

# THE SARDINE FISHERY OF VIZHINJAM WITH SUGGESTIONS FOR IMPROVEMENT

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## ABSTRACT

Lazarus, S. The sardine fishery of Vizhinjam with suggestions for improvement. *Aqua. Biol.*, Vol VII, PP-1988

The annual landings of sardine fishery at Vizhinjam for the period 1970-77 have been found to fluctuate between 126.6 and 536.7 tonnes with an average at 272.3 tonnes forming 6.5% of the total fish catch of the centre. The fishery extends throughout the year with one major peak during May and two minor peaks during August and October months. The fishery was supported by seven species of sardines namely, *Sardinella gibbosa*, *S. longiceps*, *S. sirm*, *S. davi*, *S. fimbriata*, *S. sindensis* and *S. clupeioides* forming 40.0%, 23.1%, 20.7%, 9.8%, 4.8%, 1.2% and 0.4% of the catch respectively. The important gears that are used for the exploitation of sardines include gill net (*Chala vala*), boat seine (*Thattu madi*) shore seine (*Kara madi* or *Kampa vala* or *Nonna vala*) and hooks and line (*Achiri*) with an annual average contribution of 62%, 34%, 3% and 1% respectively. The fishery has been explained by describing the seasonal and biological conditions of the individual species and the operational details and seasonal use of the different gears. An attempt has been made to see the relationships, if any, between the fishery and rainfall. A few suggestions have been made to improve the fishery by discussing earlier works on the subject.

## INTRODUCTION

Vizhinjam (lat. 8° 22' 30" N and long. 76° 59' 15" E) is one of the important fish landing centres in Kerala with facilities to carry out fishing operations throughout the year by changing crafts and gears according to the seasonal requirements and availability of different fish shoals. Sardines form a major component among the various groups of fishes which contribute to the local fisheries. Unlike other areas in Kerala where the sardine fishery is known mainly by the Indian oil sardine, here it is known not only by oil sardine, but also by a variety of other species of sardines called lesser sardines, which are normally abundant in other states like Tamil Nadu, Andhra and Karnataka. As there is no exclusive account available on the sardine fishery of this area a comprehensive account on the fishery of the sardines of this area is felt necessary. The earlier works which deals with the sardines of this area are those of Nayar (1958), Bennet (1965, 1971), Radhakrishnan (1969, 1973), Lazarus (1973, 1977, 1978, 1983, 1984, 1985, 1986), Raja and Lazarus (1975), Luther *et al.*, (1982) and Bennet *et al.*, (1986). The seasonal trend of the fishery and its relation to rain fall, species constituting the fishery and their seasons and size composition, fishing gear and their contribution to the fishery, marketing and some suggestions for improving the sardine fishery of the area are the major aspects dealt with in this paper.

## MATERIAL AND METHODS

The present account is based on the catch data collected during the period 1970-77. Random samples of sardines were collected biweekly and analysed to assess

the species composition and for biological studies. Normally 30 to 50 fish were sampled from each gear and measured in fresh condition for biological observations on each sampling day. The method of raising the sample value to catch as described by Sekharan (1965) was followed for obtaining the monthly estimates of total catch of each species and for the number of fish in each length group. Samples were collected separately from boat seine, shore seine, gill net and hooks and line. The catch per unit of effort was calculated separately following Sekharan (1965). The rain fall data for the period 1970-77 recorded at Trivandrum air port were obtained through the courtesy of the Meteorological centre, Observatory, Trivandrum. The term sardine as applied in this account relates to the species of the genus *Sardinella*.

## RESULTS

### The trend of sardine fishery at Vizhinjam

The annual sardine landings at Vizhinjam fluctuated between 126.6 and 536.7 tonnes with an average at 272.3 tonnes during the period 1970-77 (Table-I) forming about 2.8% to 11.4% of the local fish catch (Fig.1) with an average at 6.5%. The fishery extends from January to December with one major peak during May and two minor peaks during August and October months (Fig. 2). As in the case of other areas here also the fishery is subjected to wide range of fluctuations. The data analysed to find out the fluctuation using the analysis of variance technique are presented in Table II. It is seen that there is no significant difference in the catch between the years of study or between the three different seasons. Where as there is a significant difference found between the different months within each season.

### Sardine fishery in relation to rain fall

Monthly rain fall data for the years 1970 to '77 is presented in Fig. 3. The correlation coefficient worked out between the rain fall and average monthly catch of sardines of the study area show that there is no relationship between rain fall and sardine catch during the years 1970 to '76, whereas a relationship is discernible during the year 1977, the correlation coefficient being 0.6928 which is significant at 5% level of significance. The linear regression equation relating rain fall to sardine catch during 1977 is

$$Y = 1.72x + 374.4120$$

where 'Y' the sardine catch and 'x' is the rain fall. The regression is given in Fig. 4.

### Species composition in the fishery

Sardine fishery was supported by seven species in this area during the study period. According to their order of abundance they are *Sardinella gibbosa* (Blkr.) *S. longiceps* (Val.), *S. sirm* (Walb.), *S. dayi* (Regan), *S. fimbriate* (Val.) *S. Sindensis* (Day), and *S. clupeoides* (Blkr.). Table I gives the annual landings of various species of sardines, and Fig. 5 illustrates the year-wise percentage composition of various species of sardines recorded at Vizhinjam. Fig. 6 gives the succession in the seasonal occurrence of

TABLE I

Annual landings (kg) of various species of sardings at Vizhinjam for the years 1970-77

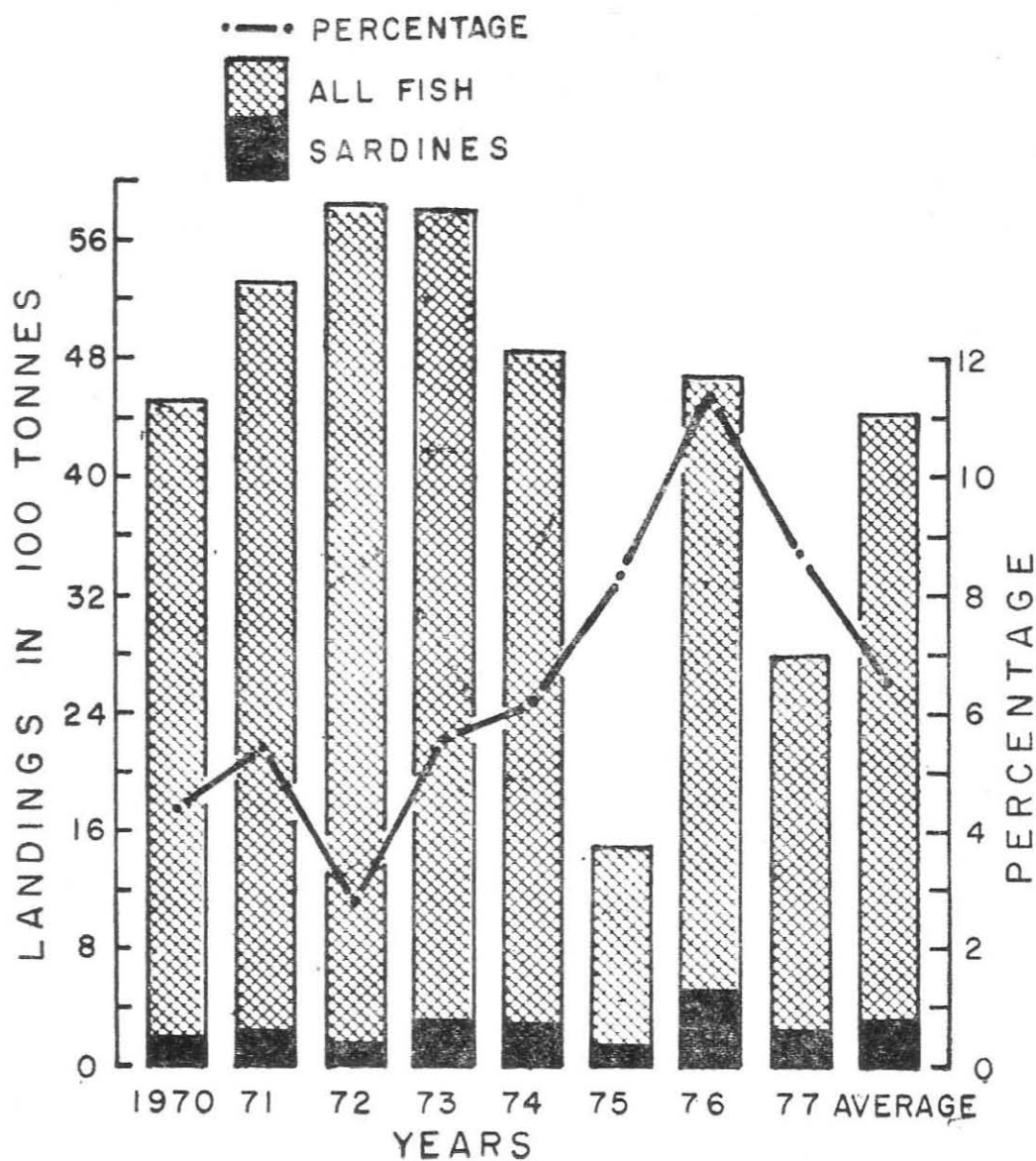
<i>Species</i>	1970	1971	1972	1973	1974	1975	1976	1977	Total	Average	% age Range	composition Average
<i>S. gibbosa</i>	12294	169200	85528	146071	66296	79208	147131	54403	870784	108848	22.7-62.6	40.00
<i>S. longiceps</i>	1739	5152	15202	17874	33561	23020	286513	120723	503784	62973	0.6-53.3	23.10
<i>S. sirm</i>	10542	30353	47076	51641	157778	21735	78896	53482	451503	56438	5.3-53.0	20.70
<i>S. dayi</i>	62772	55619	5145	65669	12695	1290	5631	4134	212955	26619	1.0-31.6	9.80
<i>S. fimbriate</i>	533	23980	3207	42311	28369	1302	3522	2209	105433	13179	0.3-13.0	4.80
<i>S. clupeioides</i>	—	333	6210	850	—	—	1008	—	8401	1050	0.1-3.8	0.40
<i>S. sindensis</i>	—	—	—	—	—	—	13966	11539	25505	3188	1.0-5.0	1.20
Total	198533	284637	162368	324416	298699	126555	536667	246490	2178365	272295	—	100.00

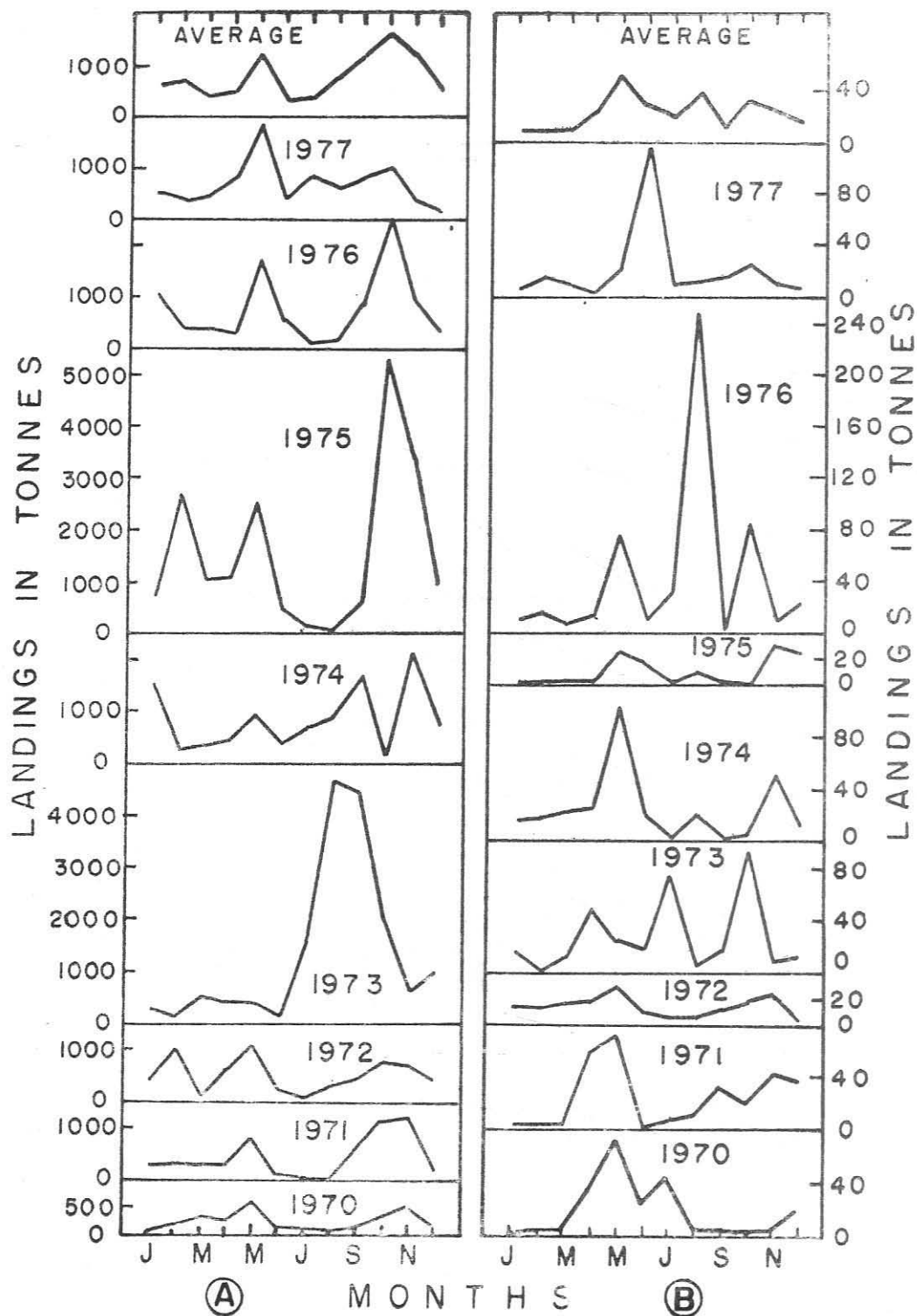
Table II

Analysis of variance table

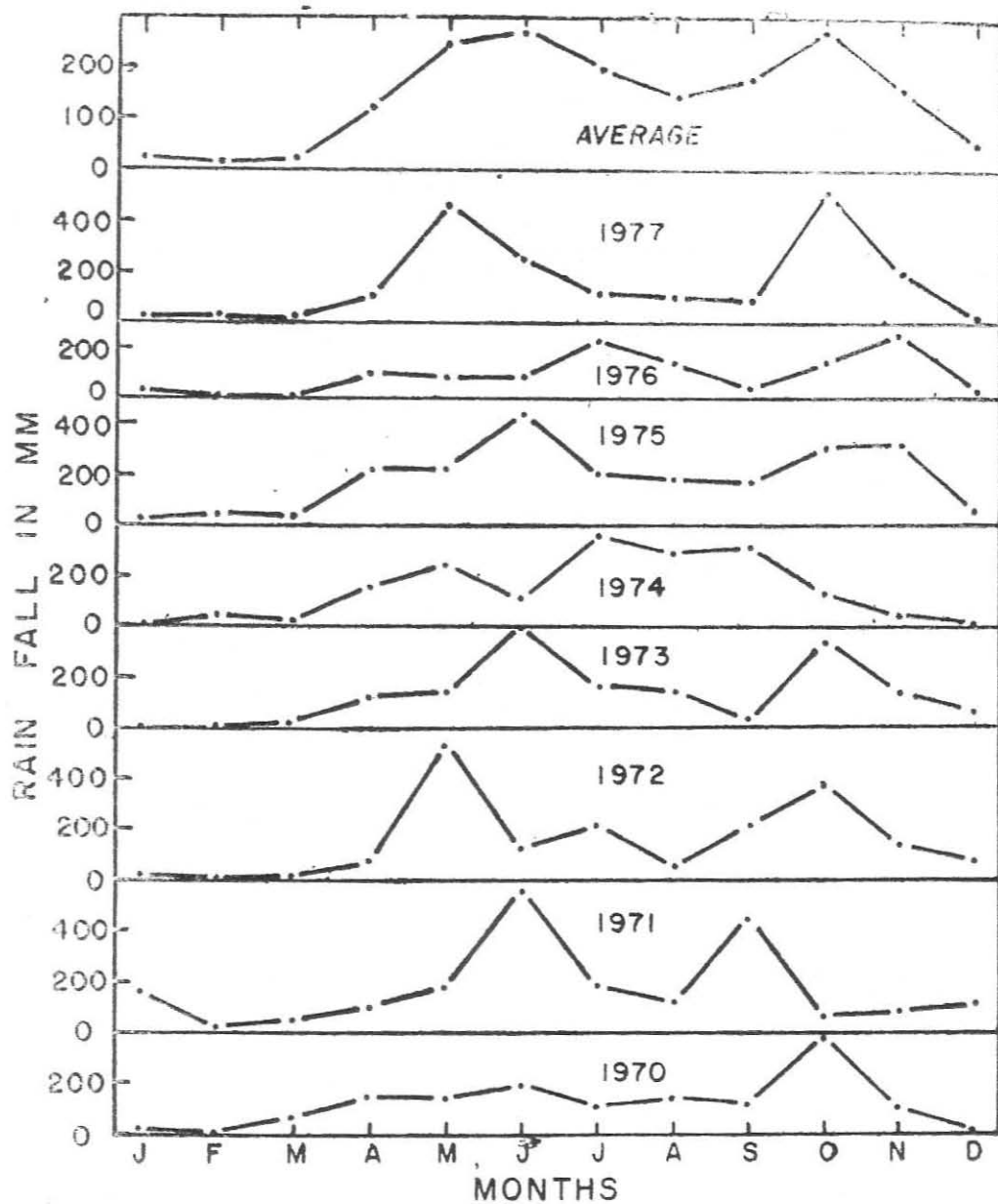
<i>Source</i>	<i>DF</i>	<i>SS</i>	<i>MSS</i>	<i>F ratio</i>	<i>Inference</i>
Total	95	674336.000			
Years	7	62130.7360	8875.8201	1.4638	Not significant
Seasons	2	1707.4999	853.7499	0.1408	Not significant
Periods within the seasons	9	143621.3400	15957.9270	2.6319	Significant at 5% level
Error	77	466877.2400	6063.3421		

DF = Degree of Freedom; SS = Sum of Squares; MSS = Mean Sum of Squares





## THE SARDINE FISHERY OF VIZHINJAM



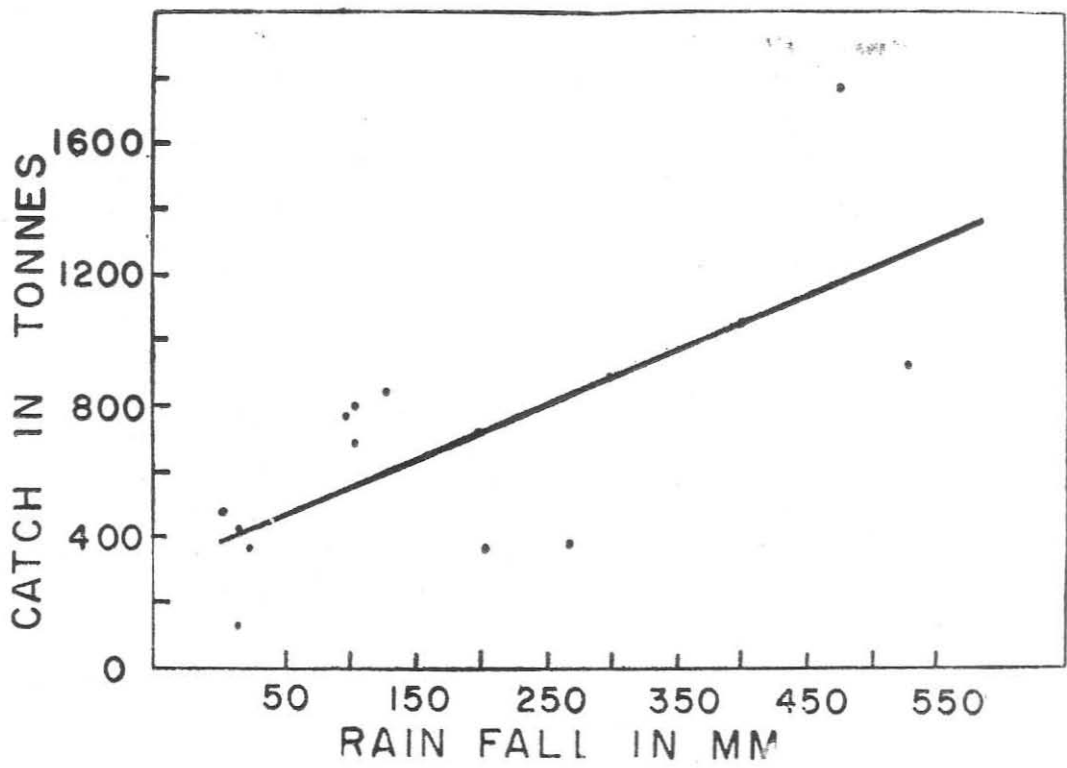


Fig. 4. Regression coefficient of rainfall and catch of sardine

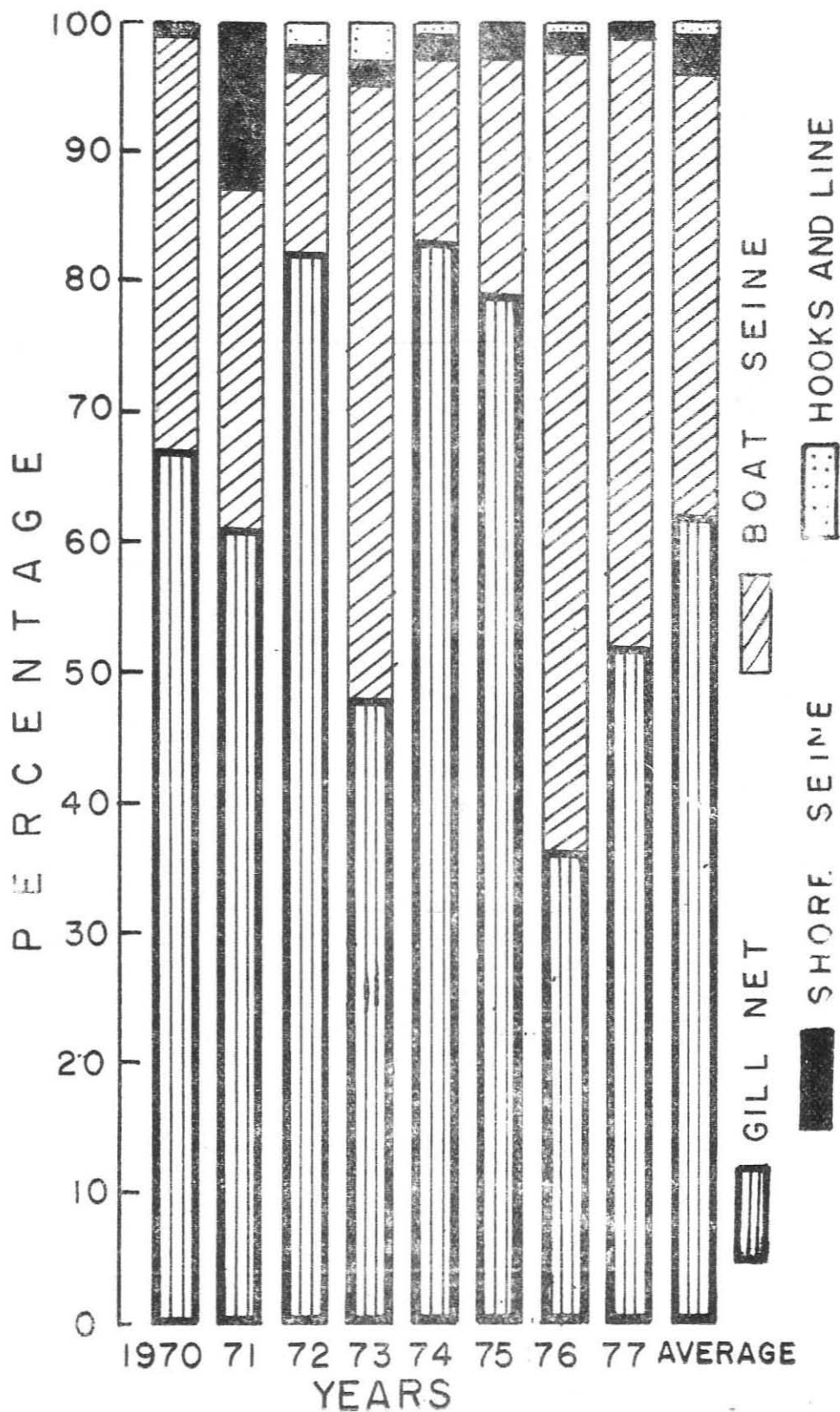


Fig. 5. Species composition of sardines at Vizhinjam during the period 1970-77



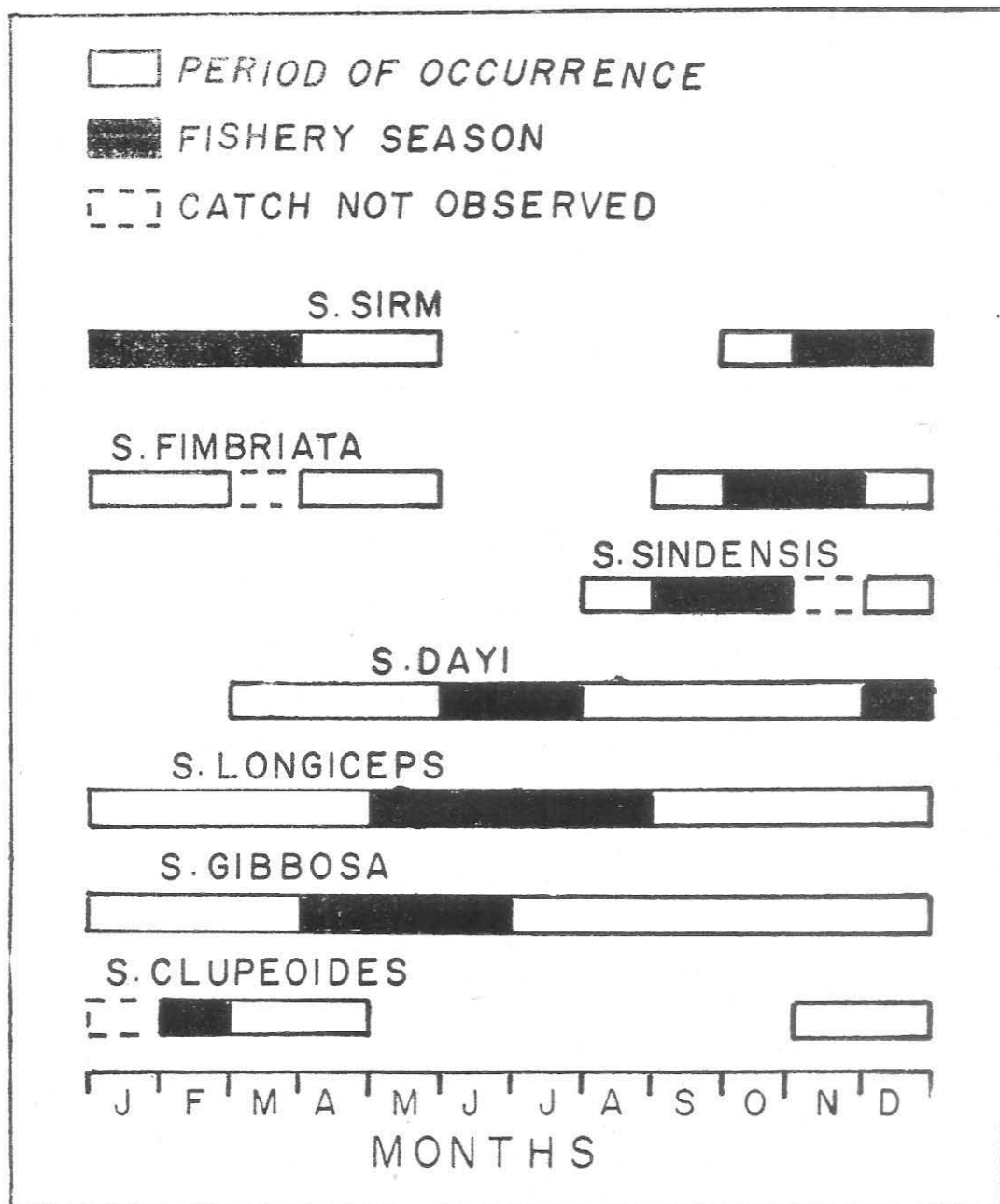


Fig 6. Period of occurrence and fishery season for the different species of sardine at Vizhinjam

different species of sardines and the period of occurrence. Monthly average catch of different species of sardines is given in Table III.

(a) *Sardinella gibbosa*

It is the dominant species of sardine of this area. It is available throughout the year, with a peak between April and June forming 55% of the annual catch (Table III). The month May alone accounts for 30% of the catch. Good landings of this species were also observed during August and October. The annual catch of this species ranged between 54.40 and 164.20 tonnes with the average at 100.85 tonnes forming 22.7 to 62.6% with an average at 40.0% of the total sardine catch at Vizhinjam. The size of the fish ranges between 45 and 185 mm total length, the dominant size varies from 90 to 160 mm in different months. Early juveniles (25 mm length onwards) normally appear in the inshore catches during January-March/May and August-October months. Immature fish in size groups 60-75 mm and mature fish in 140-165 mm size groups dominate the catch during the peak period between April and June.

(b) *Sardinella longiceps*

Though it is considered as the foremost species of fish in the fisheries of the west coast of India, it contributed to only 0.9-18.2% of the sardine fishery of this area during 1970-75. During 1976 and '77 however its contribution rose up to 53.3% and 49.0% respectively of the sardine catch. A revival of the fishery was noticed since 1974 (Table I). Thus from 1.7 tonnes in 1970 and 32.9 tonnes in 1974 the oil sardine registered a record catch of 285.8 tonnes during 1976 even though their major area of occurrence is supposed to be up to Quilon in the North. Because of this, the oil sardine which used to occupy the 5th place among sardines up to 1973 rose to the second place in 1976 and 1977. The average annual landings of the oil sardine was estimated as 62.8 tonnes. May-June and August form the periods of good landings of the species accounting for 74.2% of the annual catch followed by July and September-October accounting for about 22% of the annual catch (Table III). Individuals of the size range 15-180 mm total length were found in the fishery, with the dominant size varying from 70 to 170 mm in the different months. Post-larvae, early juveniles and juveniles occur during June to September months. Mostly indeterminates and immature fish formed the fishery during June and July, mature fish (around 155 mm size group) during May and again immature, (around 110 mm and 135 mm size groups) dominate the catch during August-October months.

(c) *Sardinella sirm*

This species formed 5.3 to 53.0% of the total sardine catch of the area and is third in the order of abundance. Although it appears in catches as suddenly as it disappears a definite periodicity in its occurrence could be made out. The fishery starts in this area by October/November and lasts till April/May. Peak landings were often noted in November (Table III). However, fairly good landings were also recorded during December-March and in May. The annual landings of this species varied

TABLE III

Monthly average landings (kg) of different species of sardines at Vizhinjam during 1970-77

Month	<i>S. gibbosa</i>		<i>S. longiceps</i>		<i>S. sirm</i>		<i>S. dayi</i>		<i>S. fimbriata</i>		<i>S. clupeoides</i>		<i>S. sindensis</i>	
	Catch	% age	Catch	% age	Catch	% age	Catch	% age	Catch	% age	Catch	% age	Catch	% age
January	291	0.27	30	0.05	8173	14.48	—	—	132	1.00	—	—	—	—
February	1231	1.31	305	0.49	6135	10.87	—	—	78	0.60	665	63.33	—	—
March	1604	1.47	3	0.01	7172	12.71	80	0.30	—	—	111	10.57	—	—
April	18097	16.63	132	0.21	3133	5.55	2474	9.29	1704	12.93	106	10.10	—	—
May	32382	29.75	9684	15.42	7473	13.24	400	1.50	2457	18.64	—	—	—	—
June	9762	8.96	13767	21.93	—	—	3030	11.38	—	—	—	—	—	—
July	5496	5.05	3762	5.99	—	—	11884	44.64	—	—	—	—	—	—
August	15317	14.07	23203	36.87	—	—	748	2.81	—	—	—	—	52	0.41
September	4044	3.72	3707	5.90	—	—	968	3.64	580	4.40	—	—	3549	27.83
October	13253	12.18	5982	9.53	3297	5.84	878	3.30	5487	41.64	—	—	8670	67.98
November	5277	4.85	2079	3.30	13184	23.36	508	1.92	2146	16.28	1	0.10	—	—
December	2092	1.92	192	0.30	7871	13.95	5649	21.22	594	4.51	167	15.90	482	3.78

between 10.54 and 157.78 tonnes with an average at 56.44 tonnes (Table I). The size range in the fishery varied from 10 to 230 mm and the dominant size varied from 120 to 220 mm. Post-larvae, early juveniles and juveniles occur in the fishery from December to May with a peak during February and March. But adults were seen all through the season. Mature fish around 185 mm and 190 mm size groups dominated the catch during the November peak. Mature fish around 200 mm size group and immature around 140 mm size group dominated the catches during December-March.

(d) *Sardinella dayi*

It ranked fourth among the species of sardines landed at Vizhinjam and its contribution ranged between 1.0 and 31.6% with the average at 9.8% (Table I). The fishery of *S. dayi* at Vizhinjam showed wide fluctuations from 1.29 to 65.67 tonnes with an average at 26.62 tonnes. The fishery season extends from March to December with two important peaks, one during June-July and another during December (Table III) accounting for 56.0% and 21.2% respectively of the annual landings. Good landings were also observed during April. It is usually not available in the fishery during January and February. The size range of the fish in the fishery varied from 20 to 150 mm total length, the common sizes varying from 70 to 140 mm in different months. Juveniles from 20 mm size onwards form the fishery during March-May. The June-July peak was dominated by immature fish with sizes varying between 70 and 115 mm and the December peak was dominated by mature fish of size 130 to 140 mm.

(e) *Sardinella fimbriata*

This species contributed 0.3%-13.0% of the sardine catch at Vizhinjam with an average at 4.8% (Table I). This species ranked fifth in the order of its abundance in this area and it was observed in the catches from September to May with fairly good landings during October-November months accounting for 57.9% of the average annual landings (Table III). A minor peak supporting 31.57% of the catch occurs during April and May. It is interesting to note that there was no landings of this species during March in all the 8 years of observation. However, Radhakrishnan (1973) reported this species in the fishery during March, 1965. The average annual landings of this species was estimated as 13.80 tonnes. During the peak fishery period between October and November, the size range found in the fishery was between 140 and 174 mm total length with immature fish between 150 and 160 mm size groups dominating the catch. Normally indeterminates, immature and developing to the first maturity stage were found in the fishery.

(f) *Sardinella clupeioides*

This is a rare species in this area and it contributes very little (0.1 to 3.8%) to the sardine fishery here. The annual landings ranged from 0.3 to 6.2 tonnes (Table I). The fish occasionally occur during November to December and February to April. Taking into consideration the observations by Bennet (1965) it can be said that the species has a single fishery season in this area extending from November to May. February can be

considered as the peak period (Table III) of its occurrence accounting 63.3% of the annual catch. December, with its contribution of about 16% makes the secondary peak for the species. The size range of the species during the peak period was from 195 to 265 mm total length. The dominant size groups found were 205-209 mm and 220-224 mm. Most of the fish were indeterminates and immature.

(g) *Sardinella sindensis*

The occurrence of this species in this area was reported for the first time in 1976 (Lazarus, 1986). Since then the annual catch has been estimated as 13.97 tonnes for 1976 and 11.54 tonnes for 1977 (Table I) and it constituted 1.0-5.0% of the sardine catch with an average at 1.2%. The fishery season extends from August to December with a peak during September-October months (Table III). The fishery during the peak period was supported by individuals with a size range 130-181 mm and the maximum size range observed in the fishery was between 120 and 191 mm.

**Gearwise contribution to the sardine fishery**

The important gear which contribute to the sardine fishery in this area are gill net, boat seine, shore seine and hooks and line and their annual average contribution to the sardine fishery being 62%, 34%, 3% and 1% respectively. Fig. 7 gives the yearly percentage contribution by the different gears to the sardine fishery for the year 1970-77 at Vizhinjam. Fig. 8 shows the period of operation of each type of net at Vizhinjam together with the best period as revealed by the catch statistics. The annual CPUE of sardines (all species combined) by various gears for the year 1970-77 at Vizhinjam is given in Table IV. Table V gives the percentage composition of various species of sardines in the catches by different gear at Vizhinjam.

(a) **Gill net**

Being a selective gear, fish above 80 mm in length alone are caught in it. About 37-83% of the annual sardine catch at this centre with the average at 62% is contributed by this gear. An average of 156 tonnes of sardines are netted per year by this gear. The annual CPUE varied from 7.89 to 29.40 kg with the average at 15.20kg. (Table IV). *Sardinella gibbosa* is the most common species in this gear forming 48.4% of the catch followed by *S. sirm* which forms 33.6% of the catch. Other species of sardines encountered in this gear are *S. longiceps*, *S. dayi*, *S. fimbriata*, *S. sindensis* and *S. clupeioides*.

(b) **Boat seine**

This is a non-selective gear, the mesh size at the cod end being about 7mm. Fish of all sizes are taken by this gear. Its annual contribution to the sardine fishery at Vizhinjam has been estimated as varying between 22.5 and 331.0 tonnes with the average at 106.0 tonnes. Sardines account for 13.86%-61.59% with the average at 34.00% in this gear. Its annual CPUE varied from 0.71 kg to 15.18 kg with the average at 5.09 kg. (Table IV). *Sardinella longiceps* is the most common species of sardine in this gear accounting for 47.0% of its catch. Next comes *S. gibbosa* and *S. dayi* forming respectively 28.3% and 16.4% of the catch. The rest of the catch was by *S. fimbriata*, *S. sirm*, *S. sindensis* and *S. clupeioides*.

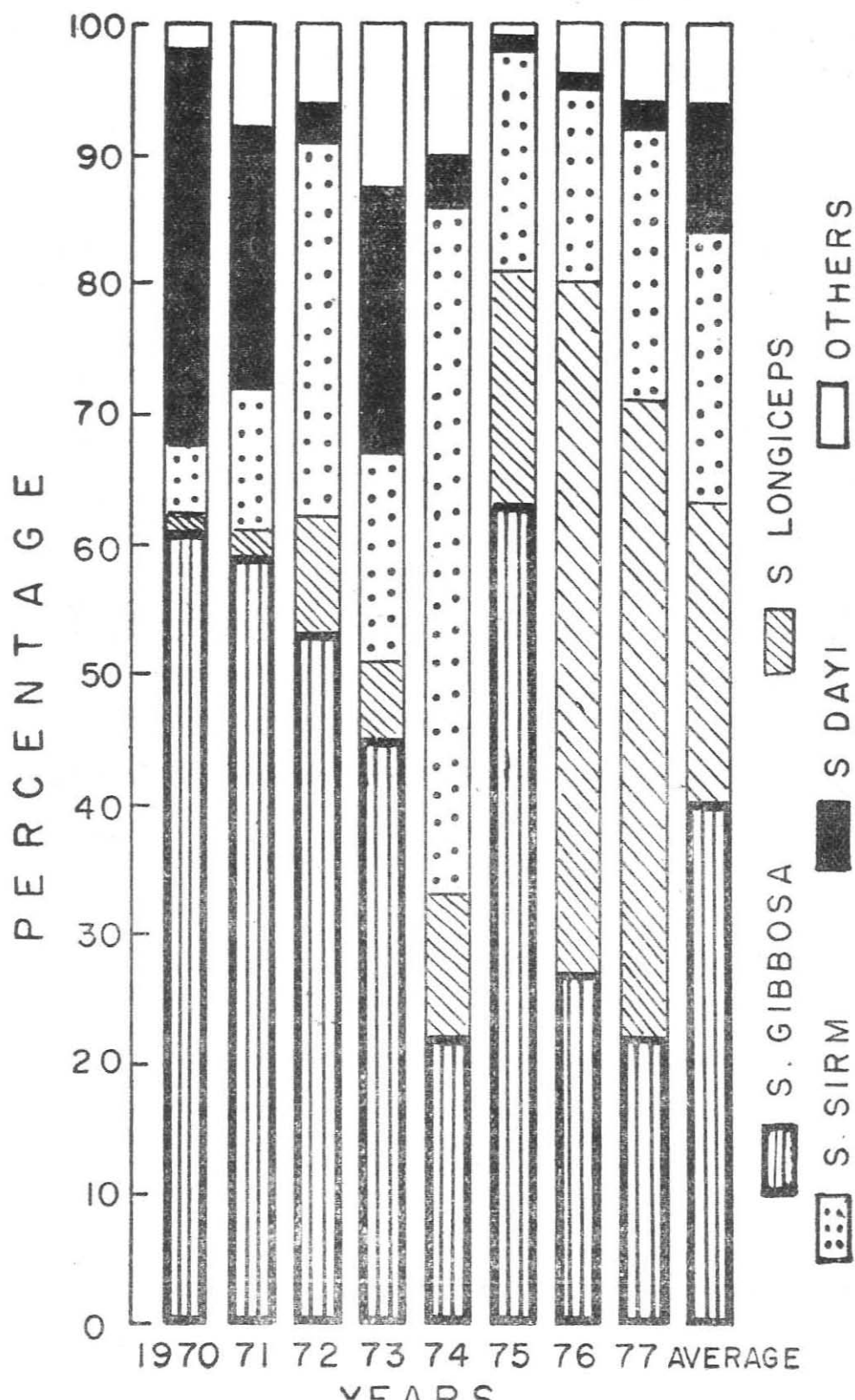


Fig. 7. Gear-wise contribution of sardines by the different gears at Vizhinjam for the period 1970-77

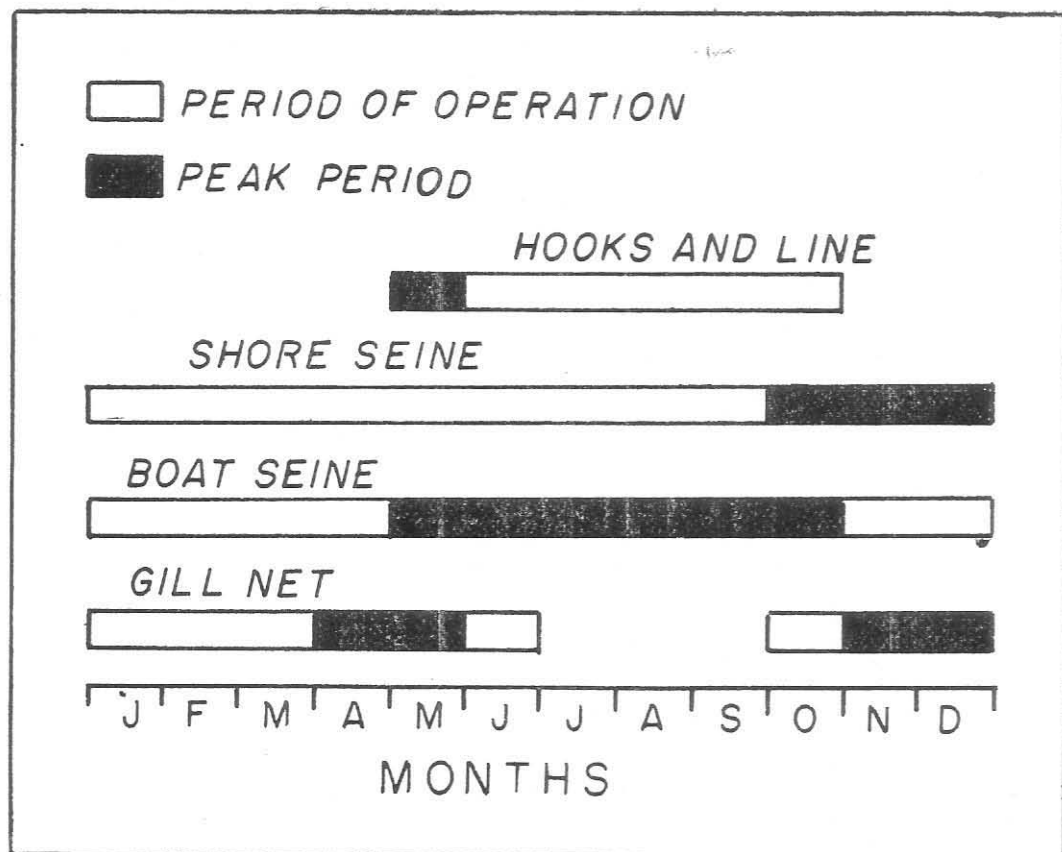


Fig. 8. Period of operation of different types of gear for fishing sardines at Vizhinjam

TABLE IV

Annual CPUE of sardines (all species) by the different gear at Vizhinjam with total catch and effort for the years 1970-77

Year	GILL NET			BOAT SEINE			SHORE SEINE			HOOKS AND LINE		
	Total catch (kg)	Total effort (no.)	CPUE (kg)	Total Catch (kg)	Total effort no.)	CPUE (kg) (no.)	Total catch (kg)	Total effort (no.)	CPUE (kg)	Total catch (kg.)	Total effort (no)	CUPE (kg)
1970	133546	11591	11.52	63543	40318	1.58	1444	2011	0.72	—	—	—
1971	176105	6428	29.40	70314	27958	2.51	38218	1294	29.53	—	—	—
1972	134121	16767	8.00	22503	27281	0.82	2644	739	3.58	3100	10838	0.29
1973	157212	12707	12.37	153973	34822	4.42	2968	698	4.25	7263	12886	0.56
1974	248376	13998	17.74	42002	38725	1.08	6771	1816	3.73	1550	2706	0.57
1975	99535	12622	7.80	23797	33159	0.71	3223	681	4.75	—	—	—
1976	19862	11867	16.74	330527	21776	15.18	6440	1153	5.59	1279	21479	0.06
1977	102640	5717	17.95	141476	9770	14.47	2374	658	3.61	—	—	—



**(c) Shore seine**

Like the boat seine this is also a non-selective gear, the mesh size at the bag portion being 7mm. An appreciable quantity of juveniles are caught by this gear. Peak landings by this gear were observed during October to December. The landings of sardines by shore seines at Vizhinjam varied from 1.4 tonnes to 38.2 tonnes per year with an average of 8.4 tonnes, thus accounting for 0.73-13.43% with the average at 3%. The annual CPUE for sardines varied from 0.72kg to 29.53 kg with an average at 6.96 kg (Table IV). All the available species of sardines are caught in this gear. According to the order of abundance they are: *S. sirm* (30.5%), *S. fimbriata* 29.7%) *S. gibbosa* (20.4%) *S. longiceps* (15.9%), *S. dayi* (2.9%), *S. sindensis* (0.5%) and *S. clupeioides* (0.1%).

**(b) Hooks and line**

This is a drop line locally known as 'achil'. This is also a selective gear and is operated only during day time at 5 to 10 fathoms depth by using artificial baits made of coloured silk called '*Minusum*'. Normally green and white baits are used. Its operation is limited to six months between May to October with intensive operation during May. *Sardinella gibbosa* is the most common species of sardine caught by this gear. Occasionally, however, *S. sindensis* and *S. sirm* are also caught. Sardines above the size of 155 mm total length are caught by this gear. A total of 1.3 tonnes to 7.3 tonnes of sardines were landed annually at Vizhinjam contributing to 0.24% to 2.24% with the average at 1% of the annual sardine catch. The annual CPUE for sardines varied from 0.06 to 0.57 kg with the average at 0.28 kg.

TABLE V

Percentage composition of various species of sardines in the catches  
by different gear at Vizhinjam

Species	Gill net	Boat seine	Shore seine	Hooks and Line
<i>S. gibbosa</i>	48.4	23.3	20.4	92.2
<i>S. longiceps</i>	7.6	47.0	15.9	—
<i>S. sirm</i>	33.6	1.3	30.5	1.9
<i>S. dayi</i>	5.7	16.4	2.9	—
<i>S. fimbriata</i>	2.9	5.9	29.7	—
<i>S. clupeioides</i>	0.5	0.1	0.1	—
<i>S. sindensis</i>	1.3	1.0	0.5	5.9

### (c) Other forms of gill nets

The other forms of gill nets where sardines are caught incidentally are locally known as *Pattu vala*, *Konchu vala* and *Nandu vala* used for catching other fishes, prawns and crabs. Normally sardines are caught in these nets during January, May-June, October and December months in this area.

### Disposal and utilization

The sardines are usually disposed off by way of auctioning on the beach as soon as they are brought to the shore. They are transported to the interior markets by head loads, bi-cycles and motorised vehicles. A small fish market is also situated at the landing centre. No part of the catch is ever used for manure or as cattle feed in the area.

### GENERAL REMARKS

Sardines already reported from this area are: *Sardinella fimbriata*, *S. melanura*, *S. longiceps*, *S. clupeioides*, *S. sirm*, *S. gibbosa* (Nayar, 1958; Bennet, 1965 & 1971 and Radhakrishnan, 1969 & 1973). The present observations show the availability of seven species namely: *Sardinella gibbosa*, *S. longiceps*, *S. sirm*, *S. dayi*, *S. fimbriata*, *S. sindensis* and *S. clupeioides* in this area. *S. melanura* reported by Nayar (1958), Bennet (1965) and Radhakrishnan (1969) and *S. jonesi* reported by Lazarus (1983) were not observed during the course of the present investigation. Out of the seven species of sardines occurring in this area the fishery is mainly supported by four species such as *S. gibbosa*, *S. longiceps*, *S. sirm* and *S. dayi* together contributing 93.6% of the total sardine catch, *S. gibbosa* alone contributing to 40%. The rest of the annual catch (6.4%) comprised of *S. fimbriata*, *S. sindensis* and *S. clupeioides*. Each species has a more or less definite fishery season and it extends from April to June for *S. gibbosa*, May to August for *S. longiceps*, June-July and December for *S. dayi*, September-October for *S. sindensis*, October-November for *S. fimbriata*, November-March for *S. sirm* and February for *S. clupeioides*.

The above specific period of occurrence of different species of sardine in this locality indicates further possibilities of improving the catch by modernisation and gear selection. The gears used for fishing sardines in this area are all indigenous and their operation is confined to the coastal waters only. There is an acute need for improvement and modernisation of traditional practices. The fishing operations with pelagic trawl conducted off Cochin by the Pelagic Fisheries Project have indicated the possibilities of using pelagic trawl for fishes like oil sardine and mackerel. The introduction of this gear for fishing sardines in this area is worth considering. Banerji (1973) recommends developing gill net fisheries along with purse seine fisheries in the off shore waters to catch the older age groups of lesser sardines.

The present study as well as the studies by Radhakrishnan (1973) reveal that except *S. clupeioides* and *S. fimbriata*, for all the other species of sardines, there exists a fishery for adults and spawners around Vizhinjam. Based on the availability of

of spawners, post-larvae and early juveniles in the commercial catches, it is inferred that the inshore area off Vizhinjam is an important spawning ground for sardines especially for *S. sirm.*, *S. longiceps*, *S. dayi* and *S. gibbosa*. Conservation of the spawning stock as well as juvenile stock in this area during the spawning season by making a general awareness among the fishermen about the impact of fishing these size groups in large scale. It is possible by implementing proper extension programmes so that the fishermen themselves will select proper gear while operating in this area for eliminating these size groups. The fishermen co-operatives also can adopt proper procedure for extension through their member-fishermen.

Though it appears that the sardine catch is influenced by the monsoon rains the correlation coefficient worked out between rainfall and sardine catch shows no relationship between rainfall and catch during the years 1970-76. For the year 1977, however, a relationship is discernible which is significant only at 5% level of significance. However, the environmental conditions during and just after the south west monsoon which bring the sardine shoals to the surface in the south west coast area has been reported by Anon (1975). Similarly the monsoon shift providing the required energy for the vertical mixing which brings appreciable quantities of nutrients to the surface layers in this area has been described by Nair *et. al* (1972).

In General roughness of the sea affects the sardine fishery of this area. This is evidenced from the fact that periods of good landings fall before and after the monsoon months (June to September). During the monsoon months the sea appears to be very rough. During this period the effort used for this fishery is also less. The rough sea during 1974 was reported as a probable cause for the failure of the shoals to appear at the surface of the south west coast area has been pointed out by Anon (1957).

The present yield according to the theoretical estimates of Nair *et. al* (1972) is only about one-half of a possible exploitable yield. So they suggest that by increasing the effort the present yield could be doubled within the 50 metre depth zone itself. Since sardines are also caught mostly within this limit it could be applicable to sardines also. But it has to be considered in the limit of the Dynamics of fish populations for stock conservation to maintain the total yield at the highest practicable level by protecting the young fish and regulating fishing effort.

The sardines have a rapid growth and a rather short life span reaching sexual maturity at the end of their first year of life. Since the fishing mortality is significant mainly during a short season in the first year of life a high rate of natural mortality is implied. Consequently, a relatively high rate of exploitation is necessary to retain the exploitation at the level of the maximum sustainable yield of the stocks which could be maintained by modernisation and selection of gear for the appropriate seasons.

#### ACKNOWLEDGEMENTS

The author wishes to express his sincere thanks to Dr. P.S.B.R. James, Director, CMFR Institute, Cochin for the encouragements and to Dr. M.D.K. Kulathingam, Head, Pelagic Fisheries Division of CMFR Institute for the guidance and suggestions.

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