STUDIES ON THE MACKEREL FISHERY OF MANGALORE AREA DURING 1969-73.

T. M. YOHANNAN
Mangalore Research Centre of CMFR Institute, Mangalore

ABSTRACT

The mackerel fishery was a success in 1970-71 and failure in 1972-73. The relative abundance of juveniles and fluctuations in monsoon intensity seem to have great bearing on the fishery. Spawning appears to be intense around July and January. The length frequency studies reveal that mackerel measuring 14-16 cm and 20-22 cm are one-year-olds and two-year-olds respectively. The length-weight relationship of male and female fish is given. The rate of decrease per month for the first two seasons were 0.19 and 0.34 respectively.

INTRODUCTION

There has been a decline in the mackerel catches in the Mangalore area in recent years. This aspect was specially kept in mind in the course of investigations on the fishery and biology of mackerel carried out from July 1969 to June 1973 at two centres viz., Ullal and Baikampady known for gill-net (*pattabala*) and shore-seine (*rampani*) catches respectively, the results of which have been presented here. Earlier studies on the fishery and biology of mackerel in this area by Sekharan (1958) George et al. (1959) Rao et al. (1962) and Rao (1962 and 1967) have contributed considerably to our knowledge of the mackerel fishery of this coast.

MATERIAL AND METHODS

The landing centres at Ullal and Baikampady were visited usually on alternate days. The methods given by Prabhu and Dhulkhed (1970) were followed for estimation of the catch of various gears and the CPUE in numbers of mackerel in each length group landed by a particular gear. The unit of effort was a fishing trip by a boat-net unit. The standard effort expressed in terms of pattabala was calculated by using the formula:

$$S.E = \frac{C\,b}{U\,a}$$

where S.E. = standard effort, Cb = catch of the particular gear and Ua = catch per unit effort in weight of standard gear.

TABLE 1B. *Catch and Effort at Ullal.*

Season	Pattabala		Kanthabala		Cast net		Odubala		Rampani		Kollibala		Total	% in
	C	C|U	C	C|U	C	C|U	C	C|U	C	C|U	C	C|U	C	total fish
1969-70														
Jul-Sep	2730	130.0	—	—	280	0.6	—	—	—	—	—	—	3010	11.4
Oct-Dec	19979	89.6	67	0.2	1404	2.7	—	—	44477	2779.8	—	—	65927	69.2
Jan-Mar	1638	34.1	12104	43.9	—	—	1526	8.2	480	240.0	—	—	15748	44.3
Apr-Jun	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	24347	83.4	12171	13.6	1684	1.5	1526	6.0	44957	2497.6	—	—	84685	53.8
(%)	(28.7)		(14.4)		(2.0)		(1.8)		(53.1)				(100.0)	
1970-71														
Jul-Sep	1056	18.2	517	0.6	—	—	—	—	—	—	24	1.7	1597	5.3
Oct-Dec	14081	75.3	—	—	7025	17.9	172	0.2	—	—	—	—	21278	20.9
Jan-Mar	25894	132.8	40	2.0	—	—	7630	9.8	—	—	—	—	33564	44.9
Apr-Jun	9172	96.6	—	—	—	—	403	13.4	—	—	—	—	9575	85.6
Total	50203	93.8	557	0.6	7025	7.5	8205	5.1	—	—	24	1.7	66014	30.3
(%)	(76.1)		(0.8)		(10.6)		(12.4)				(0.1)		(100.0)	
1971-72														
Jul-Sep	—	—	—	—	—	—	526	10.5	—	—	—	—	526	1.9
Oct-Dec	—	—	4795	13.9	—	—	—	—	—	—	—	—	4795	6.2
Jan-Mar	3071	52.9	2051	9.6	—	—	5665	5.0	—	—	—	—	10787	21.1
Apr-Jun	—	—	948	3.8	—	—	—	—	—	—	—	—	948	6.7
Total	3071	29.5	7794	5.8	—	—	6191	2.7	—	—	—	—	17056	10.1
(%)	(18.0)		(45.7)				(36.3)						(100.0)	
1972-73														
Jul-Sep	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Oct-Dec	6300	175.0	—	—	—	—	—	—	—	—	134	1.3	6434	11.5
Jan-Mar	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Apr-Jun	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	6300	175.0	—	—	—	—	—	—	—	—	134	1.3	6434	5.1
(%)	(97.9)						—	—	—	—	(2.1)		(100.0)	

C|U = Catch per unit effort in kg.C|U = Catch per unit effort in kg.

TABLE 1A. *Catch and Effort at Baikampady.*

Season 1969-70			Rampani				Pattabala		Cast net		Total	% total
		C|U	C	C|U	C	C|U	C	C|U	C	C|U	C	fish
Jul-Sep	150	37.5	9287	80.8	—	—	19	0.4	190	0.5	9646	15.6
Oct-Dec	134435	1920.5	9750	91.1	—	—	—	—	—	—	144185	35.6
Jan-Mar	52961	1891.5	2460	307.5	—	—	—	—	—	—	55421	46.4
Apr-Jun	—	—	—	—	679	10.8	—	—	—	—	679	6.7
Total	187546	1752.8	21497	92.7	679	7.7	19	00.4	190	0.4	209931	35.2
(%)	(89.3)		(10.2)		(0.3)		(0.1)		(0.1)		(100.0)	
Season 1970-71												
Jul-Sep	—	—	4850	82.2	—	—	200	9.5	—	—	5050	8.7
Oct-Dec	824882	14997.9	1894	172.0	—	—	—	—	11	0.3	826787	79.2
Jan-Mar	114500	3469.7	5807	126.2	—	—	—	—	—	—	120307	76.6
Apr-Jun	69493	4343.3	996	14.4	—	—	—	—	—	—	70489	99.7
Total	1008875	9171.6	13547	73.2	—	—	200	9.5	11	0.1	1022633	76.9
(%)	(98.6)		(1.3)				(0.1)		(0.1)		(100.0)	
Season 1971-72												
Jul-Sep	—	—	4628	171.4	—	—	—	—	—	—	4628	18.6
Oct-Dec	25656	557.7	3429	285.8	—	—	—	—	—	—	29085	8.5
Jan-Mar	237876	6259.9	200	100.0	176	16.0	—	—	—	—	238252	80.8
Apr-Jun	2467	616.8	2752	48.3	94	2.5	—	—	—	—	5313	73.3
Total	265999	3022.7	11009	112.3	270	5.5	—	—	—	—	277278	41.3
(%)	(95.9)		(4.0)		(0.1)						(100.0)	
Season 1972-73												
Jul-Sep	—	—	—	—	—	—	540	16.5	600	1.7	1140	1.5
Oct-Dec	14370	189.1	—	—	—	—	—	—	—	—	14370	1.5
Jan-Mar	363	14.0	—	—	—	—	—	—	—	—	363	0.8
Apr-Jun	300	25.0	—	—	—	—	—	—	—	—	300	0.8
Total	15033	125.3	—	—	—	—	540	16.5	600	1.1	16173	3.9
(%)	(92.9)	Kanthabala		Kairampani			(3.3)		(3.7)		(100.0)	5.5

C = Catch of mackerel in kg. C = Catch of mackerel in kg.

265 males and 360 females in the length range of 190-249 mm were studied for the length-weight relationship using the formula:

$$\text{Log } W = a + b \log L$$

The data were subjected to the analysis of covariance after Snedecor and Cochran (1967).

The relation between total length and standard length (length from the tip of the snout to the beginning of the first dorsal caudal ray) based on the average values of the different length groups (5 mm groups) of 590 numbers of mackerel was calculated by the formula (Snedecor and Cochran 1967):

$$X = a + b\,Y$$

where X = standard length and Y = total length.

The Fishery

The mackerel season in the Mangalore area usually extends from August to April. Details of mackerel landings during the different seasons are given in Table 1a and 1b. At Baikampady the mackerel catches in 1969-70 amounted to nearly 210 tonnes forming about 35.2% of the total fish catch. In 1970-71 the landings increased five-fold, contributed largely (80.7%) by *rampani,* which had a CPUE as high as 9171.6 kg. The landings sharply declined in the following year and in 1972-73 the fishery was a total failure.

At Ullal in 1969-70 the total mackerel landings amounted to nearly 85 tonnes, 53% of which was accounted by *rampani* alone and its CPUE was 2497.6 kg. In 1970-71 there was a decline in the catches partly due to disbanding of *rampani.* Steep fall in the catches were witnessed in the following season and in 1972-73 the fishery experienced a total failure. However, CPUE of pattabala (175 kg) in 1972-73 was the highest of all the seasons.

Pattabala is the common gear used for mackerel at both Ullal and Baikampady. Therefore, this gear is taken as a standard unit and the total standard effort at both the centres in terms of *pattabala* are given in Table 2.

TABLE 2. *Standard effort in terms of pattabala.*

	Baikampady			Ullal		
Seasons	C	SE	C|SE	C	SE	C|SE
1969-70	209931	2266	93	84685	1016	83
1970-71	1022633	13965	73	66014	704	94
1971-72	277278	2468	112	17056	578	30
1972-73	16173	174	93	6434	37	174

C = catch of mackerel in kg. SE = standard effort.
C|SE = catch per standard effort in kg.

1970-71 being a very good season for mackerel, more effort was put in at Baikampady and the catch per standard effort was the lowest. Better returns were recorded in 1971-72. On the contrary in 1972-73 when the mackerel fishery was a failure the effort expended at Ullal was very low and the returns were the highest. Thus the wide fluctuations in mackerel fishery do not seem to have any decernible relation to effort.

Mackerel Fishery in Relation to Rainfall

The mackerel landings at Ullal and Baikampady during different seasons and the annual rainfall (data obtained from India Meteorological Department) are shown in Fig. 1. There appears to be a direct relation between the amount of rainfall in a year and the total catch of mackerel in the following season. In 1970 there was a heavy rainfall and 1970-71 was the best season for mackerel. In the subsequent years the amount of rainfall gradually decreased and a downward trend in mackerel catches was also noticed.

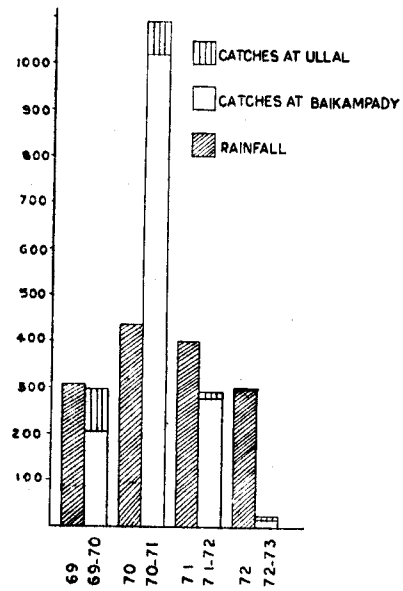

Fig. 1. Mackerel catch (in tonnes) and rainfall (in cm) at Mangalore during 1969-73.

Maturity Studies

Observations show that the mackerel measuring less than 200 mm are immature. Individuals in the 200-209 mm group are mostly immature and maturing. Mackerel measuring more than 210 mm comprised of all stages of maturity.

TABLE 3. *Maturity stages of mackerel during different months (Percentages from the pooled data for the seasons* 1969-73)

Month	Maturity stages I	II	III	IV	V	VI	VII	IIa
Jul.	—	—	7.1	10.7	2.0	46.5	33.7	—
Aug.	2.3	—	—	4.7	—	—	93.0	—
Sep.	—	—	—	15.0	—	5.0	80.0	—
Oct.	86.8	13.2	—	—	—	—	—	—
Nov.	61.9	38.0	0.1	—	—	—	—	—
Dec.	24.5	64.3	11.2	—	—	—	—	—
Jan.	9.4	64.3	26.1	—	—	—	0.2	—
Feb.	11.0	52.3	23.5	—	—	—	13.2	—
Mar.	4.4	51.0	39.7	0.5	0.4	—	3.9	0.1
Apr.	—	35.0	59.4	2.5	—	1.0	2.1	—
May	—	2.0	26.0	36.0	32.0	4.0	—	—
Jun.	—	—	—	28.6	42.9	18.3	10.2	—

IIa is spent recovering

Mackerel in advanced stages of maturity occurred almost throughout the year except during October-February (Table 3). However, spent fish were also recorded in January and February. This indicates that the mackerel has a prolonged spawning season which is in conformity with the observations of Rao et al. (1962). During July the percentage of mackerel in stage VI was high in the catches followed by a very high percentage of spent mackerel in August. Again in February large numbers of spent mackerel entered the fishery in all the seasons except in 1970-71 which incidentally was the peak season. During 1969 and 1973 February more than 95% of the catches comprised of spent fishes. Hence it is possible that the peak spawning periods are around July and January.

GROWTH STUDIES

For growth studies the CPUE (in numbers) of non-selective gears at Ullal, Baikampady and other centres of the Mangalore zone (Sekharan and Dhulkhed 1963) have been pooled since there was no marked difference in the length-frequency distribution. The different broods of 1968-72 are designated in alphabetical order (Fig. 2) and their progression is shown in Table 4.

It is seen that A1 at 172 mm in August 1969 had registered a growth of 50 mm in a year. A similar rate of growth was noticeable in the case of A2, A3 and C1. In August 1969 two modes at 117 mm (B3) and 132 mm (B1) were observed. B3 shifted to 187 mm in October 1970 and recorded a

TABLE 4. *Progression in modal sizes of different broods.*

Broods	Modal progression								
A1	172	mm	in Aug.	1969	222	mm	in Jul.	1970	
A2	172	mm	in Oct.	1969	222	mm	in Aug.	1970	
A3	162	mm	in Sep.	1969	212	mm	in Jul.	1970	
B1	132	mm	in Aug.	1969	207	mm	in Oct.	1970	
B2	122	mm	in Jul.	1969	197	mm	in Oct.	1970	217 mm in Mar. 1971
B3	117	mm	in Aug.	1969	187	mm	in Oct.	1970	217 mm in Apr. 1971
C1	172	mm	in Sep.	1970	207	mm	in Apr.	1971	
C2	152	mm	in Sep.	1970	232	mm	in Jan.	1972	247 mm in May. 1972
D1	112	mm	in Jul.	1970	207	mm	in Dec.	1971	237 mm in Jul. 1972
E1	182	mm	in Nov.	1971	222	mm	in Aug.	1972	252 mm in Apr. 1973
F1	202	mm	in Aug.	1972	237	mm	in Apr.	1973	
F2	192	mm	in Aug.	1972	227	mm	in Apr.	1973	

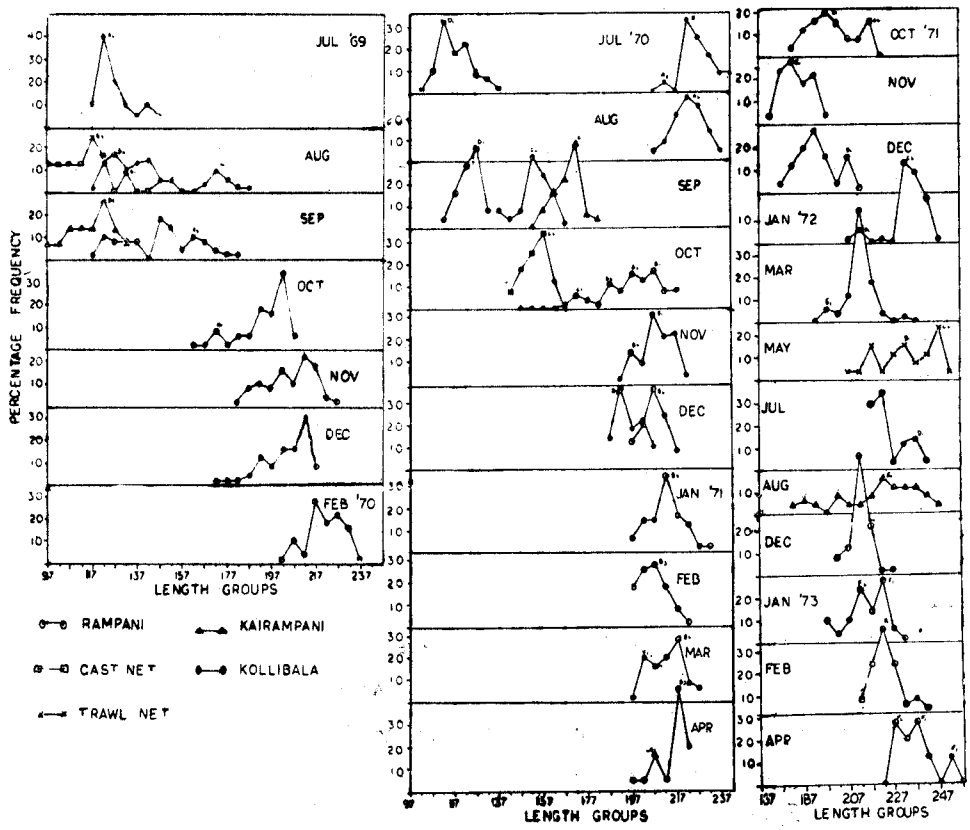

FIG. 2. Length-frequency of mackerel in 1969-73 at Mangalore.

further increase of 30 mm in the next six months. The other group B1 registered a growth of 75 mm in the course of fourteen months. The group B2 at 122 mm in July 1969 revealed a pattern of growth similar to that of B3. The mode at 152 mm (C2) in September 1970 moved on to 232 mm in January 1972 which recorded a further increase of 15 mm in the next four months. The growth pattern of D1 was more or less similar to that of C2. The group E1 at 182 mm in November 1971 shifted to 222 mm in August 1972 and later to 252 mm in April 1973. The growth rate of F1 and F2 appears to be similar.

Taking into consideration the spawning period and also the rate of growth it can be inferred that the mackerel grows to 14-16 cm by the end of first year and 20-22 cm by the end of second year. It is possible that they grow to about 25 cm by the end of third year.

Length-weight Relationship

The results of the analysis of covariance of the data for length-weight relationship of male and female are given in Table 5.

TABLE 5. *Analysis of covariance*

		Reg.		Devation from regression		
	d.f.	coef.	d.f.	S.S.	M.S.	F. Value
Within						
Males	294	3.4734	293	0.2984323		
Females	359	3.4749	358	0.3450189		
			651	0.6434512	0.0009884	
Pooled W	653	3.4742	652	0.6434515	0.0009868	
Difference between the slopes			1	0.0000003	0.0000003	0.000303
W + B	654		653	0.6575580		
Dfference between the adjusted means			1	0.0141065	0.0141065	14.29

Though the difference 'between the slopes' was non-significant the difference 'between the adjusted means' was found to be significant at 5% confidence level. Hence, separate equations were calculated for males and females which are given below:

Male Log W = $\bar{6}$.1054 + 3.4734 log L Sy.x = 0.0018

Female Log W = $\bar{6}$.0997 + 3.4749 log L Sy.x = 0.0016

Relation between Total Length and Standard Length

The relation between total length and standard length were found to be:

X = 3.3219 + 0.7832 Y Sx.y = 0.7832

Y = $\bar{4}$.096 + 1.276 X Sy.x = 0.5728

Where X = standard length and Y = total length.

RATE OF DECREASE PER MONTH

The estimation of rate of decrease per month was made as per the formula followed by Rao et al. (1962). Table 6 shows the CPUE in numbers by *rampani* for different months at Baikampady and the rate of decrease per month. The values for the rate of decrease could be calculated only for 1969-70 and 1970-71 seasons and these were 0.19 and 0.34 respectively.

TABLE 6. *Monthly CPUE in numbers of rampani at Baikampady.*

Months	1969-70	1970-71	1971-72	1972-73
October	815	217875	8270	1098
November	74982	168024	3219	3975
December	11880	86050	13939	NL
January	2898	58373	34190	96
February	58321	NL	55275	197
March	NL	42656	84940	77
Rate of decrease per month	0.19	0.34	—	—

NL = no landings

DISCUSSION

The relation between the mackerel catches and annual rainfall shows that a good monsoon is followed by a season of good catches. On the other hand, Pradhan and Reddy (1962) while discussing the mackerel catches in relation to rainfall at Calicut noted that the unusually heavy rainfall resulted in the decline of the catches. Noble (1972) also recorded an inverse relation between the mackerel catch and rainfall at Karwar. However, Murthy and Edelman (1966) have stressed the importance of monsoon which has more or less a direct bearing on the fluctuations of the oil sardine catches. The present study indicate that this is applicable in the case of mackerel fishery as well.

It is seen during the present investigations that small-sized mackerel (below 13 cm) appeared during the earlier part of the first two seasons. In 1969-70 about 1.2% of the total number of mackerel landed were of this group. This was followed by a very good fishery in 1970-71. In 1970-71 their percentage was about 0.1 and there was a decline in the catches of 1971-72. In 1971-72 small-sized mackerel were not recorded and the following seasons was a failure.

George et al. (1959) had observed mackerel in partially spent or recovering gonadial conditions from the *Nethravathi* estuary during January to March 1958 indicating presumably spawning having taken place about January. During the present study also the ascent of mackerel in spent condition into the *Nethravathi* estuary was noted during February and March. Rao (1964) stated that

there is also a supplementary or late spawning period in mackerel in about November-December. The present observation indicates that the supplementary spawning is around January.

Sekharan (1958) while studying the age composition of mackerel in the South Kanara coast observed that the normal modal size of one-year-old mackerel appears to be 12-15 cm and the fish probably measure 21-23 cm at the end of second year. Seshappa (1958 and 1969) estimated the length of mackerel at the end of first year, second year, third year and fourth year of their life to be 11-15, 21-24, 25-27 and 28-29 cm respectively. The present study more or less supports their observations.

Rao et al. (1962) calculated the average decrease per month of mackerel at Malpe, Mangalore and Karwar for the seasons 1954-55, 1959-61 and 1949-56 respectively and the values fell within the range of 0.35-0.75 except at Karwar in 1951-52 when it was 0.07. The monthly rate of decrease could perhaps be taken as a rough estimate of the total mortality. Banerji (1963) observed that the best estimate of instantaneous total mortality of mackerel at Karwar was 0.64 on a monthly basis. However, the values obtained during the present study are comparatively low.

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