ON THE JUVENILES OF *SARDINELLA FIMBRIATA* (VAL.) AND *SARDINELLA GIBBOSA* (BLKR.)

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Two species of sardines, namely, *Sardinella fimbriata* and *Sardinell gibbosa* contribute to the sardine fishery at Lawson's Bay, Waltair, extending over a period of 9-10 months (October to June or July) and the fishery is mainly supported by the juveniles of the two species, *S. fimbriata* being more abundant. Though the adults of the two species could be distinguished on the basis of their height-length ratios, the specific identification of the juveniles is difficult due to the close similarity in their external appearance. Excepting black pigmentation, all the colouration which aids to separate the two species in fresh condition,is observed to disappear after fixation and even after a few hours post-mortem. Hence a detailed study of some of the morphometric and meristic characters has been made to find out characters that could be used to distinguish the juveniles of the two species.

Dutt (1959 and 1961) has observed a difference in the mean number of vertebrae, pectoral fin rays and gill rakers, between the two species. The present study supplements the results reported by him with additional data and suggests a quicker method of distinguishing the two species on the basis of the ventral scute counts and the distribution of black chromatophores on the tongue.

MATERIAL AND METHODS

The material for this study was collected from the commercial fish landings at Lawson's Bay, Waltair, during the years 1958-1961. The following morphometric and meristic characters were used in this study.

Morphometric characters

1. *Height of the fish.*—The maximum height, at right angles to the axis of the fish, measured at the origin of the dorsal fin.

2. *Length of the head.*—The distance between the tip of the snout and the posterior edge of the operculum.

3. *Diameter of the eye.*—The horizontal diameter of the eye.

4. *Length of the snout.*—The distance between the tip of the snout and the anterior margin of the eye.

The morphometric characters were recorded as ratios between two dimensions, in other words, the number of times one dimension is contained in another. Height and head length were studied in relation to standard length* and the eye diameter and snout length in relation

*Length from the tip of the snout to the upper end of the hypural plate.

to the head length. It was observed that the ratios of various body proportions varied with the size of the fish and therefore, a comparison of ratios of these body proportions of the two species at each 10 mm. group was made.

Meristic characters

1. Number of ventral scutes.
2. Number of vertebrae.
3. Number of pectoral fin rays.
4. Number of gill rakers.

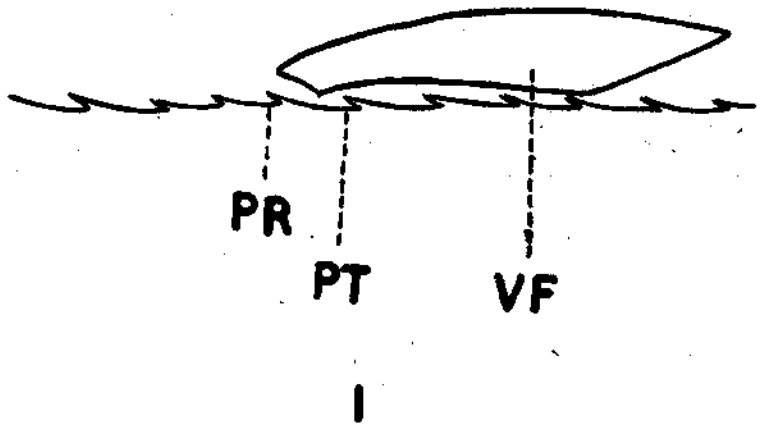

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Fig. I Ventral edge of the sardine at the region of ventral fin (VF) showing the last preventral scute (PR) and the first postventral scute (PT).

Ventral scutes.—The ventral scutes or the abdominal scutes are seen as serrations on the ventral edge of the body and the number of these serrations gives the number of scutes. The scute counts were made with a mounted needle under a binocular dissecting microscope, in the case of small fish and with the naked eye in bigger fish. The following three counts of the ventral scutes were considered in this study :

1. *Total number of scutes*
2. *Number of preventral scutes.*—This gives the number of scutes in front of the anterior origin of the ventral fin. The position of the last preventral scute is shown in fig. 1. The last two preventral scutes have been observed to be smaller than the preceding and succeeding scutes.
3. *Number of postventral scutes.*—This gives the number of scutes from the last preventral scute to the anal opening. The position of the first post ventral scute is marked in fig. 1.

Vertebrae.—In the fresh condition, the fish were boiled till the flesh became soft and it was removed from the vertebral columns. The vertebral columns were cleaned by brushing off the adhering muscle fibres and then dried before the counts were taken. When the fish were very

small or when preserved in formalin, the counts were taken after staining them with alizarin. The total number of vertebrae only was considered which included the hypural or the urostyle. Each centrum was counted as a vertebra and the counts were made under a binocular dissecting microscope.

Pectoral fin rays.—The pectoral fin on the left side of the fish was carefully removed and all the rays were counted under a binocular dissecting microscope. In very small fish, the rays were counted after staining the fin with alizarin.

TABLE I

Comparison of height/standard length ratios of S. fimbriata and S. gibbosa

10 mm. Group	*S. fimbriata*			*S. gibbosa*		
Standard length	Range	Mean Ratio	Number of fish	Range	Mean Ratio	Number of fish
50	3·69—4·33	4·08	15	3·88—4·70	4·34	18
60	3·76—4·34	4·06	34	3·72—4·69	4·15	32
70	3·74—4·28	3·99	33	3·75—4·44	3·93	23
80	3·65—4·21	3·88	55	3·73—4·24	3·97	21
90	3·45—4·13	3·78	76	3·69—4·43	4·03	33
100	3·35—4·08	3·79	90	3·67—4·12	3·91	45
110	3·32—3·96	3·62	39	3·79—4·27	3·87	22
120	3·40—3·90	3·62	41	3·75—4·46	4·06	27
130	3·14—3·80	3·46	18	3·88—4·40	4·06	9
140	3·22—3·63	3·40	51			
150	3·23—3·57	3·37	10			
			462			230

TABLE II

Comparison of head length/standard length ratios of S. fimbriata and S. gibbosa

10 mm. Group	*S. fimbriata*			*S. gibbosa*		
Standard length	Range	Mean ratio	Number of fish	Range	Mean ratio	Number of fish
50	3·38—3·93	3·68	15	3·74—4·32	3·94	18
60	3·53—4·00	3·80	34	3·81—4·40	4·01	31
70	3·64—4·05	3·85	33	3·89—4·28	3·99	21
80	3·69—4·21	3·91	56	3·81—4·19	3·94	21
90	3·80—4·21	3·96	76	3·84—4·22	4·01	33
100	3·69—4·20	3·97	90	3·82—4·24	4·05	40
110	3·90—4·21	4·05	37	3·90—4·23	4·04	22
120	3·93—4·32	4·10	41	3·84—4·25	4·02	27
130	4·03—4·26	4·17	18	3·86—4·26	4·11	9
140	4·00—4·39	4·21	38			
150	4·05—4·29	4·21	8			
			446			222

Gill rakers.—The left first gill arch along with the tongue was removed for gill raker counts throughout this study. To enable counting the smallest of gill rakers at the lower end of the arch, the gill rakers were separated from the gill arch along with a strip of tissue which keeps them connected with one another and their number counted under a binocular dissecting microscope. The gill rakers of the upper and the lower limbs of the arch were counted separately.

The number of specimens examined for various characters is given in the respective tables. The size of the specimens examined for various characters ranged from 25 mm. to 154 mm. in *S. fimbriata* and from 20 mm. to 138 mm. in *S. gibbosa*. Lengths given refer to standard length whenever any meristic or morphometric character is associated with length of the fish. It has been found that excepting gill rakers, the other meristic characters do not show any relationship with the length of the fish.

All counts and measurements were made by the author. The meristic characters of the two species have been compared by employing the t-test (Snedecor, 1956) and 0·01 probability is considered throughout.

RESULTS

Morphometric characters

1. *Height—Standard length.*—Table I shows the mean ratio values of height-standard length of *S. fimbriata* and *S. gibbosa*. The ratios are similar in both the species in fish of lower length groups and it has been found that the mean values of the two species are not significantly different upto 90 mm. length. The utility of this feature as a means of separating the two species is restricted to a very narrow range of length as it can be used to separate only fish measuring 90 mm. and above on the basis that the height of the fish is greater in *S. fimbriata* than in *S. gibbosa*. Observation of the Table I would suggest that the mean ratio of height—standard length in *S. fimbriata* decreases as the fish increases in size, in other words, allometric growth is observed in the form of disproportionate increase in height in relation to standard length, with growth, resulting in decreasing ratios. Such striking allometric growth does not seem to occur in *S. gibbosa* as indicated by the figures in Table I.

TABLE III

Comparison of eye diameter—head length ratios of S. fimbriata and S. gibbosa

Length of head 5 mm. group	*S. fimbriata*			*S. gibbosa*		
	Range	Mean ratio	Number of fish	Range	Mean ratio	Number of fish
10 . .	3·21—3·86	3·59	5	3·11—3·63	3·50	14
15 . .	3·17—4·00	3·53	65	3·00—4·00	3·57	42
20 . .	3·14—4·10	3·62	136	3·43—4·45	3·78	29
25 . .	3·38—4·25	3·83	152	3·33—4·33	3·78	50
30 . .	3·53—4·31	3·91	71	3·53—4·26	3·92	14
35 . .	3·79—4·38	3·99	23			
			452			149

TABLE IV

Comparison of snout length—head length ratios of S. fimbriata and S. gibbosa

Length of head 5 mm. group	*S. fimbriata* Range	Mean ratio	Number of fish	*S. gibbosa* Range	Mean ratio	Number of fish
5 . .	3·40—4·00	3·73	3			
10 . .	3·22—3·67	3·43	11	3·22—3·62	3·42	2
15 . .	3·08—4·00	3·51	57	3·00—3·89	3·48	34
20 . .	3·20—4·00	3·52	126	3·28—4·00	3·52	47
25 . .	3·31—4·25	3·77	146	3·17—3·86	3·28	44
30 . .	3·33—4·29	3·73	71	3·15—3·88	3·43	30
35 . .	3·60—4·00	3·78	24			
			438			157

2. *Head length—Standard length.*—As can be seen from the Table II the ratios of these body dimensions in the two species are not strikingly dissimilar as to be used as a diagnostic feature in separating them. In *S. fimbriata* contrary to the relationship between height and standard length, an increasing ratio with the growth of the fish is observed which shows that the size of the head becomes disproportionately smaller as the fish grows in size. In the case of *S. gibbosa* the proportion of the head in relation to standard length does not seem to vary much with the growth of the fish.

3. *Eye diameter—Head length.*—The ratios are similar in both the species (Table III).

4. *Snout—Head length.*—Table IV shows that the ratios in the two species are not different though the smaller mean ratio in *S. gibbosa* in large fish having a head length of 25 mm. and above, indicates that it has a longer snout than *S. fimbriata.*

A comparison of eye diameter and snout length of the respective species has shown that the snout is longer than the diameter of the eye in 75 per cent of the specimens of *S. gibbosa* examined whereas in *S. fimbriata*, only 25 per cent of the fish examined have snout slightly longer than the diameter of the eye.

TABLE V

Comparison of total scute counts of S. fimbriata and S. gibbosa

Species	Total number of scutes 29	30	31	32	33	34	35	Number of fish	Mean	SD	SE	σD*	t	Significance
S. fimbriata	1	13	298	709	8	..	..	1,029	31·69	0·5107	0·0159	0·02043	44·03	Significant
S. gibbosa	..	..	3	40	299	56	1	399	33·03	0·5296	0·0265			

TABLE VI

Comparison of preventral scute of S. fimbriata and S. gibbosa

Species	Number of preventral scutes 16	17	18	19	Number of fish	Mean	SD	SE	σD	t	Significance
S. fimbriata	1	24	985	3	1,013	17·98	0·1735	0·0054	0·01198	0·83	Not significant
S. gibbosa	..	20	366	7	393	17·97	0·2603	0·0131			

* D—Standard error of difference

The slight differences in morphometric characters between the adults of the two species are summarised as follows :

1. The height of the fish in relation to length is greater in *S. fimbriata* than in *S. gibbosa*.
2. The head is longer in *S. gibbosa* than in *S. fimbriata*.
3. The snout is longer in *S. gibbosa*.

Meristic characters

1. *Ventral scutes.*—The following are the scute counts of *S. fimbriata* and *S. gibbosa* given by various authors :

	S. fimbriata			*S. gibbosa*		
Day, 1958	(16/17)	+	(14/15)	..		
Weber & Beaufort, 1913	(18/19)	+	(15)	..		
Regan, 1917	(18-19)	+	(12-13)	(18-20)	+	(13-15)
Fowler, 1941	17	+	(12/13)	(17/18)	+	(12/13)
Smith, 1953	..			(17-19)	+	(12-14)
Munro, 1955	..			(17-19)	+	(12-14)

In this study, total number of scutes, preventral scutes and postventral scutes have been analysed separately.

Total number of scutes.—Table V gives the frequency distribution of the total scute count of *S. fimbriata* and *S. gibbosa*. The number in *S. fimbriata* ranges from 29 to 33 with a mean value of 31·69 and the number ranges from 31 to 35 in *S. gibbosa* with a mean of 33·03. About 99 percent specimens of the former species have 32 or less than 32 ventral scutes while 89 per cent of the latter have 33 or more than 33 ventral scutes, which shows that there is very little overlapping in the frequency distributions of total scute counts of the two species. A comparison of the mean number of total scute counts of the two species by a t—test shows a significant difference between the two means (t=44·03, Table V).

TABLE VII

Comparison of postventral scute counts of S. fimbriata and S. gibbosa

Species	Number of postventral scutes 12	13	14	15	16	17	Number of fish	Mean	SD	SE	σD	t	Significance
S. fimbriata	4	313	778	8	..	..	1,103	13·72	0·4746	0·0143	0·02563	53·06	Significant
S. gibbosa	..	..	37	386	77	1	501	15·08	0·4785	0·0214			

TABLE VIII

Comparison of vertebral counts of S. fimbriata and S. gibbosa

Species	Number of vertebrae 43	44	45	46	47	Number of fish	Mean	SD	SE	D	t	Significance
S. fimbriata	2	113	1499	150	1	1,765	45·02	0·3943	0·0094	0·02489	36·16	Significant
S. gibbosa	..	3	46	251	26	326	45·92	0·5021	0·0278			

Number of preventral scutes.—The preventral scute counts of the two species are shown in Table VI. The number ranges in *S. fimbriata* from 16 to 19 with a mean of 17·98 and in *S. gibbosa* it ranges between 17 and 19 with a mean of 17·97. About 99 per cent of the fish of *S. fimbriata* and 93 per cent of *S. gibbosa* studied, have 18 preventral scutes which suggests that there is not much difference in the number of preventral scutes between the two species. Comparison of the mean values shows that the difference noticed is not significant (t=0·83, Table VI).

Number of postventral scutes.—The frequency distributions of postventral scute counts are presented in Table VII. All the fish of *S. fimbriata* have between 12 and 15 postventral scute with a mean value of 13·72. The number in *S. gibbosa* ranges from 14 to 17 with a mean of 15.08. About 99 per cent of *S. fimbriata* examined have 14 or less than 14 postventral scutes whereas in *S. gibbosa* 93 per cent of fish studied have 15 or more than 15 postventral scutes showing the presence of little or no overlapping. Comparison of the two species has shown that the difference between their mean numbers is highly significant (t=53·06, Table VII).

The above analysis of pre-and postventral scutes shows that the difference between the two species in the total number of scutes is brought about by the difference in the number of postventral scutes, as the preventral scute counts are similar in both. It is therefore, sufficient if the postventral scute count alone is taken for identifying the species.

TABLE IX

Comparison of pectoral fin ray counts of S. fimbriata and S. gibbosa

Species	Number of pectoral fin rays 13	14	15	16	17	Number of fish	Mean	SD	SE	σD	t	Significance
S. fimbriata	2	46	980	797	21	1,846	15·42	0·5692	0·0132			
										0·03120	15·71	Significant
S. gibbosa	..	74	279	45	..	398	14·93	0·5426	0·0272			

Number of vertebrae.—Total vertebral counts, mean number of vertebrae and the comparison of means of the two species are given in Table VIII. *S. fimbriata* has a lower mean number of vertebrae (45·02) and *S. gibbosa* has a higher mean (45·92). Difference between the means of the two species is significant (t=36·16) which is in conformity with the observation of Dutt (1957 and 1959).

Number of pectoral fin rays.—The pectoral fin ray counts of the two species are given in Table IX. The mean number of pectoral fin rays in *S. fimbriata* (15·42) is higher than the mean number in *S. gibbosa* (14·93). A t—test has shown that the difference between the means is significant (t=15·71).

Number of gill rakers.—A total of about 1515 fish of *S. fimbriata* and 357 fish of *S. gibbosa* ranging in size from 25 to 153 mm. and 20 to 138 mm. respectively, have been examined for gill raker counts. The gill raker number in *S. fimbriata* ranges from 27 to 87 in the lower limb and from 12 to 49 in the upper limb of the left first gill arch, whereas in *S. gibbosa* it ranges from 25 to 65 in the lower limb and 10 to 35 in the upper limb. The range and mean number of gill rakers in the lower limb of the first arch of the two species at each 10 mm. length group are presented in Table X. The number of gill rakers increases with the size of the fish in both the species and the range of gill raker number at a particular length group is wide. A study of the mean number of gill rakers at various length groups in *S. fimbriata* shows that the rate of increase in the gill raker number decreases with the growth of the fish and the increase almost stops after the fish has attained a length of 100 mm. This is further emphasised by the fact that the fish measuring from 20 to 100 mm. have a wide range of gill raker counts between 27 and 81 while fish measuring above 100 mm. have a narrow range between 67 and 87. Moreover, the minimum number in the range at each 10 mm. group does not change much from 100 mm. onwards. Hence it can be inferred that there is little or no increase in the gill rakers number after the fish has attained 100 mm. length and then onwards the number remains more or less constant and lies within a narrow range (between 67 and 87). The maximum of 87 gill rakers in the lower limb has been recorded from a fish of the size 125 mm. Similarly in *S. gibbosa* the number almost stops increasing when the fish attains a size of 90 mm. and in fish above that size, the range is narrow between 49 and 65. The highest number of 65 gill rakers in the lower limb has been recorded from a fish measuring 128 mm

TABLE X

Gill raker counts on the lower limb of the left first gill arch of S. fimbriata and S. gibbosa

10 mm. group	*S. fimbriata*			*S. gibbosa*		
	Range	Mean	Number of fish	Range	Mean	Number of fish
20	27–34	30·40	15	25–31	28·66	21
30	33–47	41·11	105	30–43	36·19	42
40	44–45	50·91	23	37–43	39·88	52
50	52–64	58·62	112	42–46	44·47	23
60	54–69	61·07	265	42–50	47·54	33
70	59–74	65·63	345	46–52	48·84	55
80	62–77	68·66	205	48–57	52·00	28
90	65–81	71·56	136	50–58	54·48	31
100	67–81	71·93	110	50–61	56·22	31
110	67–85	75·86	51	49–59	53·73	15
120	68–87	76·41	61	50–65	57·32	25
130	68–82	74·59	37	53–64	57·86	7
140	68–80	73·14	42			
150	68–80	73·63	8			
			1,515			363

TABLE XI

Gill raker counts on the upper limb of the left first gill arch of S. fimbriata and S. gibbosa

10 mm. group	*S. fimbriata*			*S. gibbosa*		
	Range	Mean	Number of fish	Range	Mean	Number of fish
20	12–16	13·80	10	10–14	12–45	11
30	15–23	20·13	76	13–21	17·97	33
40	22–29	26·73	11	17–21	19·51	37
50	26–35	30·28	103	22–25	23·50	6
60	28–38	32·03	258	23–28	25·36	19
70	29–41	34·94	285	25–29	26·57	42
80	32–43	37·07	150	26–30	27·75	20
90	34–42	38·98	71	27–28	27·33	3
100	36–43	39·82	23	29	29·00	1
110	39–48	43·12	32	27–32	28·67	12
120	37–49	42·66	56	25–35	29·81	16
130	38–44	40·57	21	33	33·00	1
140	38–42	40·23	13			
150	38–45	41·00	3			
			1,112			201

The number of gill rakers in the upper limb of the first arch of the two species are given in Table XI.

A comparison of the gill raker number in the lower limb of the first gill arch of the two species at various 10 mm. groups (Table X) shows that though the range of gill raker number at a particular size group is wide in each species, there is no overlapping in the number among the two species in fish above 40 mm. length. Hence the gill raker number can be used as a diagnostic feature in the specific identification of fish measuring above 40 mm. provided the gil raker count at each 10 mm. group is known. Dutt (1961) has observed that the gill raker number does not overlap in fish measuring above 50 mm. while the present study has shown that the overlapping is restricted to fish below 40 mm. There are also some differences in the range and number of gill rakers at various length groups between the present study and that of Dutt (1959 and 1961). However, a direct comparison of the two results is not possible as he does not mention whether the lengths of fish given by him refer to total or standard length. In the case of *S. fimbriata* the present author has given gill raker counts of fish for wider length range (24 mm. to 153 mm.). Dutt (1959) has recorded 81 as the maximum number of gill rakers in the lower limb of the first gill arch in *S. fimbriata* while 87 gill rakers have been observed in some fish in the present study. Similarly in *S. gibbosa* the maximum number in the lower limb given by him is 63 whereas 65 have been recorded in this study.

The above account shows that the variation in the gill raker counts of juveniles at a given length (even in the same sample) is to such a great extent that it is doubtful whether this character could be made use of in comparing different samples of the same species unless samples containing fish of similar length groups are compared.

A Method for Distinguishing S. *fimbriata* and *S. gibbosa* in the Field

A difference between the two species of sardines under study, in the nature of distribution of black chromatophores on the surface of the tongue, was observed. This was noticed when the gill raker counts were taken, as the left first gill arch was removed along with the tongue. In *S. gibbosa*, the black chromatophores are distributed all over the surface of the tongue in a haphazard manner as shown in figs. 2,6,7 & 8. In. *S. fimbriata* the black chromatophores are either confined to the base of the tongue, rest of the tongue being free from pigments (fig. 3 and figs 9-12) or, the pigments are present in small groups at one or two places on the tongue besides at the base (figs. 4,5,13 & 14), but they are never present all over the surface as in *S. gibbosa*. Hence it is believed that the pattern of distribution of black chromatophores on the tongue can be used for distinguishing *S. fimbriata* from *S. gibbosa*. This character was found to comply with the other distinguishing features of the two species when associated with them in 100 per cent of the fish examined. This character may be reliably used for identifying these sardines measuring above 45 mm. (including adults) in the fields as it can be quickly studied by just opening the mouth of the fish wide. In fish below 45 mm., there are no black chromatophores on the tongue in the case of *S. fimbriata* while there are very few black chromatophores distributed here and there in *S. gibbosa*. The black chromatophores are retained in fish even after long-standing preservation.

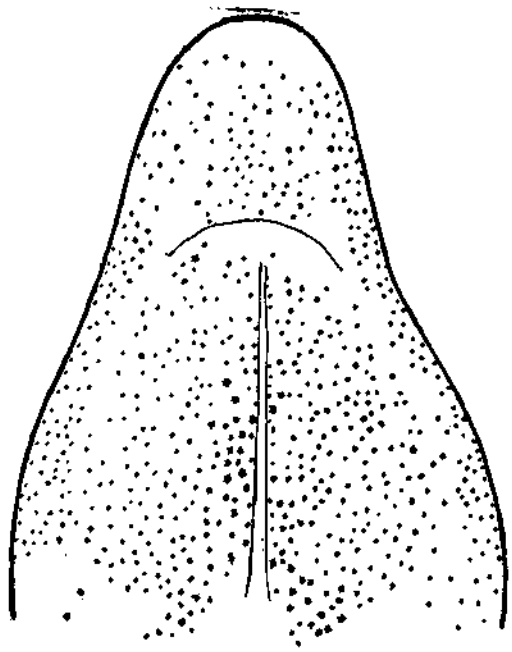

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FIG. 2. Diagram of the upper surface of the tongue of *S. gibbosa* showing the distribution of black chromatophores.

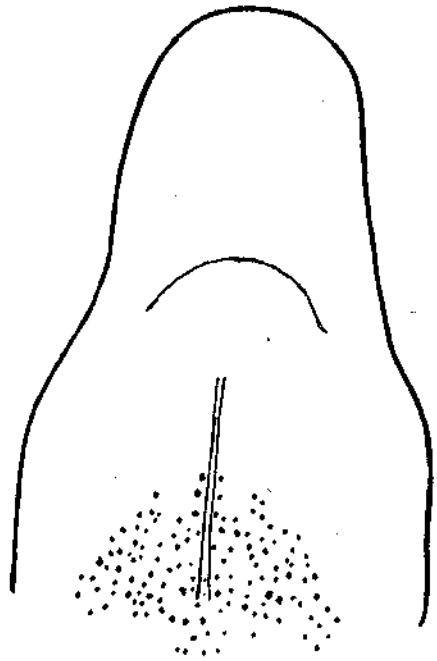

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FIG. 3. Diagram of the upper surface of the tongue of *S. fimbriata* showing the distribution of black chromatophores.

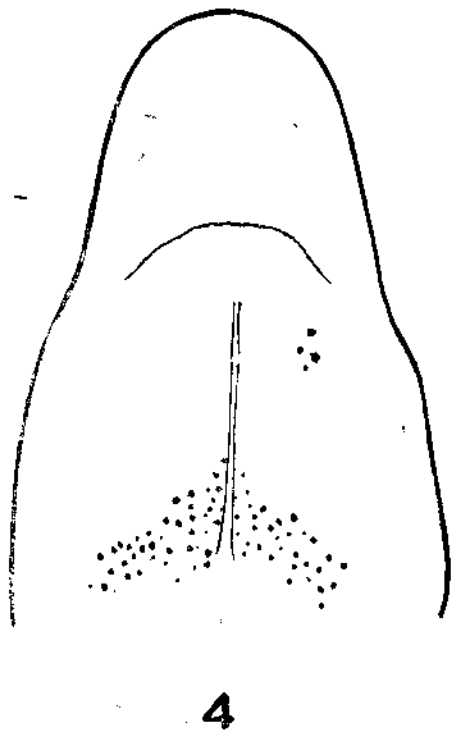

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Fig. 4. Diagram of the upper surface of the tongue of *S. fimbriata*

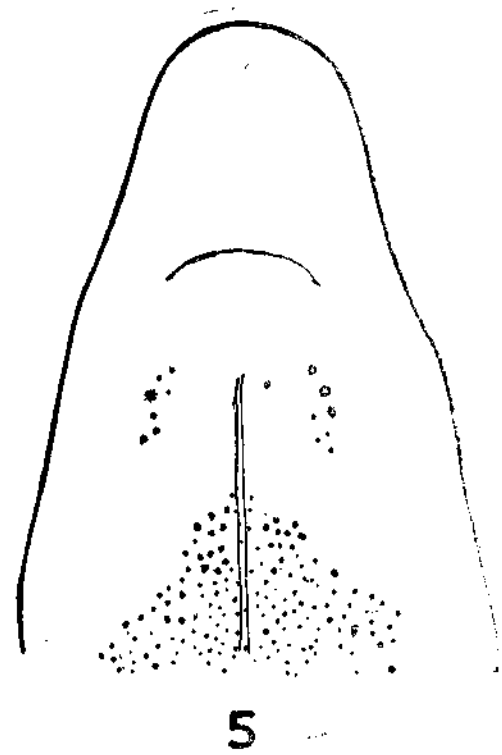

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Fig. 5. Diagram of the upper surface of the tongue of *S. fimbriata*

Fig. 6. Tongue of a 124mm. fish.

Fig. 7. Tongue of a 71mm. fish.

FIGS. 6, 7 and 8: Photographs of the tongues of *S. gibbosa*

Fig. 8. Photograph of the tongue of *s. gibbosa* (49 mm. fish)

Fig. 9. Tongue of a 130 mm. fish.

FIGS. 9-14 : Photographs of the tongues of *s. fimbriata*

Fig.. 10. Photograph of the tongue of *s. fimbriata* (90 mm. fish)

Fig. 11. Photograph of the tongue of *s. fimbriata*(79 mm. fish)

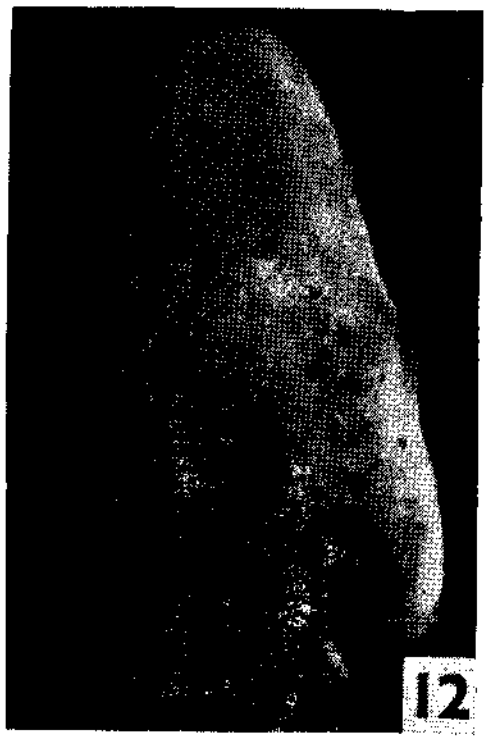

Fig. 13. Photograph of the tongue of *s. fimbriata* (130 mm. fish)

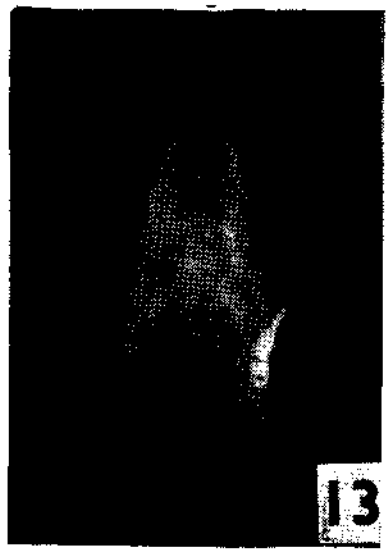

Fig. 12. Photograph of the tongue of *s. fimbriata* (57 mm. fish)

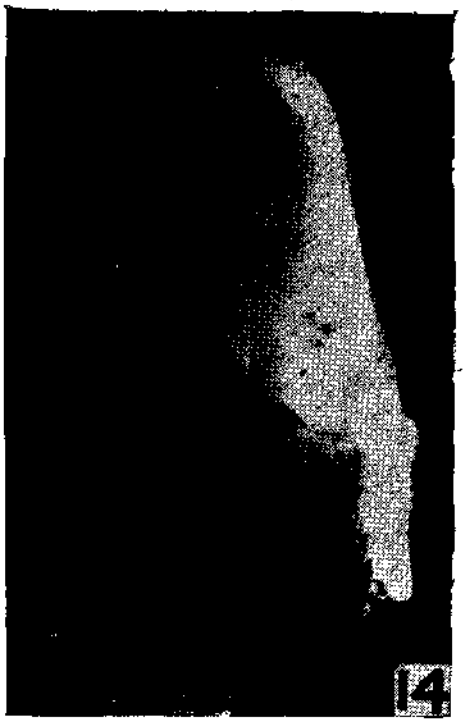

Fig. 14. Photograph of the tongue of *s. fimbriata* (129 mm. fish)

Table XII presents the distinguishing characters of *S. fimbriata* and *S. gibbosa*.

TABLE XII

Summary of characters studied in which S. fimbriata *differs from* S. gibbosa.

	S. fimbriata	*S. gibbosa*
1.	*Colour (in fresh condition) :* Dorsally blusih green sides silvery. In large fish, sides with yellow reflections as a band. In small fish, snout, lower jaw, dorsal fin and caudal peduncle are coloured greenish yellow.	*Colour (in fresh condition) :* Dorsal side bluish green, sides silvery. A faint golden yellow post opercular spot present and a lateral yellow line is continued behind upto the caudal. In small fish, snout, lower jaw, dorsal fin and end of the caudal peduncle are coloured orange-yellow.
2.	Black chromatophores, either present at the base of the tongue with the rest of the surface clear or, in small groups at one or two places besides at the base.	Black chromatophores distributed all over the surface of the tongue in a haphazard manner.
3.	12—15 postventral scutes with a mean number of 13·72; majority of the fish having 13 or 14 postventral scutes.	14—17 postventral scutes with a mean of 15·08, majority of the fish having 15 or 16 postventral scutes.
4.	Majority of the fish have 45 vertebrae, range being from 43 to 47 with a mean of 45·02.	Majority of the fish have 46 vertebrae, range being from 44 to 47 with a mean of 45·92.
5.	13–17 pectoral fin rays with a mean of 15·42	14—16 pectoral fin rays with a mean of 14 92.
6.	12 to 49 gill rakers in the upper limb and 27 to 87 in the lower limb of the first gill arch.	10 to 35 gill rakers in the upper limb and 25 to 65 in the lower limb of the first gill arch.

GENERAL OBSERVATIONS

The juvenile fish of *S. fimbriata* and *S. gibbosa* closely resemble each other in their morphometric characters. The height-standard length ratio which is different in the adults of the two species is similar in small sized fish (Table I).

Dutt (1959 and 1961) has shown that the two species differ in the means of their vertebral counts, pectoral fin ray counts and gill raker counts. The present study while confirming his results, further shows that these two species differ in one more meristic character, namely, the postventral scutes. *S. fimbriata* has a lower mean number of postventral scutes (13·72) and *S. gibbosa* has a higher mean (15·02). It has been found that the number of postventral scutes is a more suitable character to separate the two species than number of gill rakers as observed by Dutt (1959), for the following reasons:

1. The number of scutes does not vary with the size of the fish as is the case with the gill raker number and this character can be used to identify fish even below 40 mm. length. (2) There is not much overlapping in the frequency distribution of the postventral scute counts of the two species (Table VII) and the overlapping is of a lesser degree compared to the other meristic characters. (3) As this is an external character, it can be easily observed and the number can be counted without difficulty (except in very small fish). As such, this character can be used in the identification of the fish in the field. (4) The counting of postventral scutes involves far lesser time and so, in a short time a large number of fish can be examined.

The field identification of the two sardines is made easy on the basis of distribution of black chromatophores on the tongue. Little time is taken to study this character as it can be observed by just opening the mouth of the fish wide. The identification of the fish based on this character is 100 per cent reliable and it can be confirmed by taking the postventral scute and gill raker counts. The black chromatophores on the tongue do not disappear even in formalin preserved fish.

It is worth mentioning that *S. gibbosa* differs from *Sardinella jussieu* (Lacepede), synonym of *S. gibbosa*, described by Smith (1953) and Munro (1955) in possessing teeth on the tongue. The number of postventral scutes also differs in them. Smith (1953) and Munro (1955) give the number of postventral scutes in *S. jussieu* as 12-13 and 12-14 respectively, whereas in the present study, 14-17 postventral scutes have been recorded for *S. gibbosa*. However, other characters like gill raker number are similar in both the species.

SUMMARY

The juveniles of *S. fimbriata* and *S. gibbosa* closely resemble in their morphometric characters. Analyses of meristic characters show that the two species differ in the number of postventral scutes besides differing in the number of vertebrae, number of pectoral fin rays and number of gill rakers on the first gill arch. The advantages of postventral scute number over the gill raker number as means for separating the two species are shown. The postventral scute is an external character, its number not varying with the size of the fish and its number being counted in a very short time without difficulty.

The gill raker number increases in *S. fimbriata* until the fish attains a length of 100 mm. and above that length there is little increase in the number which lies within a narrow range. In *S. gibbosa* the gill raker number more or less stops increasing after the fish has reached a length of 90 mm.

Difference between the two species in the pattern of distribution of black chromatophores on the surface of the tongue is described. This character is helpful in the field identification of the two species, as it can be observed quickly by just opening the mouth of the fish wide.

Differences between *S. gibbosa* (Blkr.) and its synonym, *S. jussieu* (Lacepede) are pointed out.

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REFERENCES

Day, F. (1958). The fishes of India ; being a natural history of the fishes known to inhabit the seas and fresh water of India, Burma and Ceylon. William Dawson & Sons Ltd., London. 1 ; 637-638.

Dutt, S. (1957). Racial studies on the Indian Sprat, *Sardinella gibbosa* (Bleeker) of the Waltair Coast. (East Coast of India). Indian Fish. Bull., 4 (4), 22.

(1959). Correction to note on "Racial Studies on the Indian Sprat, *Sardinella gibbosa* (Bleeker) of the Waltair Coast (East Coast of India)", appearing in the IFB., Vol. 4, No. 4, Oct. 1957, p. 22. *ibid.*, 6 (1), 25.

(1959). Biometric Studies on *Sardinella spp.* off Waltair Coast. 1. *Sardinella fimbriata* Val. First All-India Cong. Zool, Jabalpur, Part 2, 286-298.

(1961). Biometric Studies on *Sardinella spp.* of Waltair Coast. 2. *Sardinella gibbosa* Blkr. J. Zool. Soc. India 13(1), 78-89.

Fowler, H. W. (1941). The fishes of the groups Elasmobranchii, Holocephali, Isospondyli and Ostarophysi obtained by the United States Bureau of Fisheries Steamer, "Albatross" in 1907 to 1910, chiefly in the Philippine Islands and Adjacent Seas. U. S. Nat. Mus. Bull., 100, 13.

Munro, I. S. R. (1955). The marine and fresh water fishes of Ceylon. Canberra, 26.

Nair, R. V. (1953). Key for the field identification of the common clupeoid fishes of India. J. Zool. Soc. India, 5 (1), 108-138.

Regan, C. T. (1917). A revision of the clupeoid fishes of the genera *Sardinella*, *Harengula*, & c. Ann. Mag. Nat. Hist., Ser. 8, 19.

Smith, J. L. B. (1953). The sea fishes of Southern Africa. Central News Agency Ltd., S. Africa, 92.

Snedecor, G. W. (1956). Statistical Methods Applied to Experiments in Agriculture and Biology (5th Edition) Iowa.

Weber, M. & Beaufort, L. F. (1913). The fishes of the Indo-Australian Archipelago. 2, 75-76.