STUDIES ON VARIATIONS IN THE VERTEBRAL COUNTS OF OIL SARDINE ALONG THE NORTH KANARA COAST

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ABSTRACT

The study on the sub-populations of the oil sardine *Sardinella longiceps* Val. was made based on vertebral counts recorded from specimens collected at seven centres, Karwar, Binage, Shankrubag, Chendia, Bellekeri and Belambar situated over a stretch of about 40 km south along the North Kanara coast and Kankon at a distance of 35 km north of Karwar. In all, 68 samples comprising 2183 specimens in the size range 96-209 mm were examined during the period June 1973 - April 1975. The total number of vertebrae ranged from 43 to 48, the mode being at 47. It was found that vertebral variations were not significant in fish below 160 mm length (mostly juveniles) and those above 160 mm (adults) suggesting that they were homogeneous in character. Data pooled from all centres showed significant difference indicating the possibility that samples drawn were from different sub-populations. Within centres, samples differed significally especially at Binage and Chendia suggesting that these belonged to different sub-populations. Samples from Karwar, Belambar and Kankon did not differ significantly. It is inferred that sub-populations exist in the oilsardine shoals striking the coast between Karwar, Belambar and Kankon.

ITRODUCTION

The oil sardine which is migratory in its behaviour frequents the coastal waters of North Kanara in dense shoals and supports local fisheries from September to January or up to March in certain years. Whether these shoals form one homogeneous population or whether there are regional sub-populations needs investigation, since this will have a bearing on future studies on the dynamics of oilsardine resources.

A sub-population is a fraction of a population genetically self-sustaining and self-perpetuating. Different stocks may mingle on their migratory routes or while on feeding grounds but a unit stock returns year after year to a single spawning ground thus maintaining its identity and coherence from generation to generation.

Scanty information is available regarding raciation in oil sardine. Hornell and Nayudu (1924) concluded after comparison of meristic and morphometric

characters of oil sardine from the east and west coasts of India that there was no evidence of races in the species. Devanesan and Chidambaram (1943) suggested the existence of races of oil sardine along the west coast of India on the basis of studies on morphometric characters. Subsequently, many workers stressed the need to investigate the differences, if any, between the oilsardine stocks off Mangalore and further north and those of the southern region.

The present study based on vertebral counts of oil sardine recorded during two seasons 1973-74 and 1974-75 aims at determining whether subpopulations exist in the shoals striking the coastal stretch of about 40 km between Karwar and Belambar to south and about 35 km between Karwar and Kankon to the north.

Material and methods

Samples for the study were drawn from the centres, Karwar, Binage, Shankrubag, Chendia, Bellekeri, Belambar and Kankon, the latter six being situated 5 km, 10 km, 29 km, 40 km to south and 35 km to north of Karwar, respectively. In all 68 samples comprising 2183 specimens in the size range of 98-209 mm were utilised. Because of the nature of the fishery, collections were made from the landing centres as and when the material was available without any set frequency. Though it was intended to collect specimens only during the spawning season, owing to scanty material, all fish irrespective of whether they are juvenile or adult collected duirng 1973-75 were utilised for vertebral counts.

After the specimens were collected from the landing centres, basic biological data were recorded from each individual, and then, each specimen was serially numbered taking into account the total length by inserting a numbered tag under the operculam. The specimens were then boiled in water for about ten minutes when the eyes attained the tinge of boiled sago. The vertebral columns were extricated from the flesh and the number of verebrae in each specimen was counted using a magnifying glass. The data so collected were subjected to statistical treatment to study the variations in the number of vertebrae in the specimens examined. The analysis of variance is given for all the centres below.

Results

In the course of the study, the total number of vertebrae met with in the specimens examined (including urostyle) were 43, 44, 45, 46, 47 and 48. Of these, the incidence of 47 vertebrae was the highest followed by 46, 48, 45 and 43. The data from seven centres were subjected to satistical tests taking size of fish, data pooled from all centres, data from each centre and data between centres into consideration.

A major part of the period June to December being the spawning season of the species, data on verebal counts during the period were bifurcated as those

of fish below 160 mm total length (mostly juveniles) and those above 160 mm (adults) and analysed with a view to studying whether vertebral variations differed significantly in these catagories.

1) *Fish below* 160 mm: In this catagory, 601 specimens were examined for vertebral counts from all centres. The analysis of variance is presented in Table 1.

TABLE 1. *Analysis of variance of vertebral counts of fish* < 160 mm *in length.*

Source of variation	Degress of Freedom	Sum of squares	Mean square	Observed F	Significance
Between samples	34	13.87	0.4080	1.31	NS
Within samples	566	176.17	0.3113		
Total	600	190.04			

NS Non-significant

5%F = 1.41; 1%F = 1.61

ii) *Fish above* 160 mm: In this group, 769 fish were studied for vertebral counts from all centres. The significance is tested in Table 2.

TABLE 2. *Analysis of variance of vertebral counts of fish* > 160 mm *in length.*

Source of variation	Degress of Freedom	Sum of squares	Mean square	Observed F	Significance
Between samples	35	10.31	0.2946	1.15	NS
Within samples	733	188.07	0.2600		
Total	768	198.38			

NS Non-significant

5%F = 1.41; 1%F = 1.61

It is clear from Tables 1 and 2 that vertebral variations were not significant in fish below 160 mm and those above 160 mm length.

Data on 813 specimens irrespective of size (juveniles and adults) collected during the period January to April were analysed and the analysis of variance is given in Table 3.

TABLE 3. *Analysis of variance of vertebral counts of fish all size groups combined, January - April.*

Source of variation	Degress of Freedom	Sum of squares	Mean square	Observed F	Significance
Between samples	28	12.89	0.46	1.71	*
Within samples	784	211.03	0.27		
Total	812	223.92			

* Significant at 5% probability level.

5% F = 1.47; 1% F = 1.71

It is evident that vertebral variations were significant at 5% probability level indicating the origin of samples from different populations.

Data pooled from all centres: To find out whether vertebral variations were significant from sample to sample in all the centres, the data collected during the course of the study were pooled and tested as shown in Table 4.

TABLE 4. *Analysis of variance of vertebral counts of fish of all centres, for the entire period.*

Source of variation	Degress of Freedom	Sum of squares	Mean square	Observed F	Significance
Between samples	67	28.10	0.42	1.50	**
Within samples	2115	586.95	0.28		
Total	2182	615.05			

** Significant at 1% probability level.

5% F = 1.28; 1% F = 1.41

Since the vertebral variations were significant from sample to sample, it may be surmised that the samples were heterogeneous.

Data from each centre: The data from different centres were analysed and tested for differences, if any, from sample to sample.

TABLE 5. *Analysis of variance of vertebral counts of fish collected at different centres.*

Centres	Source of variation	Degrees of Freedom	Sum of squares	Mean square	Observed F	Significance
a) Karwar	Bet ween samples	36	10.75	0.30	1.12	NS
	Within samples	1219	323.15	0.27		
	Total	1255	333.90			5% F = 1.40
						1% F = 1.59
b) Binage	Between samples	3	3.64	1.21	3.68	*
	Within samples	144	47.36	0.33		
	Total	147	51.00			5% F = 2.67
						1% F = 3.91
c) Shankrubag	Between samples	3	1.32	0.44	1.25	NS
	Within samples	138	48.34	0.35		
	Total	141	49.66			5% F = 2.67
						1% F = 3.91
d) Chendia	Between samples	10	6.59	0.66	2.44	*
	Within samples	340	93.11	0.27		
	Total	350	99.70			5% F = 1.89
						1% F = 2.44
e) Bellekeri	Between samples	1	0.03	0.03	0.09	NS
	Within samples	43	14.55	0.34		
	Total	44	14.58			5% F = 4.06
						1% F = 7.24
f) Belambar	Between samples	4	1.25	0.31	1.27	NS
	Within samples	105	25.85	0.25		
	Total	109	27.10			5% F = 2.46
						1% F = 3.51
g) Kankon	Between samples	4	2.23	0.56	2.08	NS
	Within samples	126	34.35	0.27		
	Total	130	36.58			5% F = 2.44
						1% F = 3.47

NS Non-significant

* Significant at 5% probability level

It is evident from the Table above that the samples at Karwar, Shankrubag, Bellekeri, Belambar and Kankon are homogeneous. But those at Binage and Chendia show heterogeneity.

The data in the region between Karwar and Belambar, omitting one centre at a time was analysed and tested to note whether there is any significant difference in the samples. The analysis of varianc is presented in Table 6.

TABLE 6. *Analysis of variance of vertebral counts of fish in different regions between Karwar and Belambar.*

Regions	Source of variation	Degrees of Freedom	Sum of squares	Mean square	Observed F	Significance
a) Between Karwar & Belambar	Between samples	62	25.17	0.40	1.46	*
	Within samples	1989	552.70	0.28		
	Total	2051	577.87			5% F = 1.32
						1% F = 1.47
b) Between Karwar & Bellekeri	Between samples	57	23.59	0.41	1.48	**
	Within samples	1884	526.86	0.28		
	Total	1941	550.45			5% F = 1.32
						1% F = 1.47
c) Between Karwar & Chendia	Between samples	55	23.47	0.43	1.53	**
	Within samples	1841	512.31	0.28		
	Total	1896	535.78			5% F = 1.32
						1% F = 1.47
d) Between Karwar & Shankrubag	Between samples	44	16.73	0.38	1.36	NS
	Within samples	1501	419.16	0.28		
	Total	1545	435.89			5% F = 1.40
						1% F = 1.59
e) Between Karwar & Binage	Between samples	40	14.83	0.37	1.36	NS
	Within samples	1363	370.82	0.27		
	Total	1403	385.65			5% F = 1.40
						1% F = 1.59
f) Between Karwar & Kankon	Between samples	41	13.80	0.34	1.27	NS
	Within samples	1345	357.49	0.27		
	Total	1386	371.29			5% F = 1.40
						1% F = 1.59

NS Non-significant

* Significant at 5% probability level
** Significant at 1% probability level

It is clear from the Table that vertebral variations Between Karwar and Belambar, Karwar and Bellekeri, Karwar and Chendia were significant, while the variations between Karwar and Shankrubag, Karwar and Binage, Karwar and Kankon were not significant.

TABLE 7. *Vertebral counts of oil sardine at various centres.*

Centre	Numbers of vertebrae						Total
	43	44	45	46	47	48	
Karwar	—	1	8	236	930	81	1256
Binage	—	1	1	34	102	10	148
Shankrubag	1	—	2	27	107	5	142
Chendia	1	—	3	66	265	16	351
Bellekeri	—	—	—	12	29	4	45
Belambar	—	—	—	19	82	9	110
Kankon	—	—	1	33	91	6	131
Total	2	2	15	427	1606	131	2183

DISCUSSION

The present finding that the number of vertebrae ranged from 43 to 48 with the modal frequency at 47 is in conformity with the observations of Antony Raja and Hiyama (1969) but at variance with the report of Li (1960) who stated that the range was 46-47.

During June-December which includes the spawning season of the species, the data when bifurcated at 160 mm length, analysed and tested for significance revealed that vertebral counts did not differ significantly in fish below 160 mm length (mostly juveniles) and those above 160 mm (adults) thereby indicating that they were homogeneous in character. Since most of the adults examined were in spent-recovering condition, it is likely that the fish segregated into shoals on the spawning grounds at the time of spawning may have mingled on the inshore feeding grounds. The analysis of variance of vertebral counts of fish of all size groups combined during January to April showed significance at 5% probability level indicating the origin of samples from different populations. When the data from all centres were pooled and tested, the variance ratio was significant at 1% probability level, suggesting that the samples drawn were from

different sub-populations. The data revealed significant differences from sample to sample at Binage and Chendia, but not so at other 5 centres. It is possible that samples drawn from Binage, Chendia and during January to April period from all centres, represent different sub-populations striking the coastal stretch after spawning, for feeding. When the test was carried out for data between centres (vide Table 6) there was significant difference in the regions between Karwar and Belambar, Karwar and Bellekeri and Karwar and Chendia but not in the regions between Karwar and Shankrubag, Karwar and Binage and Karwar and Kankon. This clearly shows that the samples drawn between Karwar to Shankrubag show homogeneity but those from Chendia to Belambar or Karwar to Belambar show heterogeneity. Since the species is migratory, it cannot be said that any sub-population is endemic to a particular locality.

Studies on stocks of other clupeoids are worthy of mention. Jones (1954) stated that preliminary morphological studies on hilsa in the Chilka Lake, the Mahanadi River and the Hooghly did not show any significant differences in the external characters and body porportions of the fish. Pillay (1957) utilising meristic and non-meristic characters for his studies observed that Chilka hilsa belonged to a stock separate from that of Hooghly. Graham (1956) stated that the modal frequency of vertebral counts for spring herring spawners falls at 57, while in the case of autumn spawners, this stands at 56. Although they are racially distinct, having different spawning grounds, these several closely related stocks mix with each other in spring for food. Vrooman (1964) serologically separated three genetically different groups of Pacific sardine, *Sardinops caerulea* on the basis of frequency of occurrence of C-positive blood factor. In the case of the North sea herring, Cushing (1967) opined that there are three spawning groups among the autumn spawners. Mais (1972) based on meristic and morphometric characters of Pacific sardines of the west coast of North America and Mexico showed the existence of three stocks.

Viewing the present findings in the light of the observations made by other workers in different waters, it may be inferred that there may be different sub-popuiations of oil sardine along the North Kanara coast. More detailed studies on meristic and morphometric characters coupled with serological and electrophoretic investigations may help establish the extent and identities of these stocks.

ACKNOWLEDGEMENTS

The author is grateful to Dr. R. V. Nair, Director, Central Marine Fisheries Research Institute, under whose direction the present account was prepared. He is also grateful to Dr. K. V. Sekharan, Senior Fishery Scientist, C.M.F. R. Institute for his guidance and valuable help rendered in the course of this investigation. He is thankful to Dr. M. V. Pai, Officer-in-Charge, C.M.F.R. Sub-station, Karwar for his co-operation while preparing the paper.

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