VI. EXPLOITATION

K.V. Narayana Rao

6. 1 FISHING EQUIPEMENT

The types of fishing craft and gear commonly used in the fishery have been evolved to suit the local requirement depending upon the physical characteristics of the coastline, surf conditions as well as habits of fish. Descriptive accounts of the types of these craft and gear, used both on the west and east coasts of India, are given by Hornell (1910a and 1938), Chopra (1951), Anon. (1941 and 1943), and Zeiner and Rasmussen (1958). Later Jones and Rosa (1965 and 1967) have listed the important types of fishing craft and gear commonly employed in the mackerel fishery. Similarly Rao (1969) has shown, among other things, the most common types of fishing boats and nets used in the Indian waters for this fishery.

6. 1. 1 Fishing craft

The craft that are employed in the mackerel fishery of India, are known by various names along the different sections of the coastline, and can be classified essentially into four basic types based on their constructional features (Table I.). A short description of the more important craft viz. dug-out canoes and built-up canoes or canoe boats is given below.

Dug-out canoes: As the name implies, it is made by scooping out from a single log of wood, of either Mango *(Mangifera indica)* or Jarmal *(Tetrameles nudiflora)* or Jungle Jack *(Artocarpus hirsuta).* The keel portion is kept thicker than the sides. The free board is raised by a strake of planking of teak *(Tectona grandis).* The dug-out canoe, although the most commonly employed fishing craft along the west coast, reigns supreme only along the Kerala coast where two types of it are extensively used. A bigger dug-out canoe called *Odam* or *Vanchi* measuring 9.8-10.7 m long,

0.9 m wide and 0.8 m deep and of 3-5 ton displacement is usually employed for operating bag nets; and a smaller type, called *Thoni* with dimensions 7.3x0.9x0.8 m and 2 ton capacity used for drift net, gill net and cast net fishing (Anon., 1943). The latter type is commonly used along the Canara and Konkan coasts also where they are called either *Thoni* or *Pagar* (Chopra, 1951). None is provided with rudder; steering is effected by means of a big paddle used for propulsion as well as control. Few have sail; when they do have, it is either a small square one or a sprit sail (Zeiner and Rasmussen, 1958).

Built-up canoes or or canoe boats: On the Canara and Konkan coasts, along with dug-out canoe, special type of flat-bottomed outrigger boats are used exclusively for the operation of *Rampani* net. These boats, known as *Akada Hody* in Konkan and *Pandi* along the Canara coasts, are nothing but the widened copy of west coast Dug-out, built up of planks of teak wood *(Tectona grandis)*. In size these range from 6 to 12 m in length, 0.7 to 2.4 m in beam and 0.9 to 1.2 m in depth; and are provided with a rudder fitted to the stern post by lashings. Stern to stern they are curved at about the usual angle adopted in dug-outs (Zeiner and Rasmussen, 1958). The basal part of the null of these boats may consist either of a dug-out region with low vertical sides or of three planks - a bottom plank and two narrow vertical side planks rabbeted to the edges of the basal one. In both cases the sides are spread out until they attain a distinct flare. On these flared edges a series of strakes, in turn flaring outwards, is added on order to give necessary freeboard. No mast is carried as the boat is rowed as the net is shot.

The boat is rigged with an out-rigger to give stability. The out-rigger is formed of two bamboo booms and a wooden float. Proximally the booms cross the hull several feet apart and are so tied to the gunwales that the distance between their distal ends decreases. The booms distally extend outboard about 1.5 to 1.7 m and to their distal ends is directly attached a light wooden float made of Maruka (*Erythrina indica*).

Formerly these boats were reported to be 4.9-6.1 m long (Hornell , 1938 and Anon. 1943). But in recent years they are much bigger, measuring 12.2-13.7 m (Pradhan, 1956; Zeiner and Rasmussen, 1958).

Table I

Common types of fishing craft employed in the Mackerel fishery in India

Region	Basic types of fishing craft			
	Dug-out canoes	Built-up canoes or canoe-boats	Plank built boats	Catamarans
1. Maharashtra	Pagar Thoni	Akada Hodi	-	-
2. Mysore	Thoni	Pandi	-	-
3. Kerala	Odam Thoni	Vallam	-	Kattumaram
4. Tamil Nadu	-	-	Vallam (Tuticorin-type boat) Padagu (Masula boat)	Kattumaram Periamaram Chinnamaram
5. Andhra	-	-	Padava (Masula boat)	Theppalu
6. Orissa	-	-	Ber (Masula boat)	-

6. 1. 2 Fishing gear

Surveying the fishing methods of the Malabar and the Coromandel coasts, Hornell (1927 and 1938) has given, *Inter alia* a detailed descriptions of the fishing gear and the methods employed in the mackerel fishery of those regions. Similar but concise information on the subject is also available from the accounts of Anon. (1941 and 1943) and Chopra (1951). Jones and Rosa (1965 and 1967) have also mentioned the most important types of gear employed in the fishery both in India and elsewhere. In the following table are given such of the common types of gear in which mackerel are caught. A short description of these common gear is also given based on the earlier works mentioned above.

Table II

Common types of fishing gear employed in the Mackerel fishery of India

Region	Basic types of fishing gear				
	Bag nets (Boat seines)	Drag nets (Beach seines)	Gill nets	Drift nets	Cast nets
1. Maharashtra	-	Rampani Payawada	Bangada Jal	Pettle bale	Pag
2. Mysore	Kolli bale Paithu bale	Rampani Yendi or Kairampan	Patta bale Chala bale Kantha bale Ida bale	Kandadi bale	Deb bale
3. Kerala	Ayilakolli vala Pattenkolli vala Arakolli vala Odam vala Paithu vala Nethal vala Thangu vala Madi vala	Kara madi Kara vala	Ayilachala vala	Ozhuku vala Noo vala Vangada vala	Veechu vala
4. Tamil Nadu	Thuri valai Mada valai Eda valai	Kara valai Peria valai	-	Vazhi valai Vala valai	-
5. Andhra	Iraga vala	Pedda vala	Oddi vala	-	-
6. Orissa	Iragalai vala	Ber Jal	-	-	-

As can be seen from the Table II, there is a variety of gear deployed in the mackerel fishery. Although they go by different names in various sections of the coastline, all of them can be classified into five basic types namely, *boat seines, beach seines, gill nets, drift nets* and *cast nets*, depending on the design and mode of operation. It may be mentioned, however, that among the various types of the gear employed in the fishery, the most important ones are the *Rampan, Ayilakolli, Pattenkolli, Arakolli, Paithu vala, Madi vala* and *Ayilachala vala* on the western seaboard, and *Peria vala* or *Pedda vala* and *Vazhi vala* on the eastern side. Further *Ayilakolli vala, Pattenkolli vala* and *Arakolli vala* are in fact the same type of boat seines, varying only in size of the net and mesh. So also is the case with *Odam vala, Paithu vala* and *Madi vala* of Kerala and *Kolli bala* and *Paithu bala* of South Canara. Similarly the

Thuri valai of the Coromandel coast, *Iragavala* of Andhra and *Iragali jal* of Orissa are one and the same type of nets.

In the following account descriptions of *Ayilakolli vala, Rampani* and *Ayilachala vala* are given as representing important types of gear based on the reports of Hornell (1927 and 1938). Anon. (1943) and Chopra (1951).

Ayilakolli vala: It is a boat seine, specially designed for capturing mackerel, as the name implies. The *Ayilakolli vala* has the same general design as that of *Odam vala* but differs from it in two or three important constructional details: (1) The wings, here are quite short, about 1/3 the length they have in *Odam vala* (2) Except for the peripheral section consisting of 1.83 m broad cotton netting, the bag is made of hemp twine with rather large mesh in contrast with small-meshed cotton twine bag of *Odam vala* and (3) The platform or "Kolli" and its sides in *Ayilakolli* are of cotton netting of small mesh instead of large-meshed coir of *Odam vala.* Because of these feature, *Ayilakolli vala* can be operated more easily and efficiently making it the most versatile. It has a bag 10.98 m long and a platform measuring 21.96 m. The wings, one on either side of the plantform or"kolli" are rather short, measuring 14.64 m. The mesh of the bag varies from 15 mm at cod end to 25 mm at the mouth; while the mesh of platform also measures 25 mm.

The net is operated from a pair of odams with a crew of 7-8 men. Each canoe carrying half the net, they sail to the fishing ground and when a shoal is sighted the canoes separate and the net is shot across the path of the shoal. The lead line is short and the float line is set far back. The wings and the net are well stretched by paddling the canoes. By adjustment the lead line is allowed to sink below the level of the shoal and the head rope is kept afloat above the level of the shoal. As soon as the encircled shoal passes over the platform and towards the mouth of the bag, the canoes converge. The wings are hauled till the lead line comes above the surface, thus driving the fish into the bag. By hauling the float line vertically the catch is concentrated at the cod-end which is then lifted up between the canoes. The catch is emptied into one of the canoes and the boats move for the next operation.

According to Antony Raja (1969) the *kollivala* of cotton has yielded to that of nylon twine in the major portion of Kerala coast and is operated as *Pattenkolli vala*. This net was in fact introduced at Caicut towards the end of 1956 and is being intensively used since then at Calicut, whereas its extensive use along the major portion of the Kerala coast needs verification, for no reference is made about this net at other major centres along Kerala coast so far. As *pattenkolli* combines features both of *Ayilakolli* and *Mathikolli,* it is used effectively for capturing both mackerel and the oil sardine and is likely to become popular with the fishermen in due course all along the coast. The net is reported to be larger than either *Ayilakolli* or *Mathikolli,* for it measures 25-30 m, of which the bag itself occupies half of the length. The mesh of the bag varies from 10-14mm at the cod end to about 22 mm at the mouth of the mackerel with great efficiency is obvious.

Rampani: This is a bagless beach seine of splendid catching power. It is believed to have been introduced in Canara cost about a century ago by a Portuguese parish priest, Father Rampani, and hence is appropriately named after him. Today it is extensively used both along the Canara and southern part of Konkan coasts. It is a very large beach seine, made of hemp (*Crotalaria juncea)* and of varying size. In a typical case, it consists of 100 pieces laced together; each piece measuring 11 m long, breadth varying from 7 m at the centre to 2 m towards the ends and with mesh size ranging from 30 mm at the ends to 12 mm at the centre of the net. The head rope of the net is buoyed with wooden floats and the foot rope is weighted with stone sinkers at regular intervals.

The net is operated only when a sizeable shoal of fish is noticed coming close enough to warrant its operation. On each such occasion, the net is carried, piled up in a *Pandi* or *Hodi,* leaving one end on the shore. As the net is paid out the boat takes a semi-circular course and when the last of the net is out enclosing the shoal, the boat brings back the other end of the net to the shore to a point far away from the starting point. The net is slowly dragged by a party of 40 men on each side and as the net approaches the shore, the two parties come closer and closer. The catch is finally either brought ashore or is impounded in the foreshore waters as the situation demands.

The *Payawada* and *Yendi* or *Kairampan* are nothing but smaller versions (80-120x 5 m) of rampani and are operated during the rainy season and also to remove the impounded mackerel from rampani net.

Ayilachala vala: It is a gill net made of cotton twine and is designed especially for mackerel, and is reported to be exactly similar to *Patta bale* of South Canara both in design and operation. The net is operated from two small canoes *(Thoni)* manned by a crew of 2-4 in each. Each net section usually measures 14.6-21.9 m long and 9-11 m deep with a mesh of 25 to 55 mm. The two canoes carry aboard 6-9 such pieces laced together end to end. The head rope of the net is provided with wooden floats at regular intervals and similarly the foot rope is weighted with stone sinkers.

Leaving the shore the crew reach the fishing ground and look for the indications of shoals. As soon as one is sighted, the canoes separates and the net is paid out quickly in a semi-circular manner across the direction of the shoal which gets circled by the net. Then the crew frighten the fish by making loud noise and by splashing the water; the terrified fish scatter in flight in all directions only to get themselves firmly gilled in the surrounding well or net. The net is then hauled up on board to remove the catch. The fishermen use several combinations of net pieces of different meshes to capture shoals of different size groups thus making the net efficient to meet any situation. It is also the practice, when occasion demands, to join together several units of such nets in a single operation.

The *Kantha bale* of Mysore coast and the *Bangada Jal* of Maharashtra are said to be similar type of nets as *Ayilachala vala*, with the difference that the former are made of hemp and are operated as anchored gill nets unlike the latter. Generally they are set from a single canoe in shallow waters at dusk and anchored in position by heavy stone sinkers tied, one on either side of the foot rope, to prevent it from displacement. The net is hauled up only the next morning and the fish that are gilled are collected.

In recent years these nets are constructed with nylon twine and are comparatively bigger unlike the cotton and hemp nets of former days

in several places. Spherical aluminium or polythene buoys are also frequently used with the nets, replacing the wooden floats. Similarly in the case of gill nets also nylon twine has replaced the cotton twine in the construction of nets in several states. Among bag nets, the *Patten kolli* of Kerala is said to be constructed entirely of nylon twine (Antony Raja, 1969). It is thus obvious that a resurvey of the fishing gear presently employed in the mackerel fishery is urgently called for, as it would bring out several additional facts about these gear.

6. 1. 3 Efficiency and selectivity of gear

Practically no information is available on the selectivity of the various gear that are employed in the mackerel fishery. It may be pointed out, however, that the different types of bag nets and shore seines are non-selective gear due to very little variation in their mesh size (which is normally very small), unlike that of gill nets and drift nets. Even in these latter cases, especially in gill nets, fishermen employ a combination of different mesh net-sections to make the gear efficient to capture a wide range of size groups abundant in the area. The size frequency diagrams given by Rao *et. al* (1962) for the selective and non selective gear employed in the mackerel fishery of Mangalore, fully illustrate this point. The difference in the size composition that is observed at times within the bag net and shore seine catches could apparently be not only due to the distribution pattern of different shoals but also obviously due to the difference in the time and the area of operation of these gear themselves. In this connection and also with reference to the selective efficiencies of various gear, the comments of Dutt (1965), on the experimental studies of Joseph and Sebastian (1964) on the performance of sardine gill nets of different mesh sizes, are relevant. Although the requirement for the study of efficiencies of the various gear are quite obvious, we are left with no alternative, at present, except to consider the catch-per-unit effort data of different gear, in a season in so far as they represent the rough estimates of the respective gears' fishing powers. Such data for the various types of gear employed at Mangalore are published by Rao et al. *(loc. cit)*. Similar

Table III

Relative efficiencies of different gear employed in the mackerel fishery of Calicut and Mangalore

	CALICUT					MANGALORE					
Name of the gear	1956-57	1957-58	1958-59	Avarage efficiency	Percentage efficiency	Name of the gear	1958-59	1959-60	1960-61	Avarage efficiency	Percentage efficiency
Ayilakolli vala	1.00	1.00	1.00	1.000	100.0	Pattabale	1.00	1.00	1.00	1.000	100.0
Pattenkolli vala	0.00	8.30	0.64	2.980	298.0	Chalabale	0.00	1.24	0.00	0.413	41.3
Paithu vala	0.05	0.01	0.11	0.090	9.0	Kanthabale	0.26	0.11	0.21	0.193	19.3
Ayilachala vala	0.19	0.21	0.08	0.160	16.0	Cast net	0.00	0.10	1.00	0.367	36.7
Arakolli vala	0.12	0.00	0.02	0.047	4.7	Kollibale	..	0.06	0.00	0.030	3.0
Odam vala	0.01	0.03	0.00	0.013	1.3	Idabale	..	..	3.79	3.790	379.0

information for Calicut during the years 1956-'58 is taken from the author's unpublished data. Based on the above data the relative efficiencies of the gear employed are computed separately for the two places and is presented in Table III.

It may be seen from the data given in the table III that the relative efficiencies of the different gear vary between seasons to some extent, with the notable exception of *Pattenkolli vala,* which is said to have been introduced at Calicut in 1956-57 season. This net surpassed in efficiency the *Ayilakolli vala* by eight times during 1957-58 season, probably due to availability factors, though in the succeeding season it proved to be only about 3/5 as efficient as *Ayilakollivala.* Based on the average efficiencies during the period it may be mentioned that the *Ayilakolli vala* and *Pattenkolli vala* are the two most efficient gear among the bag-nets employed at Calicut. The gill net *Ayilachala vala* has also proved to be an important gear which is about 1/6 as efficient as *Ayilakolli vala.* It is clear from the data from Mangalore that out of the six types of gear employed in the fishery, the *Idabale* which was operated only during 1960-61, has proved to be an efficient gear as it was operated during the peak months of a successful season. However, *Pattabale* is the most important and consistent gear at Mangalore and is the most efficient of the rest of the gear. The average picture, ignoring *Idabale,* shows that the *Pattabale* is about 2½ times as efficient as *Chalabale* and about 5 times that of *Kanthabale.* The cast net, *Debbale,* has showed also a good performance, proving 1/3 as efficient as *Pattabale.* It only remains to be said that, for a study of this nature, the average relative efficiencies of the different gears calculated over a number of seasons should be obtained to make the data more dependable and comparable.

6. 2 FISHING AREAS

The fishery for mackerel on the west coast is confined to the area from Ratnagiri to Cape Comorin, while on the east coast the fishing is done occasionally at important centres from the south right up to Orissa coast. On an average, about 93-98% of the total landings come

from the west coast (See table VI of the present report and Pradhan and Rao, 1958). Even on the west coast, intensive fishery is confined to the area from Ratnagiri in Maharashtra down south to Ponnani in Kerala. The important centres on the west coast for mackerel are Malvan, Karwar, Malpe, Bockapatnam, Cannanore, Tellicherry, Calicut, Tanur and Ponnani. The mackerel shoals that appear sporadically on the east coast are exploited at important centres like Mandapam, Nagapattinam, Madras, Kakinada, Pudimadaka and Visakhapatnam.

Depending upon the intensity of fishing, duration and the type of gear employed, the main fishery area on the west coast is divided into the following sub-areas: 1) Ratnagiri-Magalore area where the catches are highest, 2)Magalore-Ponnani area where they are relatively high, and 3) Ponnani-Cape Comorin area where the catches are moderate (Pradhan, 1956 and Pradhan and Rao, *loc. cit)*; The fishery is confined at present to the foreshore area within 18 m depth limit. Although considered as a typical pelagic fishery, instances where mackerel were caught in deep waters by trawls off Bombay-Saurashtra area, Wadge Bank and Bay of Bengal have come to light (Narayanankutty, 1962; Sivalingam, 1955 and Jones and Rosa, 1967). Recent surveys of R.V. VARUNA have also indicated the presence of shoals in water upto 20 m depth (Jones and Rosa *loc. cit.)*.

6. 3 FISHING SEASON

With the outbreak of the south-west monsoon on the west coast, some shoals comprising younger fish first start appearing in the inshore area followed by shoals of slightly bigger fish. According to Chidambaram & Venkataraman (1946), the fishery on the west coast extends from September to April. At Karwar, one of the important northen centres for mackerel, the fishery starts only by October extending upto February or March (Pradhan, 1956). It is stated by Pradhan and Rao (1958), Jones and Rosa (1967) and Rao (1969) that in general the mackerel fishery starts earlier and lasts longer on the Kerala coast than along the Mysore and Maharashtra coasts. The average monthly landings of mackerel compiled for four centres and presented in the Table IV and also the average quarterly data for different States given in Table V, fully illustrate the situation on the west and east coasts. It is evident from the

table IV that the fishery starts at Vizhinjam, the southern-most centre in Kerala, by June extending until October with maximum landings in July, Further north, at Calicut, it starts only by August and extends till the end of March with a major peak in September and a minor one during December. The picture of the fishery at Mangalore, though not quite suggestive of the trends, may be said to be similar to that of Calicut. The picture of the fishery at Karwar, one of the northern-most centres on the Mysore coast, is quite different. Here it starts quite late by October and extends upto April with a major peak in November and secondary one in February, the data in Table V also show the same fishery trends on quarterly basis, along Kerala, Mysore and Maharashtra.

Table IV

Avarage monthly catch (m. tons) of mackerel at different centres on the west coast

Month	Vizhingam 1960-63 (Bennet, 1967)	Calicut 1956-58 (Unpublished data of Rao, K. V. N.)	Mangalore 1958-61 (Rao *et al*., 1965)	Karwar 1956-59 (Banerji & Chakraborty 1965)
January	1.62	206.48	1.14	105.92
February	0.42	121.99	3.08	167.93
March	0.55	14.88	6.88	124.01
April	8.68	8.50	3.89	36.66
May	0.23	3.64	1.03	0.00
June	2.85	4.63	0.00	0.00
July	15.30	3.34	0.00	0.00
August	3.83	32.88	20.18	0.00
September	4.46	1221.41	4.38	0.00
October	2.94	148.05	10.21	66.91
November	1.18	92.82	13.69	664.03
December	0.35	385.72	18.29	568.20

Table V

Avarage quarterly landings (m. t.) of mackerel in different States for the years 1956-1968 (Source: CMFRI Bull. No. 13, 1969)

Regions	Quarters				Annual catch
	I	II	III	IV	
Orissa	50.2	8.8	0.8	28.3	88.1
Andhra	554.1	477.1	28.1	330.9	1,390.2
Madras	546.6	607.5	749.9	267.1	2,171.1
Kerala	5,181.8	1,367.0	3,075.5	11,782.8	21,407.1
Mysore	4,214.4	102.4	224.3	20,585.1	25,126.2
Maharashtra	904.8	2.1	6.5	1,949.8	2,863.2

Similarly, on the east coast, the fishing season is much longer on the Madras coast with peak catches occurring during the third quarter. The fishery along Andhra coast is comparatively shorter, starting by the fourth quarter and extending till the end of third quarter, while the peak occurs during the first quarter. The fishery is shortest along Orissa with maximum landings occurring during the first quarter (Table V).

6. 4 FISHING OPERATIONS AND RESULTS

6. 4. 1 Effort and intensity

Although the data on the input of effort in the mackerel fishery and its catch along the various sections of the coast during different fishing seasons are being collected regularly by the Institute and also the trends in the catch-per-unit efforts at selected centres on the west coast are studied, we have very little of published information on effort and intensity. The preliminary studies of Pradhan (1956) and the more detailed and systematic studies of Banerji and Chakraborty (1962) from Karwar have given us some insight on these aspects. It is clear from their studies that the distribution of effort and the intensity of fishing is not commensurate with the abundance of mackerel shoals not only within the season but also during different fishing seasons. This situation is brought about, it is explained, not due to the inability of

the fishermen to detect good periods of abundance, but due to economic considerations (Sekharan, 1958 and Banerji and Chakraborty, *loc. cit)* But the obvious effect of such a situation is that the fishing tends to be less efficient, thus yielding much less catch than what would be the case had the fishing intensity been increased proportionately during the periods of abundance of shoals in the inshore waters.

6. 4. 2 Catch

Annual variations: The annual landings of the Indian mackerel in different regions as well as on all-India basis and the species contribution to the all-India marine fish production for the period 1950-60 are presented in the Table VI. From the data the extend of fluctuation in the fishery not only from year to year but also over a number of years is obvious. The average catch for the period under consideration was 58,316 tonnes. It may be seen from the data that the fishery has yielded more than the average catch during the years 1950-1953, 1957-1960 and in 1963; and less than average during the other years. During the periods when more than average yields were obtained, the fishery witnessed over one lakh tons only during 1951, 1958 and 1960 with the maximum of 1,33,655 m.t. during 1960. The trends of catch indicate further that the fishery was decling since 1952 reaching the lowest level of 16,341 m.t. in 1956. Similar trend in the fishery is also evident during the past five years or so. Thus it may be seen that there are short periods of abundance alternating with long periods of decline in the fishery.

The contribution of the mackerel to the all-India marine fish production during the period under review ranges from as high as 19.65% in 1951 to as low as 2.28% in 1956 representing one of the most successful and one of the worst years of mackerel fishery respectively. Though the highest mackerel catch was obtained in 1960, it constituted only 15.19% of the total marine fish catch during that year.

Table VI

Regional and all-India annual landings of mackerel (m. tones) as compared with total marine fish production during the years 1950-1968 (Source: CMFRI Bull. No. 13, 1969)

Year	Orissa & Bengal	Andhra	Madras	Kerala	Mysore	Maha-rashtra
1950	-	-	-	-	-	-
1951	-	-	-	-	-	-
1952	-	-	-	-	-	-
1953	-	-	-	-	-	-
1954	-	-	-	-	-	-
1955	-	-	-	-	-	-
1956	17	1,110	1,286	8,986	3,177	1,638
1957	83	1,005	1,400	26,187	55,754	4,576
1958	37	293	393	55,476	65,365	1,707
1959	79	434	975	24,689	29,332	6,675
1960	46	2,862	1,166	35,504	81,882	12,187
1961	22	1,176	5,607	20,044	7,276	55
1962	17	601	3,115	11,938	11,446	1,971
1963	20	1,163	3,095	48,917	19,132	4,645
1964	38	1,898	2,932	9,657	7,263	2,063
1965	538	1,155	521	18,048	18,125	763
1966	23	2,065	1,975	10,747	7,102	175
1967	153	2,062	3,360	4,500	15,050	27
1968	13	2,249	2,400	3,599	5,736	486
Avarage	83	1,390	2,171	21,407	25,126	2,844
Percentage	0.16	2.62	4.09	40.37	47.39	5.37

Year	Total for East coast	Total for West coast	All-India total for Mackerel	All-India total for All marine fish	Percentage of mackerel in marine fish
1950	-	-	89,163	5,80,022	15.37
1951	-	-	1,04,900	5,33,916	19.65
1952	-	-	78,104	5,28,348	14.78
1953	-	-	70,748	5,81,463	12.17
1954	-	-	28,258	5,88,258	4.80
1955	-	-	22,796	5,95,725	3.83
1956	2,413	14,018	16,431	7,18,779	2.28
1957	2,488	86,522	89,010	8,75,516	10.17
1958	723	1,22,559	1,23,282	7,55,994	16.31
1959	1,488	60,710	62,198	5,84,587	10.64
1960	4,074	1,29,581	1,33,655	8,79,681	15.19
1961	6,805	27,680	34,485	6,83,569	5.04
1962	3,733	25,370	29,103	6,44,244	4.52
1963	4,278	72,702	76,980	6,55,484	11.74
1964	4,868	18,995	23,863	8,59,582	2.78
1965	2,214	40,881	43,095	8,32,777	5.17
1966	4,063	27,896	31,959	8,90,311	3.59
1967	5,575	23,619	29,194	8,62,631	3.38
1968	4,662	16,123	20,785	9,02,948	2.30
Avarage	3,645	51,281	58,316	7,13,360	-
Percentage	6.64	93.36	-	-	8.17

It may be mentioned that the year-to-year fluctuations in the catch are characteristic of a short-lived species, as is the case with mackerel, where the success or the failure of the fishery depends on the strength of the incoming age class which is dependent on the variations in the recruitment and availability. The underlying causes for the long-term fluctuations in the fishery may perhaps be sought in more basic changes that are likely to have occurred in the environment.

Spatial variations: The region-wise catch data given in Table VI fully illustrate the spatial variations in the mackerel abundance. It can be seen from the data that about 93.4% of the total average annual catch came from the west coast, while the remaining 6.6% from the east coast of India. It is also evident from the catch trends of mackerel on the west coast that the waters of Mysore and Kerala are more productive than those of Maharashtra. These two States together contribute on an average about90% of the west coast's production. Between them, however, Mysore coast is more productive than Kerala. Similarly, on the east coast, the waters of Tamil Nadu on an average yield twice that of Andhr coast, while Orissa's contributions are an insignificant fraction. The data also show further that the catches decrease from the southern to northern regions on the east coast, while on the west coast the yield is better in the central region of the fishing area of north Kerala and the whole of Mysore than either in south Kerala or Maharashtra coasts.

In order to find out the more productive regions within Kerala and Mysore, the estimated landings at selected centres in the area, where comparable data are available, are summarised from the quarterly and annual reports of the Central Marine Fisheries Research Institute and are given in the Table VII. It may be seen from the data that the mackerel fishery within Kerala yields better catches at centres north of Cochin than at the southern centres. Similarly, within Mysore, where data are avialble from two extreme centres, the landings at Karwar, the northern-most centre in Mysore, are the highest as compared with Mangalore or, for that matter, any other centre on the Kerala coast. The low yield at Mangalore may be explained as due to the fact that they represent conditions at Ullal, a minor centre, where no Rampan operations were done for mackerel (See Rao *et. al.*,1962). In fact at Malpe,

Table VII

Quarterly and annual landings of mackerel (in m. t.) at selected centres on the west coast (Quart. & Ann. Repts. CMFRI from 1958 to 1966)

Fishing season & Quarter		Vizhingam	Cochin	Calicut	Cannanore	Mangalore	Karwar
1958-59	I	2.68	-	25.78	-	-	0.02
	II	7.51	-	373.70	-	-	0.00
	III	3.26	-	865.91	-	84.40	1441.90
	IV	2.05	-	184.39	-	24.88	1262.50
Total		15.50	-	1449.78	-	*	2704.42
1959-60	I	8.90	-	9.98	-	4.54	38.00
	II	51.01	-	53.70	-	4.64	0.10
	III	5.15	-	361.62	-	9.11	837.11
	IV	1.16	-	45.83	-	1.16	95.99
Total		66.22	-	471.13	-	19.45	971.20
1960-61	I	1.24	-	0.00	0.46	2.00	0.00
	II	28.30	-	169.70	470.74	44.47	0.66
	III	5.78	-	683.04	563.23	33.09	2598.80
	IV	7.07	-	168.24	311.44	5.08	85.10
Total		42.39	-	1020.98	1345.87	84.64	2684.56
1961-62	I	3.23	-	46.46	59.78	8.23	0.22
	II	2.89	-	51.49	9.01	0.00	0.00
	III	5.35	-	353.36	28.91	14.09	50.03
	IV	1.87	-	38.64	1.68	0.00	0.00
Total		13.34	-	489.95	99.38	22.32	50.25
1962-63	I	8.16	0.00	8.17	17.40	0.01	0.00
	II	14.96	86.10	185.78	43.06	0.00	0.01
	III	2.58	5.36	236.56	69.06	72.65	773.00
	IV	1.73	0.00	33.84	9.74	6.94	33.99
Total		27.43	91.46	464.35	139.26	79.60	807.00
1963-64	I	1.17	8.49	4.32	23.47	2.18	0.02
	II	3.24	163.34	1499.01	352.93	14.69	6.21
	III	0.63	38.65	360.54	461.32	30.67	959.37
	IV	0.39	0.79	0.12	102.64	4.97	80.40
Total		5.43	211.27	1863.99	940.36	52.51	1046.00
1964-65	I	0.18	0.80	8.61	34.21	21.59	0.00
	II	16.10	0.75	53.30	8.68	0.00	1.70
	III	5.77	31.03	345.64	157.14	17.10	137.71
	IV	5.20	12.43	97.92	31.15	8.88	552.15
Total		27.25	45.01	505.47	231.18	47.57	691.56
1965-66	I	12.02	6.79	2.98	10.97	4.49	9.41
	II	8.58	17.12	11.29	0.73	2.56	0.33
	III	17.13	35.19	47.25	48.02	11.73	64.38
	IV	5.15	10.35	9.34	13.13	0.80	19.95
Total		42.88	69.45	70.86	72.85	19.58	94.07
1966-67	I	24.20	0.00	2.98	5.03	0.27	0.00
	II	15.31	49.88	444.82	23.33	7.25	0.00
	III	4.54	2.69	303.40	77.42	225.88	1012.31
	IV	0.73	7.01	15.03	12.45	14.75	9.50
Total		44.78	59.58	766.23	118.23	248.15	1021.81

I = April-June, II = July-September, III = October-December, IV= January-March.
* Incomplete.

Table VIII

Quarter-wise landings (m. tons) of mackerel in different States during the years 1956-1968

Years	Orissa				Andhra				Tamil Nadu			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
1956	0	1	0	16	0	1050	5	55	635	52	427	172
1957	0	0	0	83	93	807	6	99	475	344	527	54
1958	26	0	0	11	116	51	22	104	261	15	93	24
1959	57	11	0	11	57	160	39	178	315	253	275	132
1960	23	10	1	12	2186	146	3	527	396	478	128	164
1961	5	0	0	17	366	745	7	58	289	185	4799	334
1962	1	3	0	13	456	144	1	0	1534	1230	279	72
1963	4	4	0	12	467	78	94	524	126	776	1427	766
1964	29	66	0	3	584	508	95	711	1540	908	458	26
1965	350	7	0	181	108	113	6	928	96	212	36	177
1966	14	0	0	9	422	630	52	961	379	366	610	620
1967	135	8	10	0	967	1018	23	54	530	1874	82	874
1968	8	5	0	0	1381	753	12	103	530	1205	608	57
Avarage	50	9	1	28	554	477	28	331	547	608	750	267
Percentage	57.0	10.0	0.9	32.1	39.9	34.3	2.0	23.8	25.2	28.0	34.5	12.3

Years	Kerala				Mysore				Maharashtra			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
1956	740	73	1730	6443	911	56	172	2038	305	15	50	1268
1957	3187	2170	2374	18456	2582	24	434	52714	3388	5	4	1179
1958	13259	3940	3879	34398	10062	111	41	55151	414	0	0	1293
1959	15073	6232	135	3249	18215	385	74	10658	6438	1	1	235
1960	6346	27	4304	24827	4306	0	61	77515	77	0	0	12110
1961	11345	2009	3358	3332	121	26	1	7128	333	0	1	21
1962	1357	274	298	10009	0	0	0	11446	0	0	0	1971
1963	3413	703	16711	28090	837	192	414	17689	42	2	0	4601
1964	1405	1287	1142	5823	1541	527	888	5107	9	1	0	2503
1965	9033	875	255	7885	14980	9	57	3079	754	1	0	8
1966	935	138	3368	6306	840	1	1478	4783	1	0	2	172
1967	767	29	2180	11524	249	0	0	14801	1	0	0	26
1968	503	14										
Avarage	5182	1367	3076	11783	4214	102	224	20585	905	2	7	1950
Percentage	24.2	6.4	14.4	55.0	16.8	0.4	0.9	81.9	31.6	0.1	0.2	68.1

which is situated a little of Mangalore, the fishery yields quite high catches due to Rampani operations (Sekharan, 1958). Further commenting on the productive areas of mackerel, Pradhan (1956), Pradhan and Rao(1958) and Rao(1969) have stated that the mackerel landings, between Ratnagiri in Maharashtra and Mangalore in Mysore are very high and between Mangalore and Ponnani, the amount of catch is fairly high.

Seasonal variations: The region-wise and quarter-wise data given in Table VIII representing the average picture for the years 1956-68, fully illustrate the trends in the temporal variations of the mackerel catch in the annual fishery. It may be seen that of Maharashtra and Mysore coasts the peak landings occur during the fourth quarter, accounting for 68.1% and 81.9% of the respective State's mackerel catch. In both these States the fishery maintains a very high yield only during a short period, decreasing thereafter rapidly as it develops during the October-December period. In both the areas the fishery extends till the end of first quarter. On the Kerala coast, however, the landings are more spread out, with the peak catches occurring here also during the fourth quarter forming 55.0% of the State's average annual landings. On the east coast, off Orissa, the fishing season, again, is short with 57.0% of the annual catch in the region coming during January-March months. The data for Andhra and Tamil Nadu show that the mackerel fishery is not only more spread during the year but also the decrease in catches is more gradual, with periods of abundance shifting to later periods depending on the region. Thus along Andhra coast the fishery starts by fourth quarter extending up to the second qarter with peak landings occurring during the first quarter. Off Tamil Nadu, the fishery is more spread out and gradual compared to Andhra, with peak fishery occurring during the third quarter. Of the State's annual catch, the quarterly break-up is 25.18% 27.98%, 34.54% and 12.30% respectively. It may also be seen from the data that the period of low catch on the west coast is from April-June while on the east coast it is during July-September off Orissa and Andhra regions and during October-December along Tamil Nadu coast.

6. 4. 3 Factors affecting the fishery

It is well-known that several factors of the environment like the physical, chemical and biological phenomena, operating in a complex manner, would affect the mackerel fishery either directly or indirectly. It is easy to visualize that variations in any one or a set of the above factors could easily influence either the level of recruitment (and hence the abundance) and/or availability of the different age groups depending whether those factors are operating either on breeding and nursery and/or on fishing grounds respectively.

In the past, several attempts have been made to find out simple correlations between some of these physical, chemical and biological factors of the environment and the mackerel fishery in order to explain the observed fluctuations in the fishery. It is stated by Panikkar (1949) that any delays in the onset of monsoon on the Indian coasts are often followed by delays in the fishing seasons for mackerel and oil sardine. Thus the profound influence of the monsoon providing the main motive force for all the dynamical changes in the seas around India affecting the fisheries of the area is obvious, although very little is known about the mechanism by which the fishery affected in our seas. Chidambaram and Menon (1945) have found from their studies at Calicut that there is a correlation between the fish landings and the environmental factors like rainfall, surface temperature, salinity and specific gravity and plankton abundance of the area. Theirs and later studies (Bhimachar and George, 1952: Subramanyan, 1959; Sekharan, 1958 and Pradhan and Reddy, 1962) have indicated that the peak landings generally occur just during the period when the factors like temperature, salinity and specific gravity of the surface waters start rising in their values after reaching their minima during the south-west monsoon period on the west coast and just coinciding with or following the plankton abundance in the area.

An inverse relationship between the mackerel and the oil sardine fisheries has been observed (Hornell, 1910b, Nair and Cihdambaram, 1951 and Antony Raja, 1969). Though this relationship does not appear to be consistent on year-to-year-basis, it appears to be so over long-term

basis as is evident from the data presented in Fig. 9. Since both the species are plankton feeders and occupy the same neritic-pelagic habitat, one should except competition between them both for food and space, thus the abundance and the availability of one species affecting the prospects of the other in a given area. However, the mechanism how it is brought about is not yet satisfactorily explained.

Murty and Edelman (M.S. quoted by Antony Raja, 1969) have indicated a good correlation between the pelagic fisheries in general and mackerel fishery in particular and the sea level pressure differences as an expression of monsoon intensities. They suggested that certain low range of monsoon intensities are unfavourable, while certain higher intensities are favourable for the pelagic fisheries, since they found that during the periods of low intensities the surface waters are depleted with dissolved oxygen while at the latter periods it was not so. In a recent study. Murty (1969) has observed that the clue for the seasonal and regional variations in our pelagic fisheries (both mackerel and oil sardine) is to be found partly in the variations in the pattern of the coastal currents, for he found a close correlation between the maximum catches during the winter when the northerly drift currents get established along the west coast and suggests the possibility that the pelagic fisheries of this coast are intimately related to these coastal drift currents.

It is also observed that sudden and localized monospecific blooming of several plankters like diatoms, dinoflagellates and blue green algae will adversely affect prospects of a good fishery, since mackerel as well as other pelagic fishes are known to avoid such areas either due to choking of the gills, oxygen depletion caused by death and decay of plankters and due to the effects of ectocrines released by the organisms in the area (Prasad, 1953, and 1967; Bhimachar and George, 1950; and Subrahmanyan, 1954 and 1959).

6. 4. 4 Forecast

In the case of mackerel fishery no reliable criteria have yet been identified and developed in order to be able to predict the fishery prospects from year to year, although several attempts to link up the fluctuations in the fishery with the environmental factors like temperature, salinity, oxygen and with the plankton abundance over the fishing grounds and with the coastal currents over a wider area have been made. It was also suggested that the fishery is dependent on the strength of the incoming year class and its availability in the inshore area, both of which are subject to variations from year to year, resulting in response to the oscillations in the environmental parameters. In order to find out whether the annual trends in the mackerel fishery themselves would give some insight in the pattern of fluctuations of the mackerel fishery, the available catch data since 1925 to 1968 from the west coast were examined. The data prior to 1948-49 season relate to seasonal catch landed along the Malabar and South Canara coasts, while data for the post-1950 period represent the landings along Kerala and Mysore regions, which are made comparable, after necessary adjustments, with that of pre-1948-49 data. It is thus obvious that the data over the entire period, though not quite comparable in terms of magnitude between the pre-and post-1950 periods, are considered sufficient for the comparison of the trends in the fishery and are presented in Fig. 9. It may be seen from the data that there are certain definite trends in the fishery-periods of good fishing seasons followed by bad ones,-during the last four and half decades. Thus, leaving out the year-to-year fluctuations in the catches, the fishery may be considered to have improved during the periods 1925-32, 1942-46, 1950-53 and 1957-60 which are immediately followed by long periods of failure. The catch data indicate that both within the periods of abundance and decline a cyclical pattern of revival once in every 3-4 year period is discernible. Notwithstanding the limitations of the data examined here, the observed trends, both of short and long-term nature, are indicative of a cyclical phenomenon which, if proved consistent in future based on more reliable and comparable data, offers a simple line of approach for the development of a reliable predictive system.

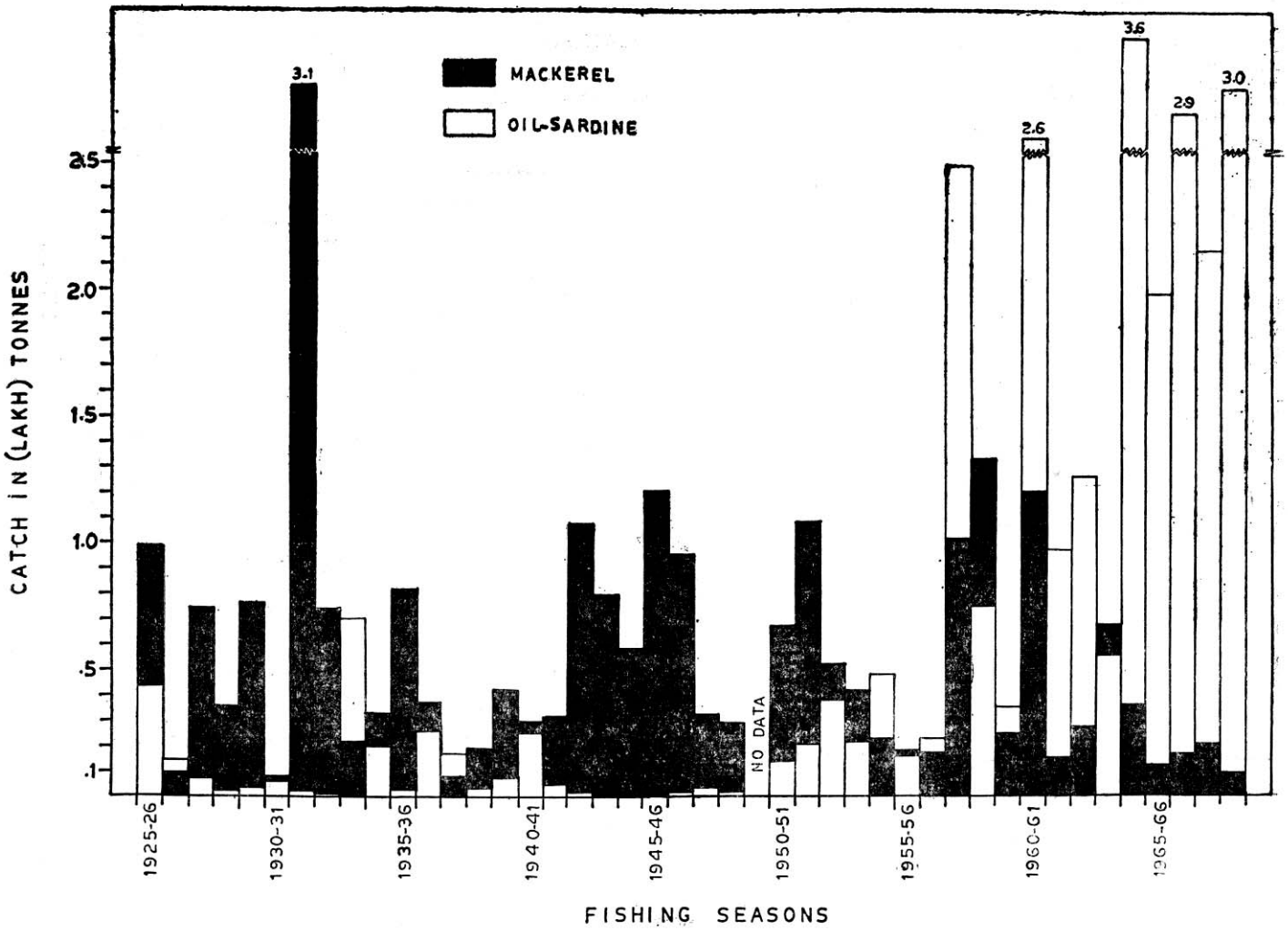

Fig. 9. Trends in the mackerel and oil sardine catch on the west coast (data for pre-1948-49 period relate to Malabar and South Canara regions and for post-1950-51 period relate to Kerala and Mysore coasts).