

A MORPHOMETRIC STUDY OF *SARDINELLA LONGICEPS* (CUV & VAL) AND *SARDINELLA FIMBRIATA* FROM THE GOA REGION

MARIA R. MENEZES

National Institute of Oceanography, Dona Paula - Goa 403 004

ABSTRACT

The metric and meristic characters of *S. longiceps* and *S. fimbriata* from the Goa region collected from December 1974 to February 1975 have been studied, and the results obtained have been compared with those of the earlier workers. The deviations found in the local populations in both the species are so distinctive that they may be regarded as comprising of separate subgroups.

INTRODUCTION

The sardines, *Sardinella longiceps* and *Sardinella fimbriata*, (family Clupeidae) are widely distributed fishes. *S. longiceps* occurs along the coasts of Somalia, Arabia, Kenya, Seychelles, Iran, Gulf of Aden, Muscat, Karachi, Gulf of Oman, Indian peninsula, Ceylon, Malayan Archipelago, around the Indonesian and Philippine waters as well as off Vietnam (Rosa and Laevastu, 1960; Whitehead, 1965, Devanesan and Chidambaram, 1943; Day 1878; Deraniyagala, 1929; Munro, 1955; and Nair, 1973) *S. fimbriata* is found in the Red sea, Indian Ocean to the Malay Archipelago, coasts of Philippines and China (Day, 1878; Munro, 1955; Nair, 1973). On the west coast of India the fishery of *S. longiceps* commences after the south west monsoon and large quantities of oil sardines are caught by

the Rampani and other types of shore seines and gill nets from October to March (Kamasastri, Prabhu and Rao, 1965). *S. longiceps* is reported to appear earlier in the southern region and move slowly northwards, their disappearance following a reverse pattern (Panikkar, 1952; Chidambaram, 1950; Nair, 1953). *S. fimbriata* occurs almost throughout the year, but its intensive fishery lasts from March-April and November-December along the west coast.

The following are some of the synonyms:

Sardinella longiceps Cuv & Val, 1847; Regan, 1917; Fowler, 1941; Here, 1953; *S. neohowii* Cuv & Val, 1847; Day, 1865; *Alausa scombrina* Cuv & Val, 1847; *Clupea longiceps* Gunther, 1868; *C. (Harengula) longiceps* Weber and Beaufort, 1913.

Sardinella fimbriata (Cuv & Val, Syn. *Spratella fimbriata* Cuv & Val, 1847; *Clupea fimbriata* Day, 1878; 1889; *C* (Harengula) *fimbriata* Weber and Beaufort, 1913. *Sardinella fimbriata* Regan, 1917; Fowler, 1914; Here, 1953.

MATERIAL AND METHODS

Samples of both the species were collected during the months of December, January and February 1975 from the Panjim fish landing centres. The fishes were preserved in 10% formalin and studied as soon as they were brought to the laboratory.

LENGTH FREQUENCY DISTRIBUTION

The length frequency of the total 110 fishes for each species has been plotted (Figs 1 and 2). Age and growth were determined largely from the length frequency distribution with a few observations on the growth checks from scales and otoliths (Balan, 1959; 1968; Nair, 1949). In *S. longiceps*, the length of the specimens collected ranged from 12.5 to 18.5 cm with two modes at 13.5 cm and 18.0 cm. These appear to represent two year classes. The younger group consisted mainly of juveniles ranging from 12.5 to 15.5 cm. The lengths in the older group ranged from 16.5 to 18.5 cm. Hornell and Nayudu (1924) estimated a growth of 125 to 140 mm in 6 months and 155 to 170 mm for one year when the fish first attain maturity, and a growth of 190 mm at the end of second year of life. Chidambaram (1950), on the other hand, inferred a growth of 100 mm at the end of the first year, 145 mm at the end of the second year and 183 mm at the end of the third year. Reanalysing

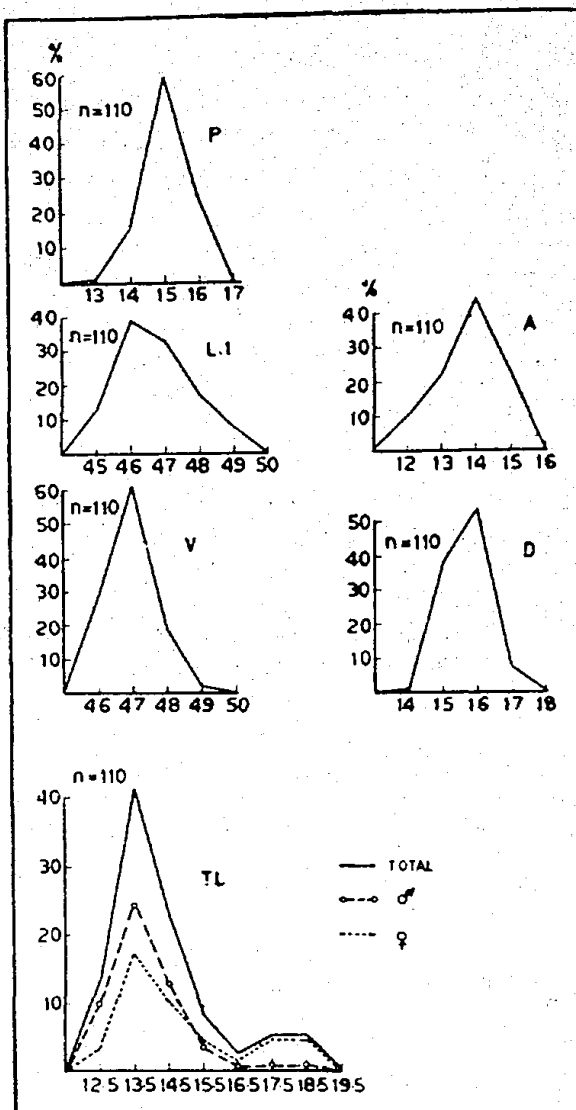


Fig. 1. *Sardinella longiceps* Frequency polygons for number of Petoral (P), Lateral line scales (L.1), Vertebrae (V), Total length (TL), Dorsal (D), and Anal (A) fin rays.

some of the published data of the earlier workers, Antony Raja (1969) estimated from his own data that the fish reaches a length of about 150-160 mm at the end of the first year when first maturity is attained and around 180 to 195 mm in length at the end of the second year of life. In the present

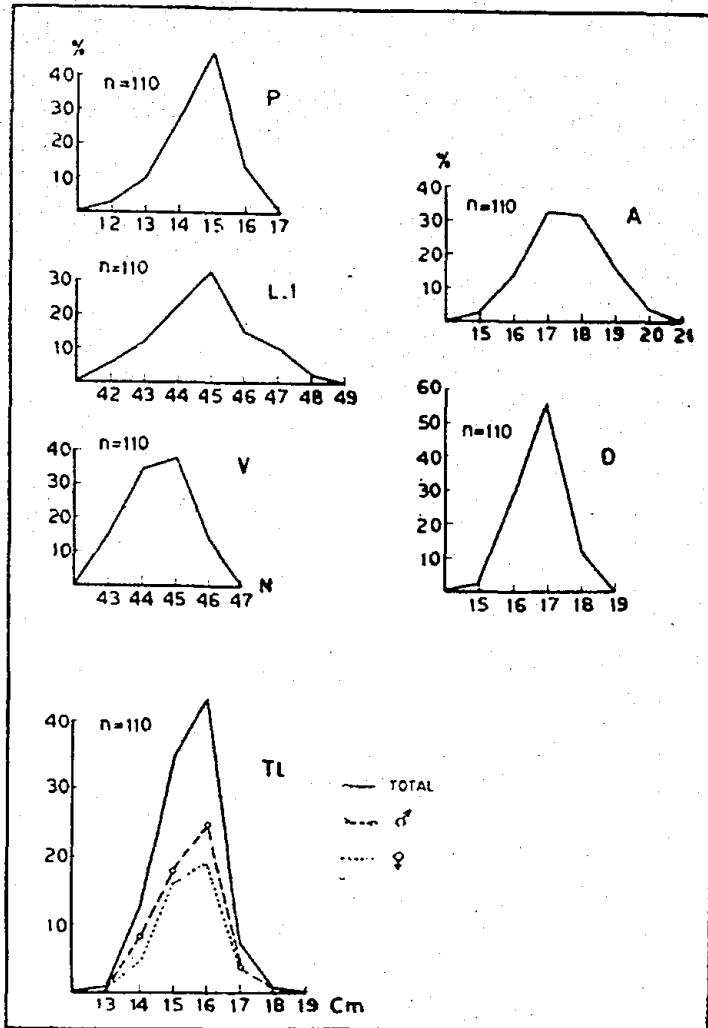


Fig. 2 *Sardiniella fimbriata* Frequency polygons for number of Pectoral (P), Lateral line scales (L. 1), Vertebrae (V), Total length (TL), Dorsal (D), and Anal (A) fin rays.

investigation also similar sizes were observed at the end of the 1st and 2nd years. The life span of *S. longiceps* is inferred to be 2½ years (Hornell and Nayudu, 1924; Antony Raja, 1964; Nair, 1949; Balan, 1959), and 4 years (Nair, 1953). However it is felt that these longevity indices need confirmation (Qasim, 1973).

In *S. fimbriata* the length of the specimens collected ranged from 13.0 to 18.0 cm with a single mode at 16.0 cm,

representing a single year class. According to Chidambaram and Venkataraman (1946), *S. fimbriata* attains a size of 15 cm at first maturity along the west coast. Chacko (1956) stated that the sardines attain maturity at 12 cm. According to Radhakrishnan (1968), sardines mature for the first time when they reach a size of 14 cm.

In the present investigation *S. fimbriata* were found to be mature in the 13 to 18 cm size group.

Sex-ratio

In all, 110 fishes of each species were sexed during the course of this investigation. In *S. longiceps*, the males were found to be relatively more abundant among the immature group ranging from 12.5 to 15.0 cm. But in the mature category, ranging from 15.5 to 19.5 cm, the females outnumbered the males. In the overall population the sex ratio of females to males was almost 1:1. In *S. fimbriata* also the males were relatively more abundant in the smaller size groups. The sex-

ratio of females to males in the overall population was 1 : 1.2.

MORPHOLOGICAL CHARACTERS

Amongst the metric characters, standard length, head length, diameter of eyes, depth of body, peduncle depth and snout length were studied for both the species. The linear measurements have been expressed as indices with reference to total length (Figs 3 and 4). The index for diameter of the eyes has been given with reference to head length (Kesteven, 1950).

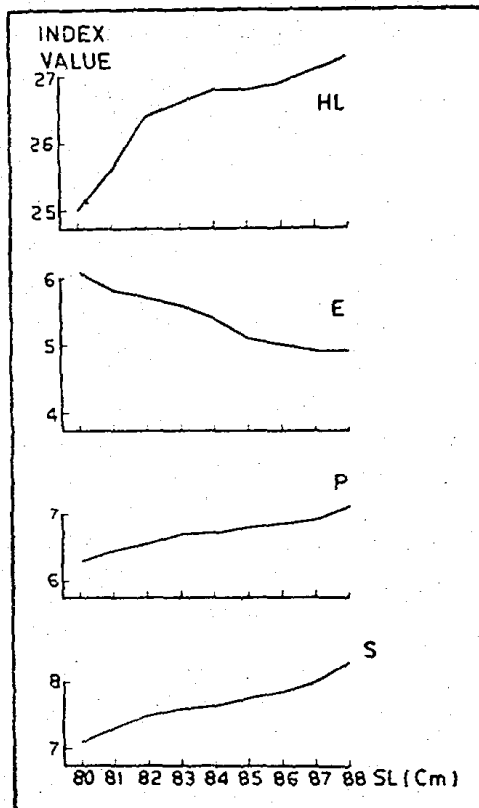


Fig. 3. *Sardinella longiceps* Index value for head length (HL), diameter of eyes (E), peduncle depth (P) and snout length (S) in relation to standard length (SL).

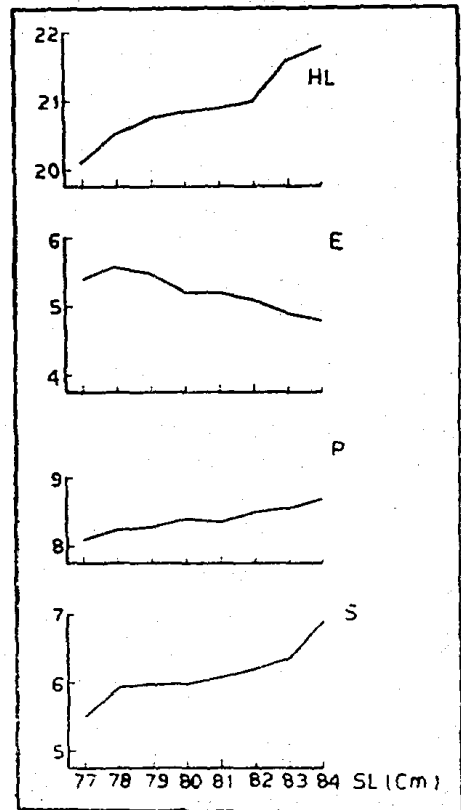


Fig. 4. *Sardinella fimbriata* Index value for head length (HL), Peduncle depth (P), snout length (S), and diameter of eyes (E) in relation to standard length (SL).

Maria Menezes: Morphometric Study of Sardines

The regression of the head length and depth of the body on the total length of the fish has been compared for both the species. Since multiple regression analysis is a more rigorous method of examination of data for detecting the homogeneity of the population, it was considered desirable to treat the data accordingly. According to Kestevan (1950) this method can be used in racial studies.

The regression equation used was,
 $Y = mx + b$

where 'x' is the value relating to individual fish and 'm' and 'b' are constants.

In *S. longiceps*, the length of the head ($b=0.002$) was found to grow faster than the depth of the body ($b=-1.38$). Thus the older specimens look comparatively longer than the younger ones (Fig. 5). In *S. fimbriata* the depth of the body was found to grow faster than the head length, which makes the older specimens look comparatively broader than the younger ones. (Fig. 6)

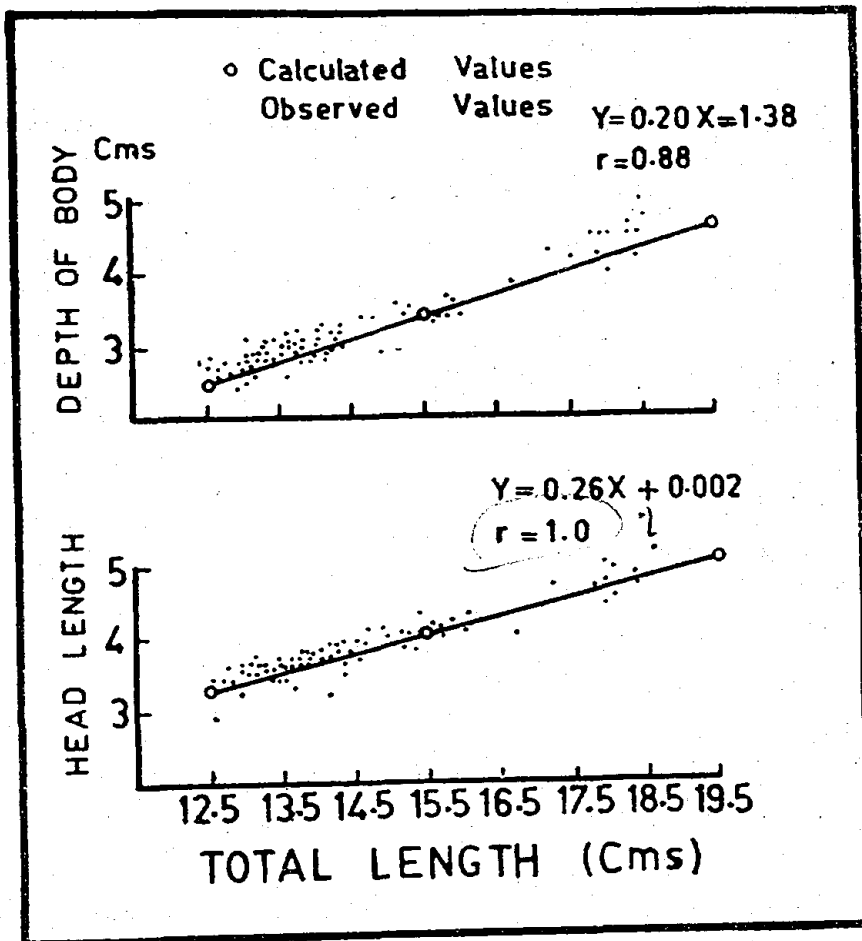


Fig. 5. *Sardinella longiceps* Regression of head length and depth of body on total length.

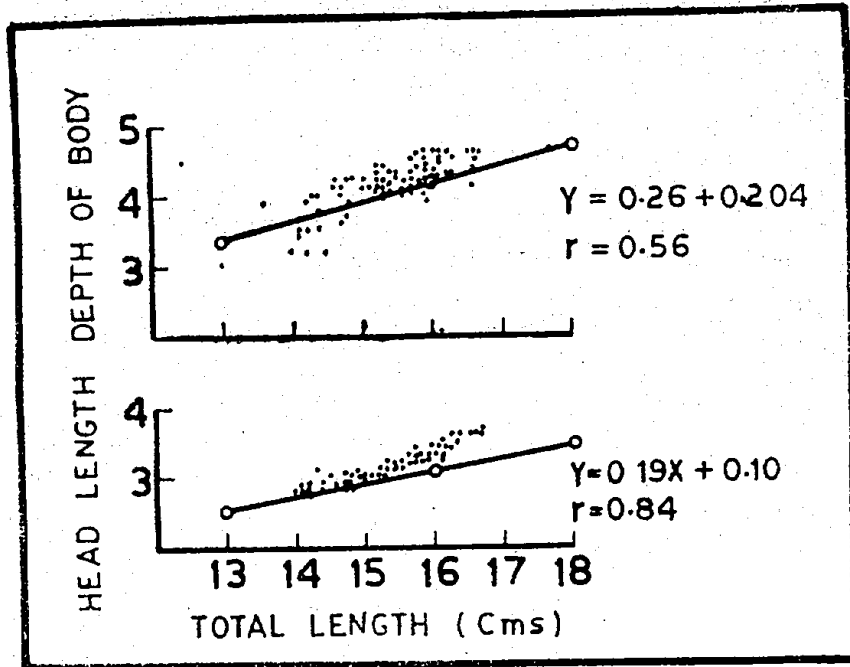


Fig. 6. *Sardinella fimbriata* Regression of head length and depth of body on total length.

Colouration

In *S. longiceps*, the back is greenish brown with golden hue. Fins mostly pale, the tips of the caudal are blackish. On the upper margin of the opercle there is a greenish gold spot.

In *S. fimbriata*, the back is bluish green. Dorsal fin with numerous fine black dots, and a black mark at the

base of its anterior rays. The caudal is tipped black.

MERISTIC CHARACTERS

Amongst the meristic characters, the number of lateral line scales, vertebrae, and fin rays of dorsal, anal, pectoral and ventral fins have been studied for both the species. Their mean values and variation are given Tables I & II. The number of specimens studied for both the species were 110.

TABLE I. *S. longiceps* Variation of meristic characters.

Characters	Range	Mode	Mean + Standard error	Coefficient of variation
Vertebrae	46—49	47	46.95 ± 0.137	1.54
Lateral line scales	45—49	46	46.70 ± 0.225	2.54
Fin rays dorsal	14—17	16	15.67 ± 0.116	3.8
Anal	12—15	14	13.80 ± 0.188	7.17
Pectoral	13—16	15	15.63 ± 0.135	4.55

Maria Menezes: *Morphometric Study of Sardines*

TABLE II. *S. fimbriata* Variation of meristic characters.

Characters	Range	Mode	Mean + Standard error	Coefficient of variation
Vertebrae	43—46	45	44.47 ± 0.171	2.02
Lateral line scales	42—48	45	45.40 ± 0.28	3.30
Fin rays dorsal	15—18	17	16.77 ± 0.108	3.39
Anal	15—20	17	17.54 ± 0.190	5.70
Pectoral	12—16	15	14.57 ± 0.176	6.36

The data for males and females were first compared for both the species (Tables III - VII & IX - XIII and there was no significant difference between them (Tables VIII & XIV).

TABLE III. Frequency distribution of vertebrae in *S. longiceps*

Vertebrae	46	47	48	49	Total
Male	17	32	10	—	59
Female	11	29	9	2	51
Combined	28	61	19	2	110

TABLE IV. Frequency distribution of lateral line scales in *S. longiceps*

Lateral line scales	45	46	47	48	49	Total
Male	6	22	20	7	4	59
Female	7	17	13	10	4	51
Combined	13	39	33	17	8	110

TABLE V. Frequency distribution of dorsal fin rays in *S. longiceps*

Dorsal fin rays	14	15	16	17	Total
Male	1	22	32	4	59
Female	—	20	27	4	51
Combined	1	42	59	8	110

TABLE VI. Frequency distribution of anal fin rays in *S. longiceps*

Anal fin rays	14	15	16	17	Total
Male	1	22	32	4	59
Female	—	20	27	4	51
Combined	1	42	59	8	110

TABLE VII. Frequency distribution of pectoral fin rays in *S. longiceps*

Pectoral fin rays	13	14	15	16	Total
Male	1	10	36	12	59
Female	—	7	30	14	51
Combined	1	17	66	26	110

TABLE VIII. *S. longiceps* comparison of vertebrae, lateral line scales, dorsal, anal, and pectoral fin rays of males and females.

	Vertebrae	Lateral line scales	Dorsal	Anal	Pectoral
Males N	59	59	59	59	59
Range	46-48	45-49	14-17	12-15	13-16
Mean	47.03	46.67	15.66	13.79	15.0
S. E.	0.178	0.262	0.165	0.234	0.173
Females N	51	51	51	51	51
Range	46-49	45-49	15-17	12-15	14-16
Mean	47.03	46.86	15.69	13.80	15.13
S. E.	0.209	0.328	0.172	0.260	0.178

TABLE IX. Frequency distribution of vertebrae in *S. fimbriata*

Vertebrae	43	44	45	46	Total
Male	11	18	22	10	61
Female	6	20	19	4	49
Combined	17	38	41	14	110

TABLE X. Frequency distribution of lateral line scales in *S. fimbriata*

Lateral line scales	42	43	44	45	46	47	48	Total
Male	4	9	12	18	10	8	—	61
Female	2	4	13	18	6	3	3	49
Combined	6	13	25	36	16	11	3	110

Maria Menezes: Morphometric Study of Sardines

TABLE XI. Frequency distribution of dorsal fin rays in *S. fimbriata*

Dorsal fin rays	15	16	17	18	Total
Male	1	18	37	5	61
Female	2	14	25	8	49
Combined	3	32	62	13	110

TABLE XII. Frequency distribution of anal fin rays in *S. fimbriata*

Anal fin rays	15	16	17	18	19	20	Total
Male	1	7	22	19	9	3	61
Female	2	8	14	16	8	1	49
Combined	3	15	36	35	17	4	110

TABLE XIII. Frequency distribution of pectoral fin rays in *S. fimbriata*

Pectoral fin rays	12	13	14	15	16	Total
Male	2	7	18	30	4	61
Female	1	4	12	22	10	49
Combined	3	11	30	52	14	110

TABLE XIV. *S. fimbriata* comparison of vertebrae, lateral line scales, dorsal, anal, and pectoral finrays of males and females.

	Vertebrae	Lateral line scales	Dorsal	Anal	Pectoral
Males N	61	61	61	61	61
Range	43-46	42-47	15-18	15-20	12-16
Mean	44.5	44.73	16.75	17.6	14.44
S. E.	0.248	0.368	0.181	0.264	0.209
Females N	49	49	49	49	49
Range	43-46	42-48	15-18	15-20	12-16
Mean	44.44	44.87	16.79	17.46	14.73
S. E.	0.229	0.386	0.214	0.319	0.268

The number of ventral fin rays for *S. longiceps* and *S. fimbriata* were 9 and 8 respectively and they did not show any variation in the specimens studied.

From the coefficient of variation in respect of several meristic characters given in Tables I & II it may be seen that in both the species, the number of vertebrae is a comparatively more stable character, the coefficient of

variation for *S. longiceps* and *S. fimbriata* being 1.54 and 2.02 respectively. This can help in characterizing the localized populations within the species if any.

Some of the morphometric and meristic characters, given by the earlier authors and those found in the present study are given in Tables XV & XVI.

TABLE XV. *S. longiceps* Morphometric and meristic characters

Authors	No.	Fin Rays				Lateral line scales	Vertebrae	Head length	Depth of body
		Dorsal	Anal	Pectoral	Ventral				
Day, 1878	—	16-17	14-16	17	9	45-48	—	—	—
Munro, 1955	—	16-17	14-15	—	—	46-47	—	—	—
Li, 1960	—	16-18	14-16	—	—	—	46-49	2.88-3.60	4.0-4.67
Chan, 1965	—	15-18	15-16	—	—	—	—	2.95-3.44	3.73-4.57
Whitehead, 1965	—	17-19	15-16	—	—	—	—	2.96-3.23	4.05-4.52
Antony Raja, 1969	200	15-17	13-16	15-16	9	45-48	43-48	2.76-3.08	3.57-4.57
Nair, 1973	—	16-18	14-16	—	9	46-48	47	3.0-3.6	4.0-4.7
Present study	110	14-17	12-15	13-16	9	45-49	46-49	2.8-3.5	3.0-4.2

Author	Snout length	Caudal peduncle depth	Diameter of eyes
Day, 1878	—	—	4.5-5.0
Munro, 1955	—	—	—
Li, 1960	3.50-3.88	3.40-4.50	5.0-6.0
Chan, 1965	3.32-3.78	—	4.12-5.22
Whitehead, 1965	3.88-4.0	—	4.44-5.0
Antony Raja, 1969	3.48-4.12	4.0-5.18	4.76-5.77
Nair, 1973	—	—	—
Present study	2.8-4.1	3.2-4.9	4.0-5.8

Maria Menezes: *Morphometric Study of Sardines*

TABLE XVI. *S. fimbriata* Morphometric and meristic characters

Authors	No.	Fin Rays				Lateral line scales	Vertebrae	Head length
		Dorsal	Anal	Pectoral	Ventral			
Day, 1878	—	18-19	19-20	15	8	45-48	—	—
Munro, 1955	—	17-20	16-19	—	—	42-45	—	—
Nair, 1973	—	18-19	18-21	—	8	45	—	4.0
Present study	110	15-18	15-20	12-16	8	42-48	43-46	3.0-4.5

Author	Depth of body	Snout length	Caudal peduncle depth	Diameter of eyes
Day, 1878	—	—	—	3.4
Munro, 1955	—	—	—	—
Nair, 1973	3.0-3.5	3.5-3.7	—	3.5-3.7
Present study	2.5-3.7	2.8-4.0	2.0-3.2	3.1-4.8

While parts of the head and caudal peduncle depth are expressed in head length, the other ratios are related to body length.

On comparing the present results with those of the earlier workers, some marked deviations in certain metric and meristic characters were noticed in both the species. Based on the present studies it may be stated that each of these two species, *S. longiceps* and *S. fimbriata*, forms a distinct homogeneous subgroup in this region.

ACKNOWLEDGEMENTS

I wish to express my sincere gratitude to Dr. S. Z. Qasim, Director of this Institute for constant encouragement and guidance while the work was in progress and also for the valuable criticism in the preparation of this paper. My sincere thanks to Dr. S. N. Dwivedi, Director C. I. F. E. for the valuable advice and keen interest. I am thankful to Mr. K. V. Rao, Scientist Emeritus, for his suggestions and scrutiny of the manuscript.

REFERENCES

- Antony Raja, B. T. 1964. Some aspects of the spawning biology of Indian oil sardine, *Sardinella longiceps* Valenciennes. *Indian J. Fish.*, 11: 45-134.
- Antony Raja, B. T. 1969. The Indian oil sardine, *Bull. cent. mar. Fish. Res. Inst.*, No. 16: 128pp.

- Balan, V. 1959. Age determination of the Indian oil sardine *Sardinella longiceps* by means of scales *Curr. Sci.*, **28**: 122-123.
- Balan, V. 1968. Studies on the age and growth of the oil sardine *Sardinella longiceps* Valenciennes by means of scales. *Indian J. Fish.*, **11**: 663-686.
- Chacko, P. I. 1956. Annual report of the Marine Biological Station, Tuticorin. *Fish. Stat. Rep. Yearb. Govt. Madras, 1954-55*: 37.
- Chan, W. L. 1965. Systematic revision of the Indo-pacific clupeid fishes of genus *Sardinella* (Fam: Clupeidae). *Jap. J. Ichthyol.*, **12**: 104-118.
- Chidambaram, K. and R. Venkataraman. 1946. *Tabular statement on the natural history of certain marine food fishes on the Madras presidency west coast.* Government press: Madras, 26pp.
- Chidambaram, K. 1950. Studies on the length frequency of oil sardine *Sardinella longiceps* Cuv. & Val. and on certain factors influencing their appearance on the Calicut coast of the Madras Presidency. *Proc. Indian Acad. Sci.*, **31 B**: 252-286.
- Day, F. 1878. *The Fishes of India.* Vol. 2, London, Taylor and Francis. 778 pp.
- Devanesan, D. W. and K. Chidambaram. 1943. On the alleged existence of races in the population of the oil sardine, *Sardinella longiceps* in the Arabian Sea. *Proc. 30th Indian Sci. Congr.*, III, 60 (abstracts).
- Deraniyagala, P. E. P. 1929. Ceylon Sardines. *Spolia Zeylanica - Ceylon Journ. Sci.*, **15**: Pt. 1. B, 31-47.
- Hornell, J. and M. R. Nayudu. 1924. A contribution to the life history of the Indian oil sardine with notes on the plankton of the Malabar coast. *Madras Fish. Bull.*, **17**: 129-197.
- Kamasastri, P. V., P. V. Prabhu and D. R. Rao. 1965. Further studies on the Indian sardine oil. *Indian J. Fish.*, (1962) **9B**: 84-90
- Kestevan, G. L. 1950. *An Examination of Certain Aspects of the Methodology and Theory of Fisheries Biology.* (Mimeo - issued by the Bingham Oceanographic Laboratory, New Haven).
- Li, Kwan-Ming. 1960. Synopsis on the biology of *Sardinella* in the tropical eastern Indo-Pacific area. Species synopsis No. 5, *Proc. World. Sci. Meeting on Biology of Sardines*, **2**: 175-212.

Maria Menezes: Morphometric Study of Sardines

- Munro, I. S. R. 1955. *The marine and fresh water fishes of Ceylon*. Dept. of External affairs, Canberra, 349pp.
- Nair, R. V. 1949. The growth rings on the otoliths of the oil sardine, *Sardinella longiceps* Cuv. and Val. *Curr. Sci.*, 18: 9-11.
- Nair, R. V. 1953. Studies on the revival of the Indian oil sardine fishery. *Proc. Indo-Pacific Fish. Coun.*, 1952. Sec. 2: 115-229.
- Nair, R. V. 1973. *Indian Sardines*. C.S.I.R. New Delhi. Zoological monograph No. 2: 107 pp.
- Panikkar, N. K. 1952. Fisheries research in India. Part I. Marine fisheries. *J. Bombay nat. Hist. Soc.*, 50: 741-765.
- Qasim, S. Z. 1973. Some implications of the problem of age and growth in marine fishes from the Indian waters. *Indian J. Fish.*, 20 (2) 351-371.
- Radhakrishnan, N. 1968. Oil sardine investigations at Karwar. *Adv. Abst. Cont. Fish. Aquat. Sci. India*, 2 (2): 4-5.
- Rosa, Jr. H. and T. Laevastu. 1960. Comparison of biological and ecological characteristics of sardines and related species - A preliminary study. Subject synopsis No. 1, *Proc. World Sci. Meeting on Biology of Sardines.*, 2: 523-552.
- Whitehead, P. J. P. 1965. A review of the elopoid and clupeoid fishes off the Red Sea region. *Bull. Brit. Mus. nat. Hist. (Zool.)*, 12 (7): 227-281.