

ON THE MACKEREL FISHERY OF THE MANDAPAM AREA

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MACKEREL supports a minor fishery in the Mandapam area, especially along the Gulf of Mannar coast. The landings are, of course, small and cannot be compared with those on the West Coast. According to Krishnamurthi (1957), the total mackerel catch in Rameswaram Island in 1952-53 and 1953-54 amounted only to about 9.3 tons. He also found that among the important fishes there, mackerel occupied the 15th and 11th ranks respectively with regard to its contribution to total catch and the monetary yield. However, the catch and financial returns are certainly much better on the mainland. Mackerel are rarely landed on the Palk Bay side where the general fishing season extends from April to October. However, in October 1956, unusually large catches were recorded on this coast also. During April-September there is little fishing activity on the Gulf of Mannar side. Fishing operations here extend from October-March and it is during this period that mackerel appear in the nearshore waters in sufficiently large numbers as to constitute an important fishery. This account deals with the observations conducted on the fishery from 1952-57 with special reference to catch-per-unit of effort, size composition and maturity.

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METHODS

This study was confined mainly to the region between Dhanushkody and Periyapatnam (a distance of about 40 miles) on the Gulf of Mannar side. Field observations were undertaken at least twice a week. But more visits were paid to fishing centres at Pudumadam and Muthupet, about 10 and 12 miles respectively from Mandapam, than to other villages, as these two places are among the most important mackerel centres. As the trade deals with the fish in numbers the catches are also given in numbers here. From observations, a monthly catch-per-man-hour (P) was estimated according to the formula

$$\frac{\sum_{i=1}^n y_i}{\sum_{i=1}^n m_i h_i}$$

where y_i is the catch in numbers of the i -th observed unit, m_i , its man-power and h_i , the duration of fishing. It may be mentioned that shore-seine is the main gear employed in the Mandapam area.

For length-frequency studies, usually 1-4 samples, according to availability, were collected on every day of observation. Each sample consisted of 25-50 fish. The monthly size composition was estimated by the formula

$$l_c = \sum_{i=1}^n \frac{l_i}{S_i} y_i$$

where l_c = the number of fish of the l -th length group in all the observed catches, l_i , the number of fish of the l -th group in the i -th observed catch and S_i , the total number of fish in the i -th sample.

Let $\sum l_c = N$. Then

$$\frac{l_c}{N} P$$

gives an estimate of the contribution made by the l -th length group to the catch-per-man-hour. These were multiplied by 10 when drawing the length-frequency diagrams, which thus represent the number of fish in each length group per 10 man-hours. Only total length is taken into account here. Measurements were grouped into 5 mm. size classes.

The relation between length and catch was also investigated. Since average length did not prove to be quite satisfactory, each catch was plotted against an average cube of length calculated by the formula

$$\frac{\sum n_i l_i^3}{\sum n_i}$$

where n_i is the number of fish of the i -th length group and l_i , the mid-point of the i -th length group.

The length-weight relation was studied by the method of least squares after converting the data to logarithms. The maturity scales correspond to the definition of the stages for herring given by the International Council for the exploration of the sea.

THE FISHERY

The maximum number of fish observed in a haul on the Gulf of Mannar Coast was 5,000. Two such catches were recorded—one in December 1955

and another in January 1956. Usually, however, during the January–March period the individual catches varied from 50 to 300 fish.

Moderate catches were reported during the 1951–52 season. The number of hauls observed and the estimated catch-per-man-hour during the period 1952–53 to 1955–56 are given in Table I. Generally, the season extends from December–March on the Gulf of Mannar side, the months of peak landings being January and February. The table also shows that the mackerel fishery was practically non-existent in 1954–55. It may be mentioned here that the 1954–55 season on the West Coast also was a failure; the 1955–56 season was better. In the Mandapam area also, the landings improved considerably in 1955–56. Based on the catch-per-boat and the number of boats operating, the total landings at Pudumadam and Periyapatnam during this year were estimated as about 110 metric tons.

On the Palk Bay side, catches of more than 25 mackerel were very rare. But in October 1956, there was an unusually heavy concentration of shoals in the nearshore waters of Palk Bay. At Uchipalli and Irumeni, two important fishing centres, where field studies were undertaken, the fishery extended from 7th to 25th and the total estimated catch was 69 m. tons (about 5,14,000 Nos.). The estimated number of hauls at the two places was 141 and the total man-hours 8,140. The catch-per-man-hour* thus amounted to 8.4 kg. (about 63 in Nos.). The catches of individual hauls varied from 100–30,000. Such large catches have not so far been observed on the Gulf of Mannar Coast.

Night- and Day-Catches

Table I shows that night-hauls gave a much higher catch-per-unit of effort than day-hauls. The Palk Bay catches of October 1956 were also landed exclusively at night, no mackerel shoal having been spotted during daytime. Perhaps mackerel are able to evade capture more easily or they approach the coastal waters in lesser numbers during daytime than at night. According to Rounsefell and Everhart (1953) many species of fishes tend to move closer to the shore at night.

Size- and Age-Composition of Catches

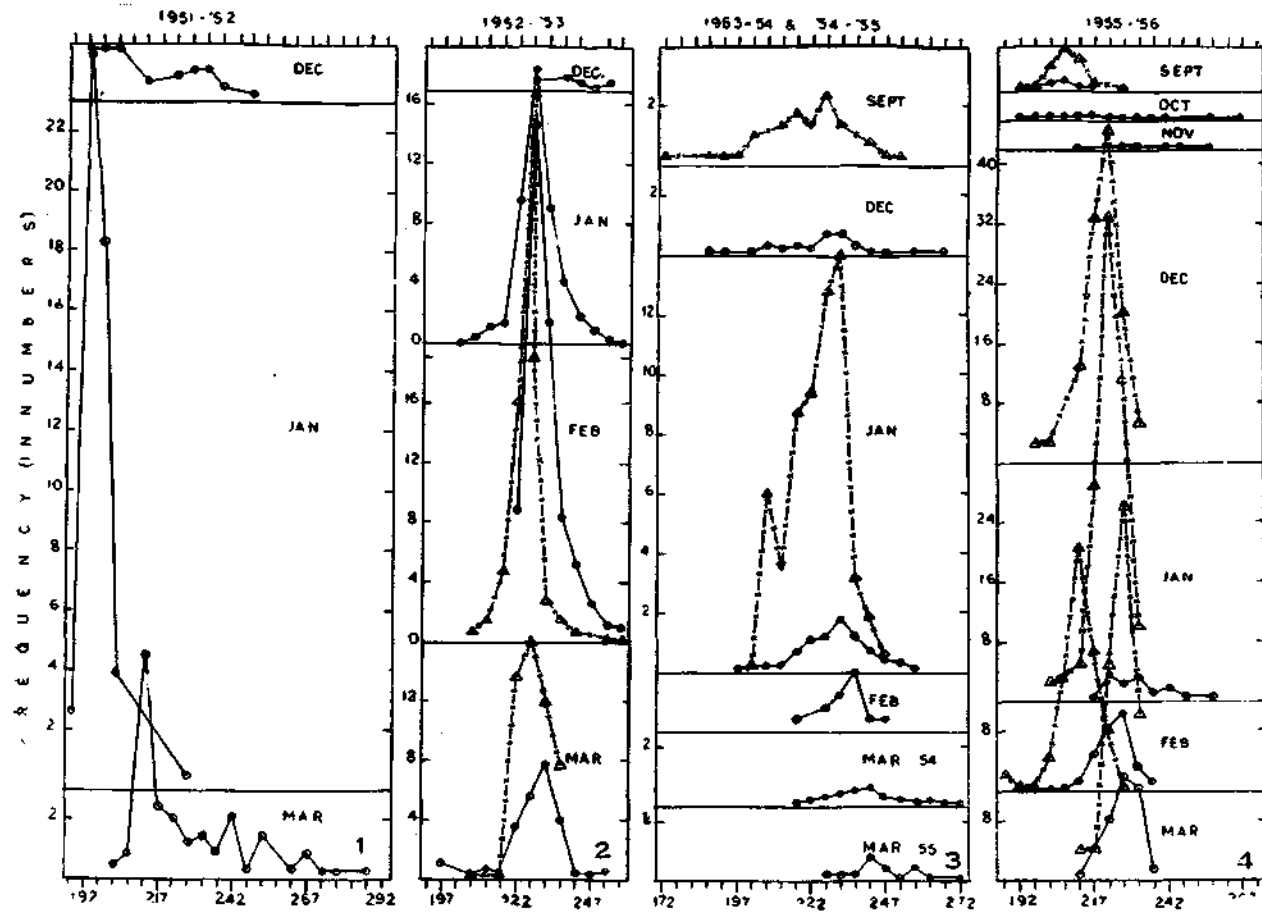
The length-frequency distributions are shown in Figs. 1–5. It will be evident that every year the catches were supported mainly by a single age-

* At Malpe, the monthly catch-per-man-hour of *Rampani* net varied from 21.5 to 0.5 kg. in 1954–55.

TABLE I
Catch-per-man-hour of mackerel in shore-seine (in numbers) during the period from 1952-53 to 1955-56

	1952-53			1953-54			1954-55			1955-56															
	D		Monthly	D		Monthly	D		Monthly	D		Monthly													
	H	A	H	A	H	A	H	A	H	A	H	A													
September	2	0.01	1	1.17	3	0.50	..	..	2	0.25	6	1.44	8	1.1							
October	6	0.27	..	..	6	0.27							
November	3	0.20	..	..	3	0.20							
December	..	3	0.28	..	..	3	0.28	6	0.30	..	..	6	0.30	3	..	4	0.13	4	12.50	8	7.86
January	..	14	4.77	..	..	14	4.77	6	0.81	3	6.08	9	2.79	4	..	4	1.25	6	15.42	10	9.75		
February	..	6	8.48	12	8.41	18	8.39	3	0.52	..	..	3	0.52	3	..	20	2.97	10	8.10	30	4.80		
March	..	6	2.48	4	4.90	10	3.54	4	0.30	2	1.67	6	0.78	2	0.25	2	0.25	5	3.67	3	11.00	8	6.60
Seasonal value	..	29	4.64	16	7.43	45	5.67	21	0.46	6	3.79	27	1.27	12	0.02	12	0.02	44	1.97	29	10.00	73	5.41

D = Daytime operations. N = Night operations. H = No. of hauls observed. A = Average catch-per-man-hour (in Nos.).

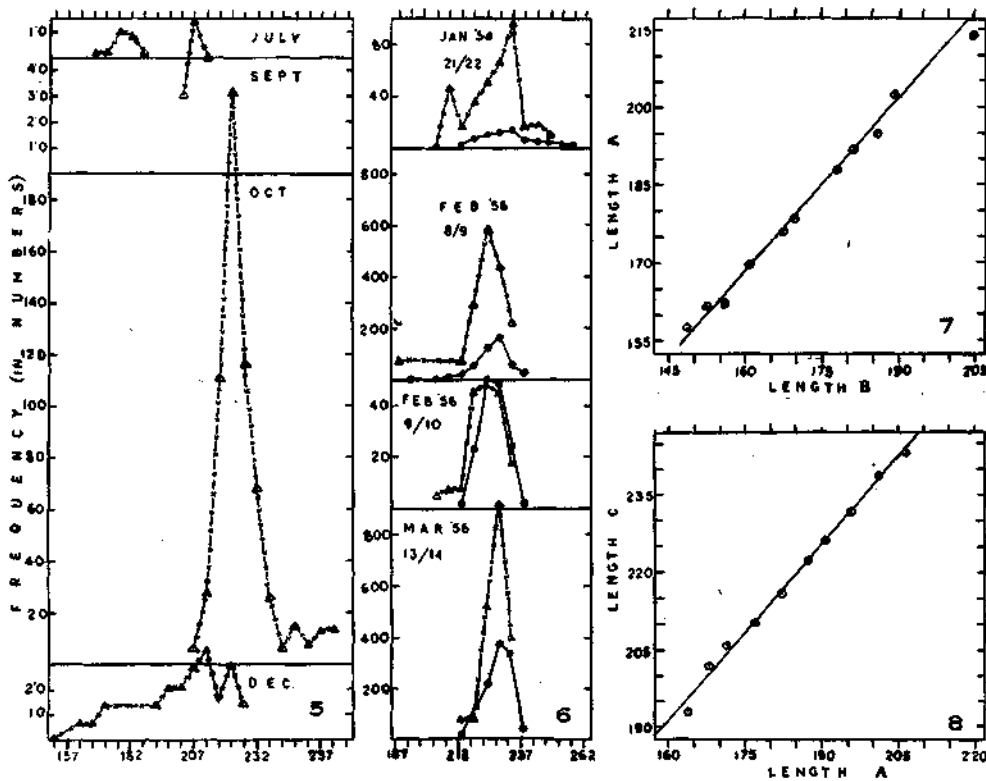


FIGS. 1-4. Length-frequency distribution of shore-seine catches of mackerel from 1951-52-1955-56. (September data refer to Palk Bay catches. Δ -X-X- Δ Night catches. O-O Day catches.)

group, but mackerel of the various seasons might not have been of equivalent age, in view of the fact that between years there were differences in the modal size-groups. Thus during the December-March periods of 1952-53 and 1953-54, the modal sizes varied from 227 to 232 mm. and from 232 to 242 mm. respectively. The age of the fish could not be estimated as mackerel were rarely landed during the April-November period and data for these months were scanty. But from Fig. 5 it would appear that either there are two broods in an year or mackerel of Gulf of Mannar and Palk Bay may have different spawning periods.

Night- and Day-Catches

The length-frequency distribution of mackerel of night- and day-hauls on a monthly basis are also shown in Figs. 1-5. There were generally more of smaller fish in night-hauls than in day-catches; the modes in respect of



FIGS. 5-8. Fig. 5. The length-frequency distribution of shore-seine catches of mackerel in 1956 (July-October data refer to Palk Bay catches). Fig. 6. 24-hour observation on (the length-frequency distribution of mackerel. O—O Day-hauls. Δ -X-X- Δ . Night-hauls. (The dates of observation are given in the Figure). Fig. 7. Relation between length A and length B. Fig. 8. Relation between length A and length C.

TABLE II

Monthly average length of mackerel in day-hauls (D) and night-hauls (N)

		1953		1954		1956	
		D	N	D	N	D	N
January	..	..	..	220	225	231	222
February	..	231	227	..	..	224	222
March	..	228	228	..	..	226	226

night-landings were either the same as those of daytime hauls or were smaller to the extent of 5–15 mm. Therefore the monthly average length of fish in night-landings was usually lower, as shown in Table II, which gives the data for the relevant months.

The difference between the two averages exceeded 5 mm. the size interval chosen during the study, only once. But what is interesting is that when the two averages differed, the lower values belonged to the night-hauls.

To investigate this aspect further, 24-hour observations were undertaken on four occasions at Pudumadam (on the Gulf of Mannar side). Those operations which started between 6·00 hours and 18·00 hours were regarded as daytime-fishing and others which started between 18·00 hours and 6·00 hours as night fishing. The length frequencies for catch-per-haul are shown in Fig. 6. The differences were of two kinds: (1) the numbers of fish of corresponding size-groups were always greater in night-hauls, (2) on three occasions, the first 1–2 size-groups found in night-catches were not observed in day-hauls, while the last 1–2 size-groups of the day-hauls were absent in night-hauls. The modes differed only once. The averages are given below.

	21/22 Jan. 1954	8/9 Feb. 1956	9/10 Feb. 1956	13/14 Mar. 1956
Day ..	230·2	224·4	224·5	227·7
Night ..	225·2	221·8	221·4	225·7

It may be seen that the night-catches always had the lower average, although the differences exceeded 5 mm. only once.

Length-Weight Relation

During 1952–53, the length-weight relation of mackerel in day- and night-hauls on the Gulf of Mannar side were estimated separately according to the method of least squares. The relationship was obtained on the basis of average values of length and weight in different length intervals. The relations were:

For day-hauls,

$$\text{Log } W = 6 \cdot 2161 + 3 \cdot 3390 \text{ Log } L.$$

For night-hauls,

$$\text{Log } W = \bar{c} \cdot 5662 + 3 \cdot 1571 \text{ Log } L.$$

(W = Weight, L = Total length.)

Applying the *t*-test (Fisher, 1958), it was found that the difference between the two regression coefficients was not significant at the 5% level (see Table III). (The number of fish examined was 100 for day-hauls and 350 for night-hauls.)

TABLE III

Length-weight relation of mackerel in day-hauls (D) and night-hauls (N)

(b_1, b_2 are regression coefficients. Formulae given in Text)

Daytime hauls (D)			Night-hauls (N)		
Log length	Log weight		Log length	Log weight	
X	Observed y	Estimated \hat{Y}	X	Observed y	Estimated \hat{Y}
2.3201	1.9638	1.9629	2.2856	1.7709	1.7819
2.3391	2.0157	2.0284	2.3272	1.9096	1.9134
2.3469	2.0607	2.0524	2.3363	1.9435	1.9421
2.3545	2.0750	2.0778	2.3474	1.9908	1.9772
2.3649	2.1006	2.1125	2.3585	2.0123	2.0059
2.3750	2.1553	2.1462	2.3647	2.0325	2.0318
2.3826	2.1828	2.1716	2.3746	2.0535	2.0630
2.3962	2.2014	2.2170	2.3834	2.0943	2.0908
2.4014	2.2455	2.2344			

$$\bar{X} = 2.3645, \quad \bar{y} = 2.1112.$$

$$\bar{X} = 2.347, \quad \bar{y} = 1.9759.$$

$$D: \Sigma (y - \hat{Y})^2 = 0.00090846.$$

$$d.f. = 7 + 6. \quad S^2 = 0.00010565.$$

$$N: \Sigma (y - \hat{Y})^2 = 0.00046631.$$

$$\text{Variance of } b_1 \text{ (of day-hauls)} = 0.01812.$$

$$\text{Total} = 0.00137477.$$

$$\text{Variance of } b_2 \text{ (of night-hauls)} = 0.01561.$$

$$b_1 - b_2 = 0.1819.$$

$$t. = 0.1819$$

$$\sqrt{0.03373}$$

$$= 0.9902; \quad d.f. 13.$$

$$0.20 < P < 0.40.$$

Standard and Tota' Length

Three types of length measurements were made on Gulf of Mannar mackerel. They were: (1) from snout to the beginning of the first dorsal ray of caudal (length B), (2) from snout to the end of the fleshy portion of the caudal peduncle (length A) and (3) from snout to the end of the longest caudal ray when that was flexed to be in line with the snout (length C). The relations estimated by the method of least squares were

$$(1) A = 3.2103 + 1.0323 B$$

$$(2) C = 8.7350 + 1.1395 A.$$

The number of fish examined was 161 and 397 respectively.

Catch and Cube of Length

The individual hauls varied widely even on the same day. During 1952-53, the average length of the mackerel of each haul was calculated. In Fig. 9 A are plotted the individual catch and the average catch-per-haul against the average length taken at 1 mm. intervals. Again, an average cube of length for each haul was calculated, the average grouped into convenient classes, and plotted against the corresponding catch-per-haul. This is shown in Fig. 9 B, where the number of fish in each haul is also represented. There appeared to be a tendency for the catches to fall in relation to length, especially in relation to average L^3 .

Maturity

The samples from December-February contained mackerel of stages I and II. Stage III was observed in March, especially in fish measuring more than 225 mm. The ova diameter of 12 fish varying in length from 220-237 mm. collected in February and March were measured, but there were no ova more than 0.18 mm. in diameter. Higher stages of maturity were observed in stray specimens landed in April and May but none in stage VI could be collected. On the Palk Bay side also, mackerel were in stages I-II in September-October. The largest ova in five fish ranging in length from 219-237 mm. examined in October 1956 were less than 0.09 mm. in diameter, while in another fish of 261 mm. in length collected in the same month, there were no ova more than 0.19 mm. In November 1955, two fish measuring 247 and 257 mm. were collected from Dunlop gill-net landings. Their ovaries were short, stumpy and sac-like, but did not contain large opaque eggs and hence they were regarded only as recovering spents.

Hydrological Conditions and Plankton

Data on salinity, temperature and oxygen of the surface inshore waters of Gulf of Mannar at Mandapam, which is situated about 22 and 15 miles from Dhanushkodi and Periyapatnam respectively, have been published by Prasad (1956 and 1958) and Jayaraman (1954). These data refer to the period 1950-56. Salinity is high from May-October ($32.3-37.4\text{‰}$) and low from November-March ($25.4-36.8\text{‰}$). The minimum values were recorded in December-January ($25.4-31.3\text{‰}$). Temperature has the maximum value in April ($28-31^{\circ}\text{C}$.) and minimum in December-January ($23.5-28^{\circ}\text{C}$.). Oxygen content has no marked fluctuations. During the period of the

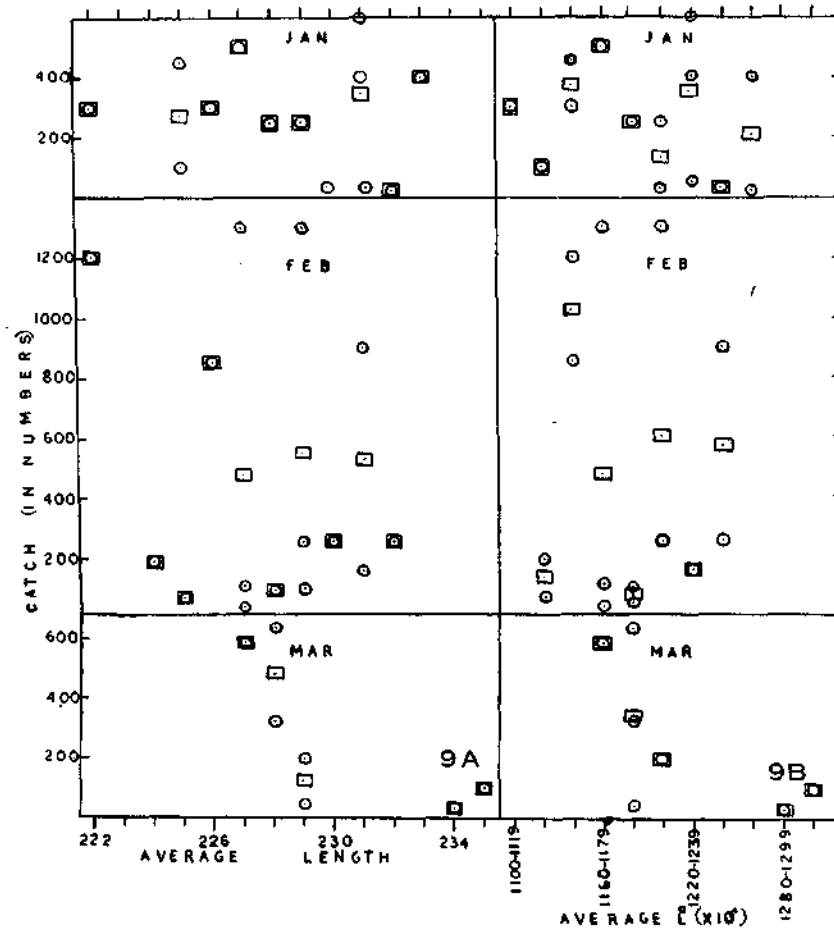


FIG. 9. A. The relation between average length and catch in 1953. Circles represent individual hauls and squares, average catch-per-haul. B. The relation between average L^2 and catch in 1953. Circles represent individual catches and squares the average catch-per-haul.

mackerel fishery in October 1956, on the Palk Bay side, the surface temperature was steady at 27° C. and salinity varied between 34.20 and 35.44‰. In the previous month, salinity was higher, but temperature was lower.

At Calicut on the west coast, surface temperature and salinity of the nearshore waters are high from March–May and low during the monsoon months (*see* Nair, 1952; Seshappa, 1953; George, 1953). The same trend is seen at Karwar also. According to Pradhan (1956) at Karwar, surface salinity varies from 23.2–40.8‰ and temperature from 25.0–30.0° C. during the October–March period, the mackerel season.

Prasad (1956) has shown that net-plankton has two maxima on the Gulf of Mannar side, one in January–March and the other in September–October. Mackerel are caught during January–March, when salinity and temperature have intermediate values but during September–October, salinity and temperature are high and mackerel are not observed in large numbers. Thus, it would appear that mackerel approach the coastal waters at a time when salinity and temperature show an upward trend after attaining their minimum values.

DISCUSSION

On the West coast the mackerel fishery extends from September–March or April. At Karwar and on the South Kanara coast there are generally two peaks in a season, one in October–November and the other in February–March (Sekharan, 1958; Radhakrishnan, 1958). On the other hand, in the Mandapam area, the duration of the fishery is shorter, being only December–March and the peak is attained in January–February. It will be interesting to know, in this connection, the characteristics of the mackerel fishery of the Gulf of Mannar coast of Ceylon. Both on the West coast of India and at Mandapam on the East coast, the mackerel fishery is observed during the period when temperature and salinity values show an upward trend after attaining their minima. On the West coast the minima are observed during the monsoon months and at Mandapam in December–January.

At Karwar and at Malpe, the modal size of mackerel varies from 19.5–22.5 cm. during December–March (Pradhan, 1956; Sekharan, 1958; Radhakrishnan, 1958). Mackerel in the Mandapam area are generally larger during this period. During 1952–56, the modal size of 22.5 cm. was attained even in December, and in March it varied between 232 and 242 mm. At Madras, Rao and Basheeruddin (1953) noted 4 modal size groups in March–April, *viz.*, 8–9, 13–14, 20–21 and 23–24 cm. The first three modes were not

observed at Mandapam during December–March where the fishery would also appear to be supported mainly by one age-group.

It has been shown above that night fishing at Mandapam yields better catches than daytime fishing. But in South Kanara District on the West coast, where also the main gear used is a shore-seine (*Rampani*) night fishing is socially banned (Sekharan, 1958). In the Karwar area there would appear to be no such ban. The decrease in catches during daytime may, of course, be the result of vertical migration, but it may be mentioned here that on the South Kanara coast, huge catches, sometimes running into lakhs in numbers, are landed by *Rampani* during daytime.

The decrease in average length at night observed at Mandapam is also quite interesting. This seems to be at least partly associated with larger catches at night, since it has been shown that there was a tendency for the individual catch and the average catch-per-haul to decrease in relation to average cube of length of the fish. Other conditions remaining the same, catch will be dependent on shoal size which possibly is a function of the cube of length of the fish.

SUMMARY

Mackerel supports a minor fishery in the Mandapam area, especially along the Gulf of Mannar coast, during the December–March period. The catches on the Palk Bay side are generally negligible, but in October 1956, there were unusually large catches here also. Shore-seine is the main gear employed. Monthly catch-per-man-hour based on observed landings is given.

As on the West coast, so also in the Mandapam area, mackerel approach the nearshore waters at a time when salinity and temperature show an upward trend after attaining their minimum values. On the Gulf of Mannar side net-plankton volume also has a maximum during the January–March period.

The fishery appears to be supported mainly by a single age-group. The modal size varied from 227 to 242 mm. during the December–March periods of 1952–56. These modal sizes are larger than those occurring at Malpe and Karwar during the December–March period.

Catch-per-man-hour (in numbers) for night-hauls was considerably greater than that for daytime-hauls. On the other hand, the average length of mackerel in night catches was slightly smaller.

During 1952-53 the length-weight relations of mackerel in day- and night-catches were estimated separately. The difference between the two regression coefficients was not significant at the 5% level.

During 1952-53, an average cube of length of mackerel for each haul was calculated and plotted against the catch in numbers. A tendency for the catches to drop in relation to average L^3 was noticed.

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