW ratios had significant differences (at 5% P) while all the other ratios had their differences at the statistically non-significant level only.

The Co-variance analysis has thus indicated that none of the inter-centre alignments noticed from trends of the F-values are of such a high degree as to indicate anything more than merely minor variations of systematic, taxonomic or even biological significance. It is therefore concluded that the Malabar sole (*C.semifasciatus*) studied from the samples of the five centres was more or less homogeneous on the basis of the statistical analysis of the morphometric characters chosen.

TABLE 5. *Co-variance analysis of Length-weight regressions in C.semifasciatus from samples of January 1981 (Cochin) and January 1982 (Calicut)*

Statistics		Sources of Variations				Deviations from regression		
	df	Sx^2	Sxy	Sy^2	b	df	SS	MSS
Within:								
1. Cochin	129	0.58431	1.76156	5.51614	3.0164	128	0.205443	0.001605
2. Calicut	769	4.5955	13.62160	13.1340	2.9641	768	2.757983	0.003591
3. Total of deviations from regresssions:						896	2.963426	0.003307
4. Pooled,W.	898	5.17981	15.38316	48.65014	2.9698	897	2.964756	0.003305
5. Difference between slopes :						1	0.001330	F : NS

(Note : SS = Sum of Squares. MSS = Mean sum of Squares)

(b) Direct comparison of regressions among the measurements:

Table 4 shows the final results of regression comparisons by Co-variance analysis from pooled data of all centres sampled in this work. Only ten important regressions were chosen for this study (in place of the 15 ratios considered in the previous section) as shown in the above table. Six out of the ten regressions showed clearly non-significant results, these being SL/TL, SL/HL(i), SL/HL(ii), SL/ED, SL/IOW and SL/Snt.L; the remaining four regressions (viz. SL/MD, SL/le.Am., and SL/Rh.Snt, and SL/Am, Snt. showed highly significant (SS) results. The SL/TL differences were highly non-significant with almost equal *b*-values for Mangalore and Malpe and equal or closely placed values for the other three centres.

STUDIES ON LENGTH-WEIGHT RELATIONSHIPS

The earlier studies of the four centres showed that the length-weight relationship did not differ significantly among the centres, this being the case in the results of both comparisons of regressions by t-test, and the Co-variance analysis.

The regression coefficients and equations of the length-weight relationship of the Malabar sole were as follows at the different centres on the basis of pooled data over the entire period of the work: *b* is the coefficient of regression in the equations:

(a) *Malpe*: Y = -2.5708 + 3.2247 or W = $0.002687L^{3.2247}$; *b* = 3.2247

(b) Mangalore: Y = -2.4491 + 3.1361 X or W = 0.003555L$^{3.1361}$ B = 3.1361

(c) Cannanore : Y = -2.2531 + 2.9348 X or W = 0.005088L$^{2.9348}$ b = 2.9348

(e) Cochin : Y = -2.3658 + 3.0164 X or W = 0.004307L$^{3.0164}$ B = 3.0164

The results of the studies on the length-weight relationship at Cochin (Tables 5

TABLE 6. *Summary results of t-test comparisons of morphometric ratios between pairs of centres*

Centres	Cannanore & Calicut	Mangalore & Calicut	Malpe & Calicut	Cannanore & Mangalore	Malpe & Cannanore	Mangalore & Malpe
1. TL/HL (i)	S	SS	S	S	NS	NS
2. TL/HL (ii):	SS	SS	SS	S	S	NS
3. SL/HL (i):	S	SS	NS	S	NS	NS
4. SL/HL (ii):	S	SS	S	S	NS	NS
5. TL/Ht:	NS	NS	SS	NS	NS	NS
6. SL/Ht:	NS	NS	NS	NS	NS	NS
7. TL/SL:	S	NS	SS	NS	S	NS
8. HL (i)/Ht:	S	SS	SS	SS	NS	NS
9. HL (i)/Snt:	SS	NS	SS	SS	NS	NS
10. Snt/ED:	NS	S	S	S	S	NS
11. HL(i)/ED:	SS	S	NS	SS	SS	NS
12. ED/IOW:	NS	SS	NS	SS	NS	S
Total SS:	3	6	4	4	1	0
Total S+NS:	9(=75%)	6(=50%)	8(=66.67%)	8(=66.67%)	11(=92.5%)	12(=100%)

(For expansions of abbreviations, see Table. 2)

TABLE 7. *Co-variance analysis comparing Length-weight regressions between Cochin (Pooled data) and the other four centres (Pooled)*

Statistics	Sources of variation					Deviations from regression		
	df	Sx^2	Sxy	Sy^2	b	df	SS	MSS
Within:								
1. Cochin	129	0.58431	1.76156	5.51614	3.0164	128	0.205443	0.001605
2. Other Centres	1360	6.35610	18.8649	60.9180	2.9670	1359	4.926991	0.003625
3. Total deviations from regressions:						1487	5.132434	0.003452
4. Pooled. W. :	1489	6.94041	20.6646	66.43414	2.9719	1488	5.133604	0.003450
5. Difference between slopes :						1	0.00170	F:NS

(d) Calicut: Y = -2.2345 + 2.9641 X or W = 0.0058277L$^{2.9641}$ b = 2.9641

and 7) also falls in line with the other centres indicating no statistically significant difference

between Cochin and Calicut and other four centres in the regressions obtained from the pooled data. Thus the length-weight relationship studies also do not reveal any heterogeneity of a significant nature in the populations of the species along the coast.

CONCLUSION

Based on the results obtained from examination of different criteria *viz.* Length-frequency trends, sex and maturation studies, comparison of meristic characters, t-test comparision and regression analysis of selected morphometric ratios and characters, scalimetric work and also length-weight relationships, it is concluded that the stock of *C. semifasciatus* (the Malabar sole) of the west coast is a homogeneous one inspite of the fact that the fishery is abundant only in some places along the coast and not uniformly distributed at all centres. This is also inspite of the fact that the species is demersal in habit. Internal morphology (e.g. skeleton) could not be examined in this work.

REFERENCES

BAILEY N. T. J. 1965. *Statistical methods in Biology* vi + 200 pp. English Language Book Society and the English Universities Press Ltd., Great Britain.

CHAKRAPANI B. K. AND G. SESHAPPA 1982. A morphometric comparison of the Malabar sole *Cynoglossus semifasciatus* Day from different centres of the west coast of India. *J. Mar. biol. Ass. India.*, 24, (1 & 2), pp 72-79 (1987).

SESHAPPA, G. 1964: Length-Frequency studies on the Malabar sole *Cynoglossus semifasciatus Day* at West Hill, Calicut during the years 1959-60 to 1962-63. *Indian J. Fish.* 11 : (2), pp. 533-546.

————, 1968. *Flat fish Resources of the seas around* India. *Proc. Symp. Living Resources of the seas around India.* Special publication, CMFRI, Cochin, pp. 470-482.

————, 1970. Some morphometric studies on five species of *Cynoglossus* (Family Cynoglossidae, Order Heterosomata) from the west coast. *Indian J. Fish.*, 17 : pp. 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), pp. 160-173.

————, 1978. Some observations on the size-distribution and the occurrence of growth rings in the scales of three species of *Cynoglossus* at Calicut. *Ibid.*, 25 : (1 & 2) pp. 188-196.

———— AND R. S. BHIMACHAR 1951: Age determination studies in fishes by means of scales with special reference to the Malabar sole *Cynoglossus semifasciatus* Day. *Curr. Sci.*, 20 : pp. 260-262.

———— AND ————, 1953. Studies on the age and growth of the Malabar sole *Cynoglossus semifasciatus* Day *Indian. J.Fish.*, 1 : (1) pp. 145-162.

———— AND ———— 1955. Studies on the fishery and biology of the Malabar sole *Cynoglossus semifasciatus* Day. *Ibid.*, 2 : pp. 180-230.

———— AND B. K. CHAKRAPANI 1982a: Length-frequency distribution in *Cynoglossus Semifasciatus* Day from different centres of the west coast during 1980-81. *Ibid.*, 30 : (1) pp. 74-86.

———— AND ———— 1982.b Raciation studies in the Malabar sole (*Cynoglossus semifasciatus*) by morphometric, meristic and scale studies, *Project report of the Emeritus Scientist* submitted to ICAR. ii + 16 pp + 20 figs and 24 tables (1-9-1982) Mimeo.

———— AND ———— 1984a. A scalimetric comparison of the Malabar sole *Cynoglossus semifasciatus* Day from different parts of the west coast. *Indian J. fish.*, 31 : (1), pp. 82-89.

———— AND ———— 1984b. Comparison of the meristic characters of the Malabar sole *Cynoglossus semifasciatus* Day from the west coast of India. *J. Mar. biol. Ass. India*, 26 : (1 & 2), pp 125-131.

———— AND ———— 1987. On the sex proportions and maturity trends in *Cynoglossus semifasciatus* Day on the west coast of India during 1980-81. *J. Bombay Nat. Hist. Soc.*, 84 : (3), December 1987, pp. 620-627.

———— AND ————, 1991. The Length-weight relationship in the Malabar sole *Cynoglossus Semifasciatus* Day from the Malabar and South Kanara coasts of India. *Proc. 78th session. Indian Sci. Congr. Assn. Part III.* (Ab. p. 79).

SNEDECOR G. W. AND W. G. COCHRAN 1968. *Statistical Methods:* Oxford and IBH Publ.Co., 593 pp.