

SOME OBSERVATIONS ON THE FISHERY AND BIOLOGY
OF *SARDINELLA FIMBRIATA* (VAL.) AT VIZHINGAM

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The sardines, *Sardinella* spp., constitute an important resource along the coasts of India. Commercial fishing in the inshore waters has shown that the different species of sardine are concentrated at different localities all along the coast. Thus the oil sardine *Sardinella longiceps* is localised along the Kerala and Mysore coasts. *S. fimbriata* occur in commercial quantities along the South Kerala and North Mysore coasts. *S. albella* is not abundant anywhere on the west coast, but at times occurs in small quantities along the coast. On the south-west coast *S. clupeioides*, along with *S. sirm* and *S. melanura* forms a minor fishery during December (Bennet, 1965). All the six species have been caught in the inshore waters up to 10 km from the land. On the east coast of India *S. fimbriata*, *S. albella*, *S. gibbosa* and *S. sirm* occur in commercial quantities along the Madras and Andhra coasts. Other sardines occur only in small quantities.

Much work has been done on the most important sardine on the west coast, *Sardinella longiceps*. Early recorded information on *S. fimbriata* is in the form of short reports on the occurrence and natural history of the fish (Devanesan and Chidambaram, 1948; Chidambaram and Venkataraman, 1946; Nayar, 1958). Dutt (1959) has given an elaborate account on the biometric studies on *S. fimbriata* from the Waltair coast. Dharmamba (1963) has given a comprehensive account of a quicker method of distinguishing *S. fimbriata* and *S. gibbosa* on the basis of ventral scute counts and distribution of black chromatophores on the tongue. This short paper deals with some aspects of the fishery and biology of *S. fimbriata* based on data collected at Vizhingam near Trivandrum between 1960 and 1963.

The samples were collected at random from the commercial catch at Vizhingam between July 1960 and June 1963. Detailed work was done mainly on fresh material. Length and weight measurements were made in metric system. Ova diameter measurements and fecundity counts were made on mature ovaries. Ovaries were preserved in 2% formalin. From each ovary small samples were taken from the anterior, middle and posterior regions. These were kept for a day or two in Gilson's fluid and the individual ova were separated by a brush for measurement and counts.

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AVAILABILITY OF FISH

Sardinella fimbriata is an intermittent and unpredictable visitor to the south-west coastal waters of India. In some months they were extremely abundant, reaching as much as 23,717 kg in October 1960 and 42,566 kg in June 1962, while during other months they were scarce or absent. At Vizhingam during the 1960-61 season they appeared in fairly large quantities from September to December and April and May. In the 1961-62 season they were abundant in October, December and April to June. In the 1962-63 season *S. fimbriata* occurred in good quantities in the commercial catch during September to December and May. They were caught entirely by small inshore boats and catamarans with boat seines and gill nets. Sometimes they occurred in shore seines also. In the Vizhingam area *S. fimbriata* is chiefly used for food in the fresh condition.

The relative abundance of *Sardinella fimbriata* in Vizhingam coastal waters from July 1960 to June 1963 is shown in Table 1. Nayar (1958) has given a comparative account on the abundance of sardine at Vizhingam from 1950 to 1954. The fishery has been showing violent fluctuations during that period also.

TABLE 1. Monthly landings (in kg) of *Sardinella fimbriata* at Vizhingam.

Months	1960-61	1961-62	1962-63
July	2308	00	00
August	725	00	00
September	3420	00	5677
October	23717	9111	4557
November	7505	303	8104
December	3148	2679	2043
January	124	00	1200
February	00	320	1330
March	671	250	1170
April	2104	2720	1317
May	18438	5792	9702
June	00	42566	195
Total	62160	63741	35295

SIZE COMPOSITION

Regular samples were obtained from the commercial landings for length frequency observations. It was not always possible to get samples separately from seine nets and gill nets. So samples were taken without any distinction of gear. Figs. 1-3 give the size composition of *S. fimbriata* at Vizhingam.

During the 1960-61 fishing season *S. fimbriata* from 3.0 to 18.5 cm total length were observed in the fishery. The smallest specimens were recorded in November and March. Larger fish above 15.0 cm were recorded in all the months except

January when only smaller fish were available. In the 1961-62 season fish below 3.0 cm were recorded in November, February and March. Fish above 15.0 cm were noticed in the fishery during October, November and April to June. During the season the smallest fish recorded was 2.5 cm and the largest was 18.0 cm. In the 1962-63 season *S. fimbriata* from 3.0 to 17.5 cm entered the fishery. The smallest size groups were recorded in January and February. Fish above 15.0 cm were recorded in September, November, April and May.

Eventhough fish from 2.5 to 18.5 cm were observed in the fishery from 1960 to 1963 an accurate tracing of the growth of the different year classes was difficult. New recruits entered the fishery more than once in the season. In the 1960-61 season new entrants appeared during November and March. In 1961-62 new recruits were noticed during November, February and March. In 1962-63 small fish were seen in January. Moreover the continuous absence of *S. fimbriata* from the commercial catch for over two months made accurate separation of different year-classes difficult. Scale studies showed that only one annulus was formed in fish above 17.0 cm. No rings were observed in fish below 17.0 cm total length.

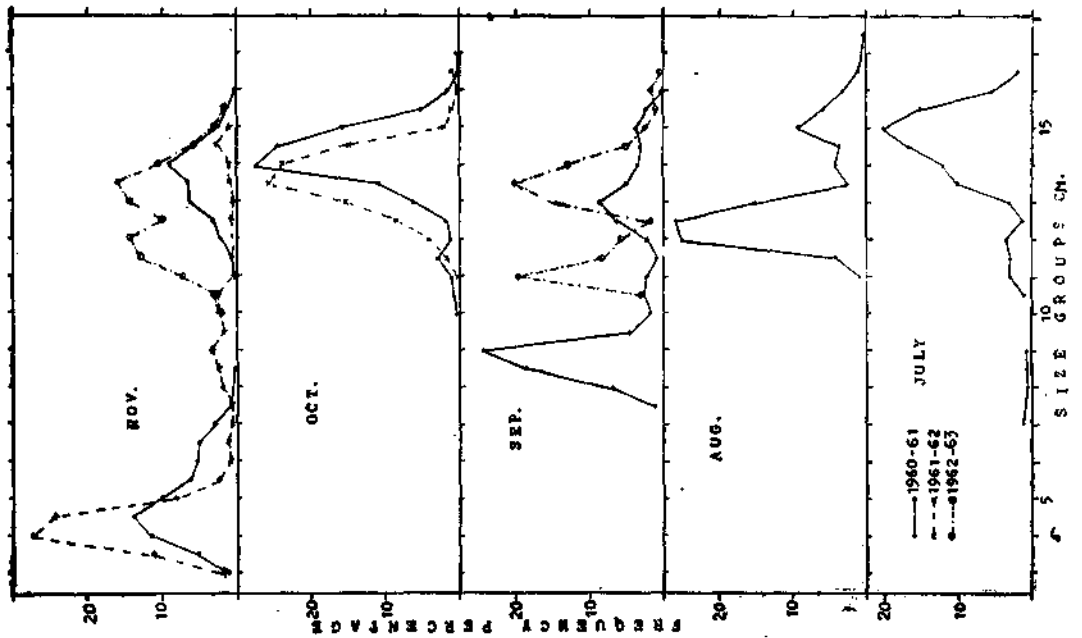
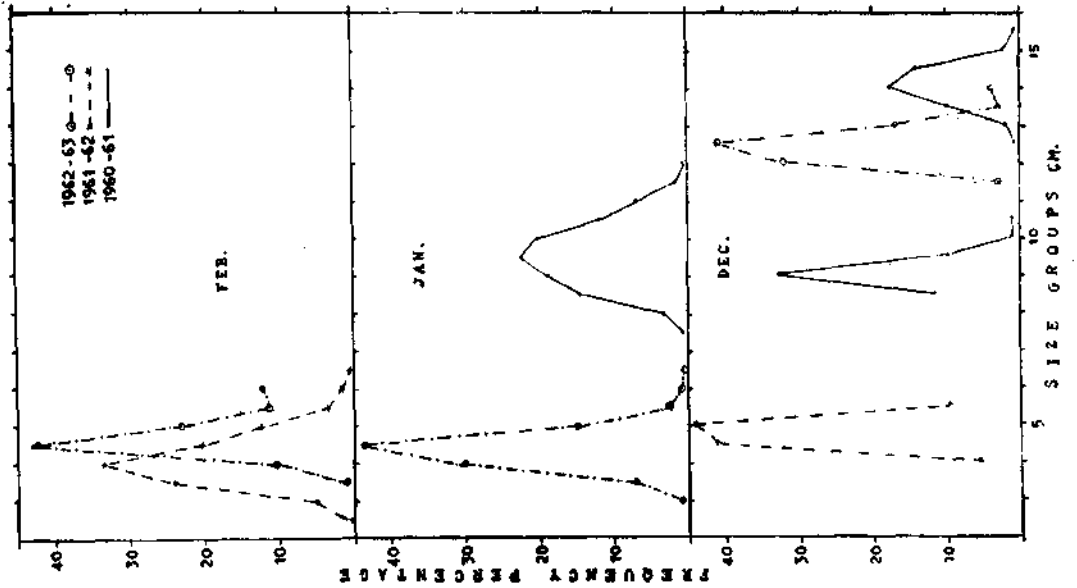
Comparison of the different fishing years indicates that the size groups of fish from one season are not consistently smaller or larger than the size groups of fish taken in any of the other seasons.

MATURITY AND SPAWNING

Both macroscopic and microscopic observations were made on the gonads. Since it may be assumed that the sexual cycle is adjusted in the two sexes so that spawning acts coincide, knowledge of the seasonal gonad cycle of one sex will be enough to determine the general picture. Studies were made in detail on the ovary only.

Sex composition—During the 1960-61 season 1,962 fish were observed for the composition of sexes. The results are given in Table 2. Well over 50% of the specimens were indeterminates having indistinct gonads. Among the rest of the specimens females were slightly more in number than the males. Females constituted 21.8% whereas only 18.6% were males. Out of 1,759 specimens in 1961-62 season over 80% were indeterminates. Males made up 9.2% and females 10.6%. In the 1962-63 season 1,298 fish were taken for sex composition studies. 74% were indeterminates, 13.4% were females and 12.5% were males.

Size at maturity— It was observed that most of the fish below 10.0 cm total length were either indeterminates or immature with gonad in stage I of maturity. Fish above 10.0 cm were showing various degrees of sexual maturity. Maturity was determined applying the ICES key based on the macroscopic appearance of the gonads. Fish in stages II and III were considered as maturing. Mature fish were with gonads in stages IV and V. Fully ripe fish with gonads in stage VI were



not encountered. Stage VII included spent fish. It could be possible to get a fairly clear picture of the spawning cycle of the fish by noting the condition of the gonads.

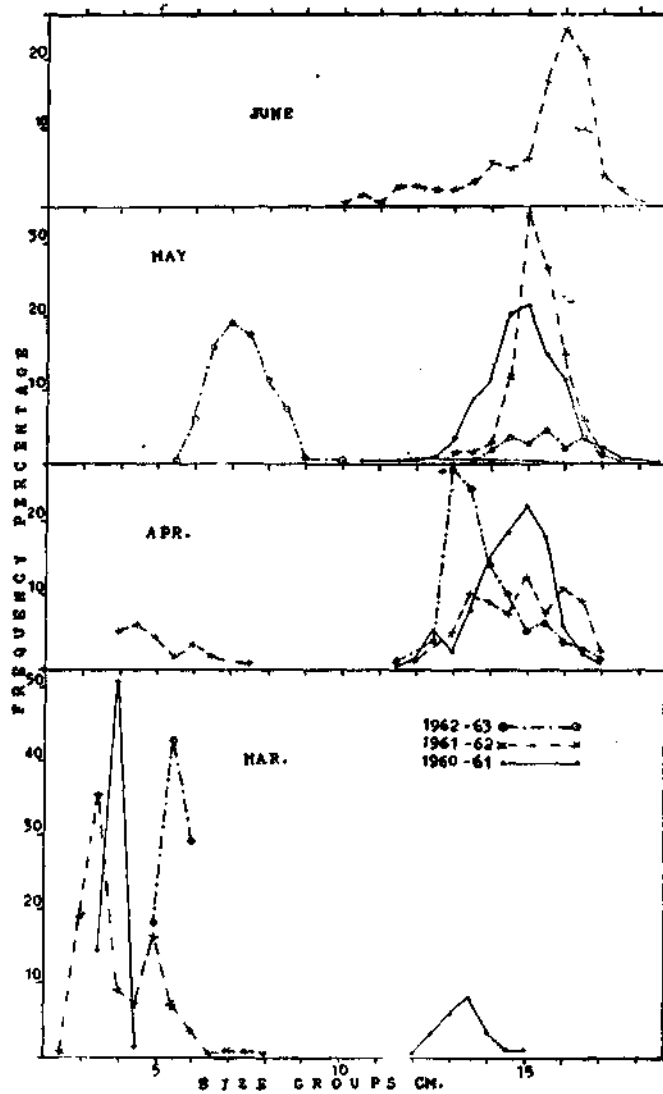


FIG. 3. Length frequency distribution of *Sardinella fimbriata* from Vizhingam during 1960-63.

However, this was made a little complex because of the irregular appearance of mature fish. Stages of maturity at different months and at different size groups are given in Tables 3 and 4.

TABLE 2. Sex ratio (percentage) of *Sardinella fimbriata* from Vizhingam.

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Total
1960-61													
Total													
sexed	110	21	288	246	792	..	48	156	156	..	145	..	1962
Male	60.9	14.3	15.6	44.3	8.6	..	..	5.1	5.1	..	39.3	..	18.6
Female	35.5	85.7	11.5	55.7	11.6	..	..	6.4	6.4	..	60.7	..	21.8
Indeterminate	3.6	..	72.9	..	79.8	..	100	88.5	88.5	..	..	..	59.6
1961-62													
Total													
sexed	..	..	..	99	438	137	..	440	398	112	68	67	1759
Male	..	..	..	34.3	1.1	..	..	..	..	42.0	60.3	50.7	19.2
Female	..	..	..	65.7	5.3	..	..	..	..	33.9	39.7	49.3	10.6
Indeterminate	..	..	..	..	93.6	100	..	100	100	24.1	..	..	80.2
1962-63													
Total													
sexed	..	..	361	..	181	..	214	108	72	78	284	..	1298
Male	..	..	3.9	..	43.1	..	..	..	..	53.8	9.9	..	12.5
Female	..	..	4.2	..	55.8	..	..	..	..	46.2	7.7	..	13.4
Indeterminate	..	..	19.9	..	1.1	..	100	100	100	..	82.4	..	74.1

Microscopic study of ovary:- An objective estimate of the time and duration of the spawning period may be obtained by assessing the seasonal variation in the ovaries. Forty-seven mature ovaries were observed from 1960 to 1963. Measurements of ova in a representative sample were taken from each of the ovaries and the frequency at different size of ova were recorded. (Figs. 4 to 6).

Large, transparent, ripe ova were not met with during the course of observation. Three other groups of ova were encountered in mature ovaries. Large, opaque ova are the mature ova ready to become ripe. These are distinctly round and pale yellow in colour. Slightly smaller and opaque ones are the maturing ova with yolk. The largest of the maturing group merge with the smallest of the mature group. By far the most numerous are the very small transparent ova without yolk. These constitute the immature group. It is seen that a group of ova with modal diameter at about 0.5 mm is distinct in most of the ovaries. During June 1962 a few ova of 0.9 mm were seen. Delsman (1926) has observed from Java Sea that the egg of *Clupea fimbriata* is about 0.8 mm excluding the egg membrane.

Clark (1934) inferred that multiple modes occurring in ova diameter frequency polygons of the Californian sardine, *Sardina caerulea* were suggestive of more than one spawning per season by a particular fish. Andreu and Pinto (1957) observed a similar multiple spawning for the European pilchard *Sardina pilchardus*. They proved

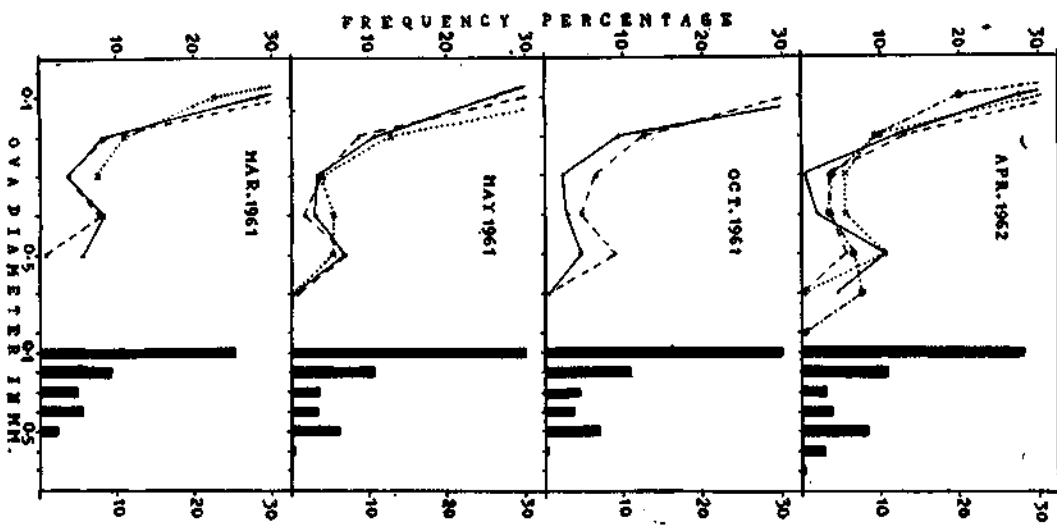
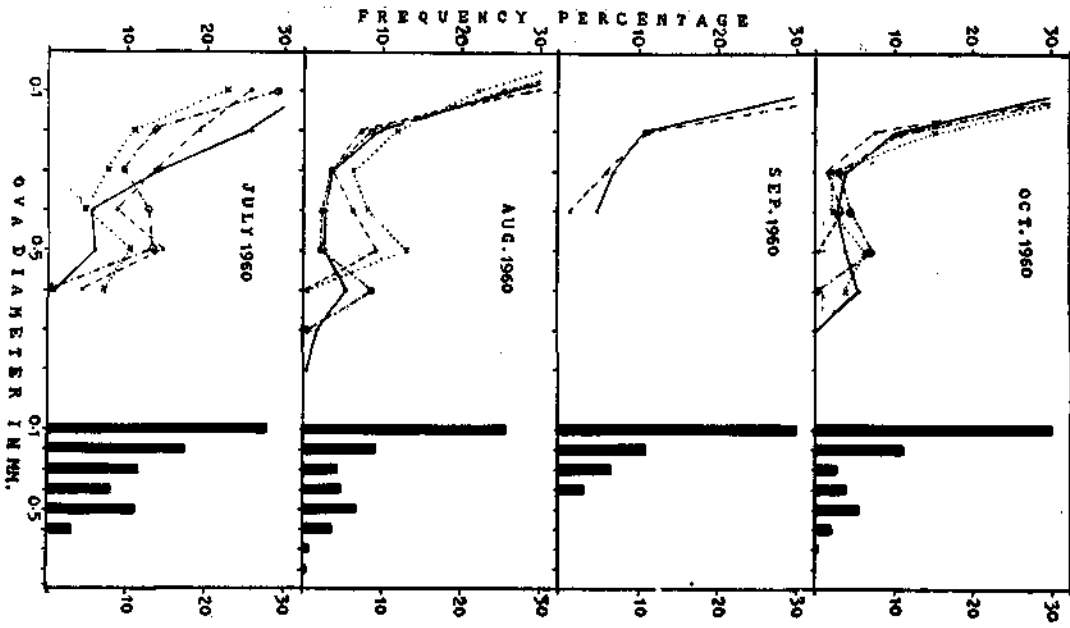
histologically that every female pilchard is able to spawn many times in the same season. De Jong (1940) is of the view that in *S. fimbriata* from Java Sea the first batch of eggs reaches maturity before a second one separates from the general stock, so that just before spawning the frequency curve shows two well-separated peaks. After spawning the ovary contains besides the small eggs of the general egg-stock, a batch of rather large eggs, half way to maturity, which will be spawned in due course. The absence of fully ripe fish in the fishery is a handicap to infer conclusively whether the same sardine spawns more than once. No evidence is available from the present ovarian studies to suggest the possibility of more than one spawning per individual fish. On the other hand it appears that the larger fish ripen at an earlier date than the smaller individuals, probably just attaining their first maturity. There is a slight difference between the rate of development of the gonads of larger and smaller fish. It appears that *S. fimbriata* must be having a prolonged spawning period from September or even late August to February with the older fish spawning earlier in the season. This view is well supported by length frequency observations also. Monthly progression in the ova diameter during the three seasons also throw additional light on the maturation cycle of *S. fimbriata*. One group of ova, which ultimately is destined to become ripe in the season, is distinctly separated from the remaining stock. The ova start attaining maximum size in June and spent individuals appear around August. In the spent fish the block of mature ova is spawned almost completely. Any unspawned ova in this group are quickly resorbed.

Spawning— Studies relating to the percentage of maturity stages during the period reveal some interesting features. Data regarding the maturity of females is given in Tables 3 and 4. Most *S. fimbriata* attain maturity when they are 15.0 to 16.0 cm. The data show that the ovaries are in Stages IV and V of maturity from April onwards. Perhaps the environmental conditions give the inducement to become ripe and spawn. The total absence of mature fish during November to March is significant. The presence of fish in Stages III and IV during September and October provides adequate evidence to indicate that all the fish in Stages III and IV during the pre-spawning and spawning months did not take part in the spawning during August.

Fecundity— The egg production per female varies considerably among *S. fimbriata* (Table 5). Twelve females from 13.8 to 18.4 cm were observed. Ova in the advanced group of maturity were counted. Smaller fish in the 13.5—14.5 cm size range produces 5,500 to 16,300 eggs in a season. Fish of 17.0 cm produces about 33,700 eggs, whereas *S. fimbriata* of 18.0 cm produces nearly 41,700 eggs. It is possible that as the fish wait for the spawning time more eggs are added to the mature stock.

FOOD AND FEEDING HABITS

No detailed analysis of food and feeding habits of *S. fimbriata* was undertaken during the course of this study. Only preliminary observations were made to find



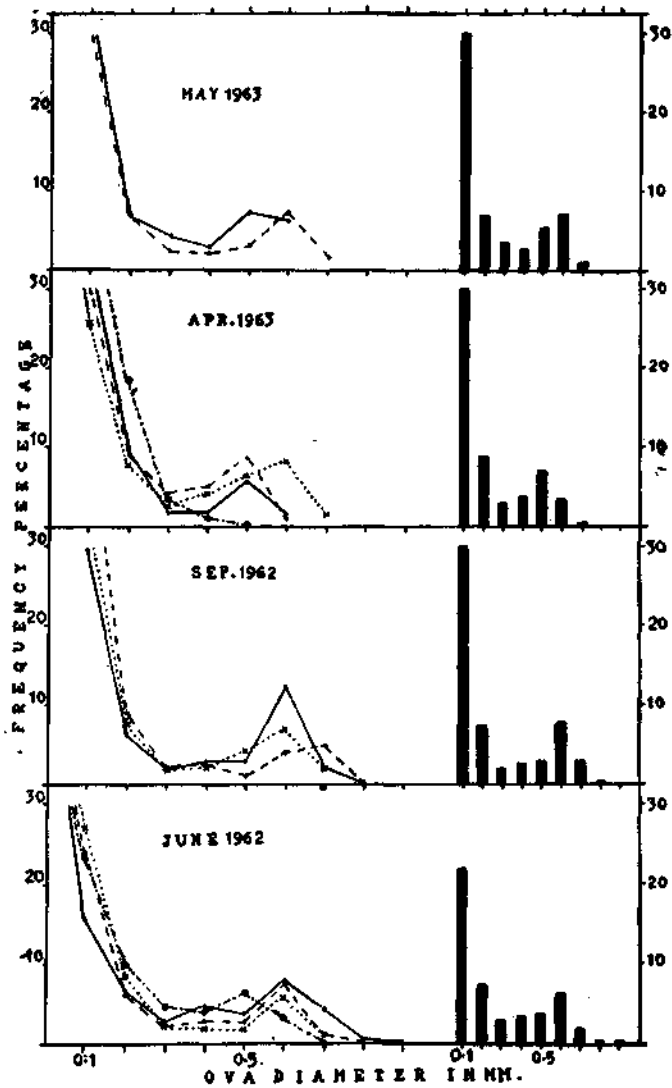


FIG. 6. Individual and combined ova diameter frequency of *S. fimbriata*.

out the feeding activity during different stages of growth and the food items of the sardine. Gut contents in the fresh condition were observed from over 850 specimens ranging from 3.5 to 18.0 cm. The index of abundance of *S. fimbriata* feeding on different organisms is given in Table 6. The numbers have been calculated in the following way:

$$\frac{\text{No. of fish feeding on a particular organism}}{\text{Number of fish examined}} \times 100$$

TABLE 3. *Maturity stages of female Sardinella fimbriata.*
(Months in which only indeterminates occurred are omitted)

Months	Total sexed	Number of females at stage					
		I	II	III	IV	V	VII
1960							
July	46	..	..	..	46	..	..
August	77	28	20	15	9	4	1
September	35	13	19	1	..	..	2
October	139	12	114	9	2	..	2
November	94	51	43	..	..	..	..
1961							
March	10	1	7	1	1	..	..
May	89	5	40	14	7	10	13
October	64	7	51	6	..	..	..
November	23	17	6	..	..	..	..
1962							
April	40	..	..	1	2	4	33
May	27	..	..	9	..	1	17
June	33	..	1	16	15	1	..
September	19	3	11	1	4	..	..
November	112	2	110	..	..	..	..
1963							
April	40	..	17	14	3	..	6
May	23	..	2	14	6	..	1
Total	871	139	441	101	95	20	75

TABLE 4. *Maturity of female Sardinella fimbriata of different length groups.*

Length groups (in cm)	1960—61		1961—62		1962—63	
	Maturing	Mature	Maturing	Mature	Maturing	Mature
10.0	1	..	..	..	..	..
10.5	1	..	..	..	..	..
11.0	2	..	..	..	..	..
11.5	1	..	2	..	..	..
12.0	10	..	2	1	..	..
12.5	11	1	8	1	..	..
13.0	23	2	8	2	7	..
13.5	51	7	23	9	8	..
14.0	87	7	22	9	6	1
14.5	109	11	28	6	5	1
15.0	61	27	33	16	9	2
15.5	33	18	15	16	10	..
16.0	9	16	8	21	5	..
16.5	2	5	3	11	6	1
17.0	..	1	..	2	2	1
17.5	..	..	..	1	..	1
18.0	..	..	..	1	..	..
Total	399	95	152	96	56	7

TABLE 5. *Estimated number of ova in Sardinella fimbriata ovary.*

Ovary No.	Fish length (cm)	Fish weight (g)	Ovary weight (g)	Stage of Maturity	Total number of ova in advanced group
1	15.2	31	1.152	IV	9937
2	14.5	27	0.711	IV	6857
3	13.8	22	0.460	III	5525
4	17.0	44	2.900	IV	33700
5	14.7	28	1.175	IV	16341
6	14.0	25	1.105	IV	107311
7	14.2	25	0.880	IV	12158
8	18.4	58	4.610	V	41753
9	15.4	32	2.130	IV	16938
10	14.6	32	0.660	IV	5695
11	15.4	35	1.300	IV	13110
12	14.1	27	1.135	IV	15881

TABLE 6. *Food items in the stomach of Sardinella fimbriata from Vizhingam.*

Year and range of body length (cm)	Condition of stomach			Food organisms									
	full	half full	empty	Fish tissue	Copepods	Aceres	Mysis	Other crustaceans	Sagitta	Crustacean eggs	Alima larva	Molluscs	Pyhyto-plankton
1960-61 3.5-17.0	89	92	114	8	129	30	38	61	3	30	1	16	24
1961-62 11.0-18.0	0	4	185	4	..	..	..	..	..	..	..	..	..
1962-63 10.0-17.5	28	..	348	..	28	..	..	28	1	..	..	13	..

Accurate estimate of the quantities of each food item in the gut contents of fishes has been a subject of much controversy. Many a personal error and bias possibly creep into food estimates. For that reason the quantity of the food organism has not been taken into consideration in this work. Only whether the particular organism was fed on by the fish or not was considered. A precise evaluation of the feeding habits of the fish was made difficult because of the presence of a large number of stomachs without food. Over 75% of the fish examined had empty stomach. Empty stomach was prevalent in the larger size groups. Copepods and other crustacean items were preferred by majority of the fish indicating plankton-feeding habit.

DISCUSSION

The *Sardinella fimbriata* catch at Vizhingam shows widespread monthly as well as annual fluctuations. The data provide a rough measure of the changes occurring in the fishery and with certain limitations may be considered to be proportional to the abundance of fish on the coast during the fishing season. Irregularities in the movements and behaviour of the fish may have played a great part in the availability of the fish to the fishermen. Furthermore, during certain years the unfavourable sea conditions should have made important reduction in sardine fishing when they are more abundant. This would tend to distort the availability index. The present study is inadequate to give any conclusive inference about the availability of this fluctuating food resource.

An interesting feature of the *S. fimbriata* fishery is the presence of very small fish, as small as 2.5 cm. It is a sure sign that the spawning grounds for the fish are not far off from the Vizhingam coast. Very young age groups occur between November and March. Although fish from 2.5 to 17.5 cm or even 18.5 cm enter the fishery every year, constructing a growth pattern for the fish is a great difficulty. Size groups suddenly disappear from the fishing grounds for a few months and an unexpected size group appears after the lapse of two or three months. This is more or less the result of multiple recruitment within the season. In such a situation failure of one or other of the recruitments is enough to adversely affect the availability in general leading to a reduction in catch.

Hickling and Rutenberg (1936) propounded the theory that vital information regarding the spawning habits of fish may be obtained by the investigation of a mature ovary. According to them the number of peaks of ova in a mature ovary gives a clue to the number of spawnings per individual. From the Java Sea De Jong (1940) has observed that *S. fimbriata* has two spawnings in a season. Just before spawning the frequency curve shows two well separated peaks. A similar multiple spawning is observed in the Californian sardine by Clark (1934), in the European sardine by Andreu and Pinto (1957) and in *Thrissoctes mystax*, *T. dussumieri* and *Anchoviella* spp. from the Waltair coast by Dharmamba (1959). A quite contrary picture is seen in *S. fimbriata* from the south-west coast of India where each individual most probably spawns only once during the season. Nair (1959) observed a similar spawning nature for the Indian oil sardine based on ova diameter studies. The observations of Dharmamba (1959) on *S. gibbosa* from the Waltair coast reveal close similarity in ovarian structure between *S. fimbriata* and *S. gibbosa*. Based on an elaborate study of the maturation and spawning habits of *S. gibbosa* she infers that since there is only one mode formed by the big maturing ova and as it is sharply separated from the rest of the stock of eggs, spawning in this species is restricted to a definite period and most probably each individual spawns only once during each season. The complete demarcation of a group of ova in the mature ovary of *S. fimbriata* gives the impression that individual fish spawns only once in the season.

But, the presence of many fishes with mature and maturing ovaries after the first batch of fish have been spawned is an unmistakable indication that the period of spawning is extended.

SUMMARY

The present study deals with the fishery and certain biological aspects of the sardine *Sardinella fimbriata* from Vizhingam on the south-west coast of India. Landings in certain months reach as high as 42,566 kg. while in certain other months the fish is entirely absent. Fish of 2.5 to 18.5 cm total length are recorded in the landings during the three seasons from July 1960 to June 1963. Small sardines occur from November to March. Larger sardines above 15.0 cm are recorded in several months. The major portion of the catch is composed of indeterminates. A slight preponderance of females over males is indicated in all the three years. Based on ovarian studies it is inferred that the breeding season of the sardine is from August to February with the individuals spawning only once in the season. There is indication that larger and older fish become ripe earlier than smaller and younger fish. Fecundity of individual female varies from 5,500 to 41,700 eggs according to the size of the fish. *Sardinella fimbriata* is a plankton feeder feeding mostly on copepods and other crustacean organisms.

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