AGE AND RATE OF GROWTH OF THE INDIAN MACKEREL, *RASTRELLIGER CANAGURTA* (CUVIER) WITH NOTES ON ITS FISHERY AT KARWAR

By N. Radhakrishnan

(*Central Marine Fisheries Research Institute*)

Introduction

Information on the growth of a fish is an important pre-requisite in understanding the dynamics of fish populations. In fishery yield studies, such as those of Beverton and Holt (1957) the growth is a basic variable determining the exploitable stock and yield from the fishery. The present paper deals with the age and growth studies of the Indian mackerel incorporating the results of investigations carried out at Karwar from January 1954 to March 1959. At Karwar, the mackerel season generally commences in October and ends in the following March. After this period, only stray specimens are netted.

Length Frequency Studies

For purposes of this study, the total length of the fish was taken into account. The specimens used in the present investigation were obtained from the inshore fishing grounds around Karwar by the shore seines (*Rampan* and *Yendi*) which are the most important gears used all along the Kanara coast. Text figures 1 to 4 show the length frequency distribution of samples obtained at monthly intervals from January 1954 to March 1959. In some months, where the samples were too small to form a comparison with other months, the data for these months were neglected from the length frequency analysis. Further, the monthly data of each year have been pooled into three periods, (1) January to March (2) April to September and (3) October to December. This was done for the sake of convenience, to make comparison from one period to the other more uniform. The yearly analysis as based on these three periods, can be summarised as follows:—

1954: In 1954, the catches were heavy only during January, March, July and September to December. In April and June there were no landings and in May and August only a few specimens were present in the catch. Since in these months, the numbers were too small to form a basis of comparison the data were omitted. The size ranges recorded during the various months of the year are given below:—

January	182—233 mm.	July	129—252 mm.
February	181—227 mm.	August	151—175 mm.

March	183—222 mm.	September	153—229 mm.
April	Nil landings	October	171—214 mm.
May	113—161 mm.	November	184—245 mm.
June	Nil landings	December	171—237 mm.

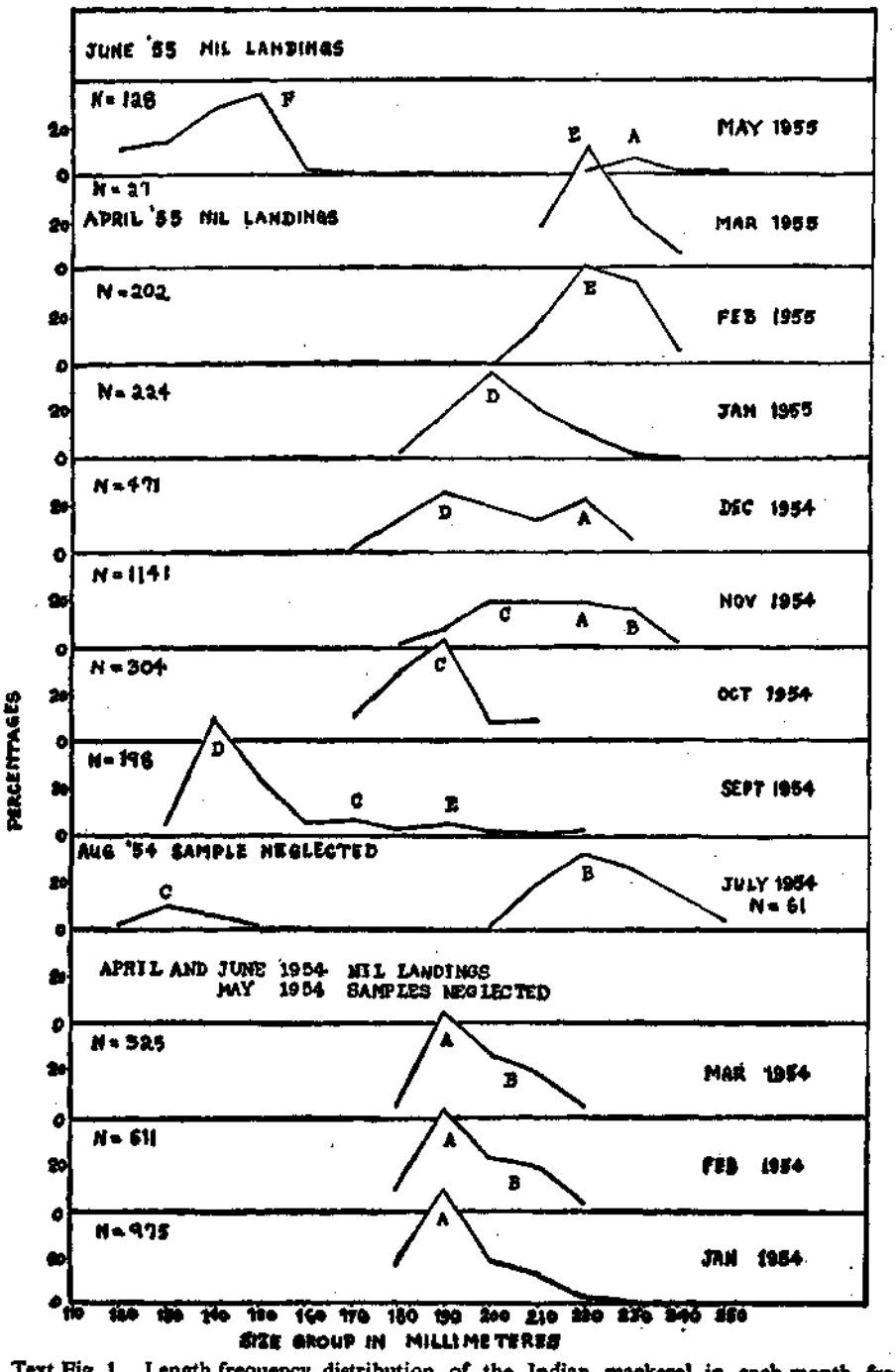
January to March: These months represent the latter half of the 1953/1954 mackerel season. It can be seen from Text figure 1 that the mode "A" at 195 mm. group in January remained more or less unchanged during the corresponding two months — February and March. Besides this, another mode "B" at 215 mm. were noticed for all the three months.

July to September: The mode "B" can be traced further at 225 mm. group in July 1954. During the same month, another mode "C" representing a new brood makes its first appearance at 135 mm. group. Three modes at 145 mm., 175 mm. and 195 mm. are visible in September. The mode at 175 mm. may have arisen from a group seen in July with mode at 135 mm. ("C"), while the modal group 145 mm. ("D") is a new brood entering the fishery for the first time. The group 195 mm. ("E") may have arisen from a still earlier brood whose existence cannot be traced owing to the lack of data during April-June period.

October to December (First half of the 1954/1955 season): The mode "C" seen at 175 mm. in September 1954 enters the fishery at 195 mm. in October and at 205 mm. in November. The mode at 225 mm. seen for November and December may be the continuation of the mode "A". The mode "B" can be further traced at 235 mm. in November 1954.

1955: Large samples were available for January, February, May, September, October and November. Landings of mackerel were not recorded at Karwar during April and June. Even though the samples were not very large in March and July, yet they depicted a true picture of the size distribution of the species. The size ranges recorded for the year are shown below:—

January	181—247 mm.	July	163—248 mm.
February	195—247 mm.	August	115—145 mm.
March	212—246 mm.	September	120—169 mm.
April	Nil landings	October	140—224 mm.
May	121—251 mm.	November	171—247 mm.
June	Nil landings	December	173—243 mm.



Text Fig. 1. Length frequency distribution of the Indian mackerel in each month from January 1954 to June 1955.

January to March: (Latter half of the 1954/1955 season): The mode "D" seen first in September 1954 at 145 mm. and later at 195 mm. in December continued to appear in the catches of January at 205 mm. (Text figure 1) The mode "E" seen in September at 195 mm. can be further plotted at 225 mm. for February and March.

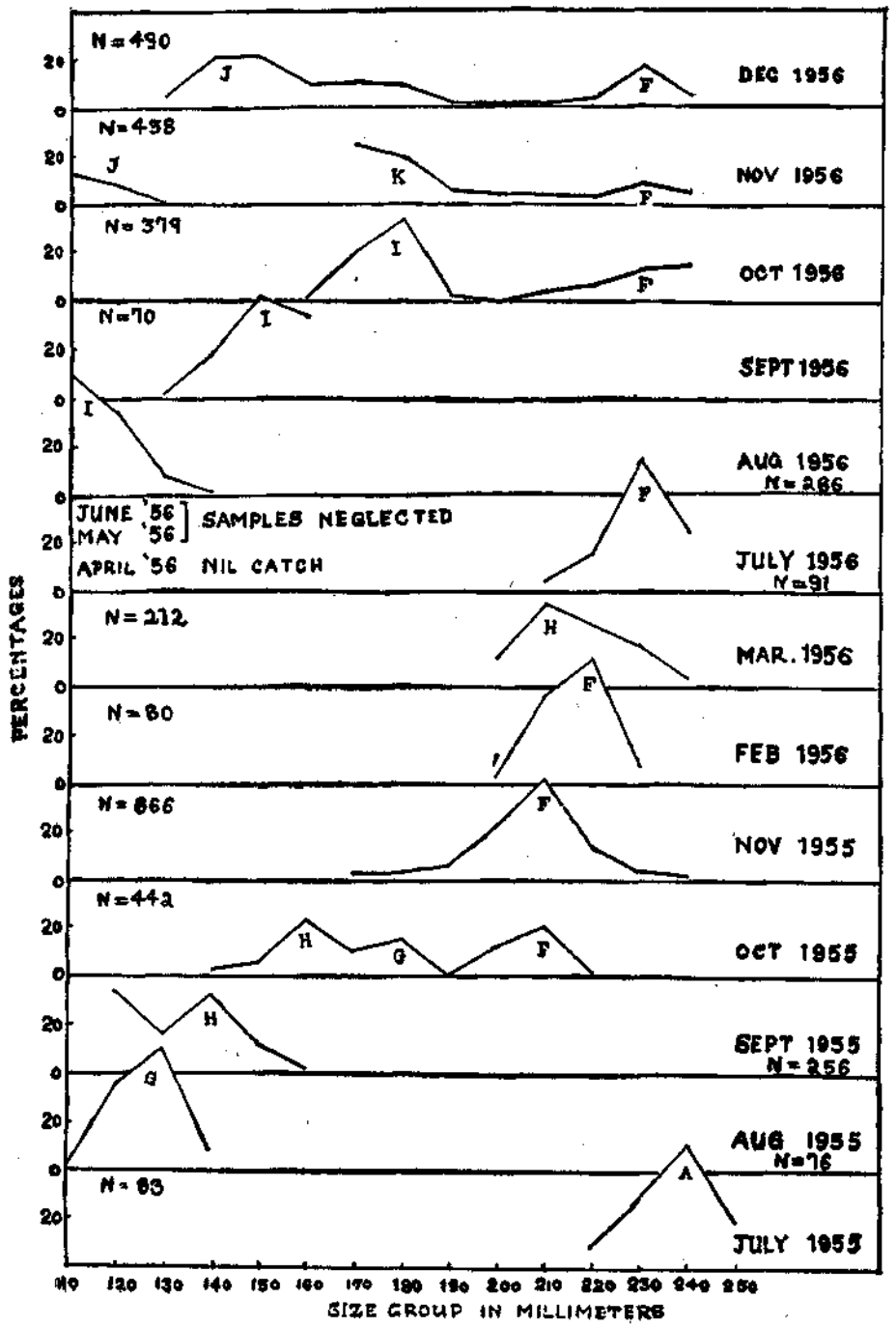
April to September: The mode "A" is traced further at 235 mm. in May and at 245 mm. in July, thus giving a clear indication of the growth which has occurred during this period. Thus, one could clearly see that the mode "A" which made its first appearance in January-March 1954 at 195 mm. continued to occur in the catches during November-December 1954 and when it entered into the month of July 1955 it attained a length of 245 mm. (Text Figure 2). Modes "F" at 155 mm. in May, "G" at 135 mm. in August and "H" at 145 mm. in September 1955 give indications of the entry of different broods of different size groups into the fishery of this period.

October to December: (First half of the 1955/1956 season): In October, three dominant size groups were noticed, the mode "H" at 165 mm., "G" at 185 mm. and "F" at 215 mm. In November, the mode "F" is seen at the same position as it was for the previous month.

1956: During the period from May to June only stray specimens were recorded and hence this has been considered as insufficient for analysis. Mackerel landings were not recorded for the month of April. The size ranges noted for the year are as given below:—

January	174—249 mm.	July	212—246 mm.
February	203—239 mm.	August	98—246 mm.
March	201—249 mm.	Septembe	132—168 mm.
April	Nill landings	October	161—235 mm.
May	219—262 mm.	November	105—246 mm.
June	259 mm.	December	131—248 mm.

January to March: (Later half of the 1955/1956 season): The mode "F" seen first in May 1955 at 155 mm. can be traced further for February at 225 mm. (Text Figue 2). Viewing the frequency curve for March 1956, it is seen that the mode "H" has shifted to 215 mm.



TEXT FIG. 2.—Length frequency distribution of the Indian mackerel in each month from July 1955 to December 1956.

April to September: In July 1956, the dominant size groups recorded were 235 mm. This can only be the continuation of the mode "F" seen during the 1955/1956 season. For August and September, individuals in the smaller size groups entered the fishery. The dominant group in August was 115 mm. (mode "I") which can be further traced in September at 155 mm.

October to December: (The first half of the 1956/1957 season): In October, the presence of two modes one at 185 mm. ("I") and the other at 235 mm. ("F") were noticed. The "F" mode remained at the same position for November and December. In November, besides this mode, two other modes *viz.*, "J" at 115 mm. and "K" at 175 mm. are seen. The former mode can be further located at 155 mm. in December.

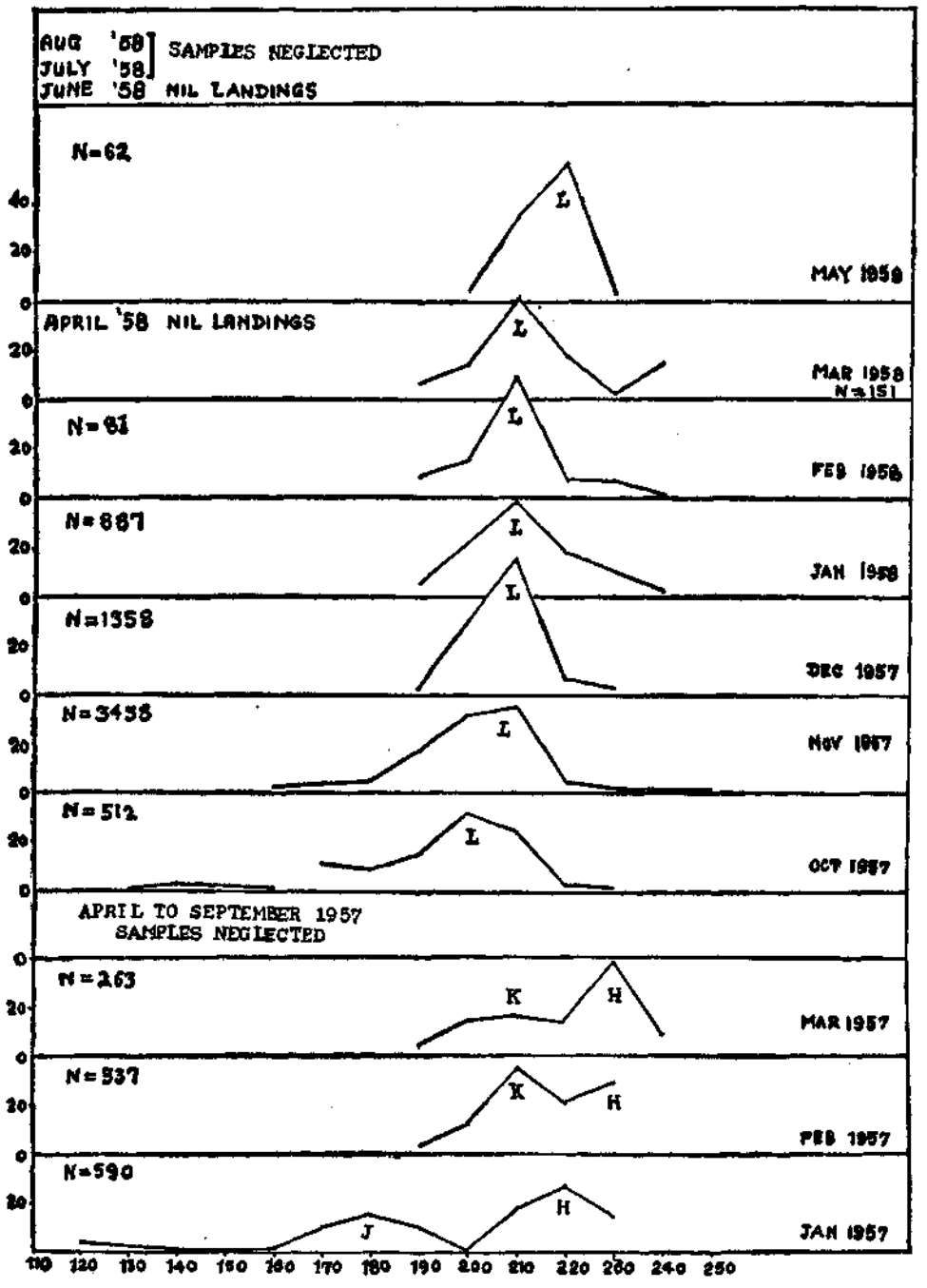
1957: Samples for April to September were not sufficient and therefore these have been omitted from the length frequency analysis. The size ranges recorded for the year are as follows:—

January	121—238 mm.	July	215—248 mm.
February	191—236 mm.	August	Nil landings
March	191—254 mm.	September	122—142 mm.
April	154—240 mm.	October	122—245 mm.
May	185—235 mm.	November	164—254 mm.
June	196—237 mm.	December	191—249 mm.

January to March: (Latter half of the 1956/57 season): The mode "K" seen during November 1956 at 175 mm. contributed to the fishery again in February-March 1957 (Text Figure 3). This mode has progressed to 215 mm. thus showing an increase of about 40 mm. The mode "J" appeared at 185 mm. in January. The dominant groups seen at 225 mm. and 235 mm. for January and March 1957 are the continuation of the mode "H".

April to September: Only stray specimens were recorded during this period and the data were too insufficient to be considered for analysis. It may however be mentioned that small sized individuals measuring 122 to 142 mm. were encountered in very small quantities during September.

October to March: (The first half of the 1957/1958 season): The major mode "L" is seen at 205 mm. in October, and by November the position has



TEXT FIG. 3.—Length frequency distribution of the Indian mackerel in each month from January 1957 to August 1958.

shifted to 215 mm. (Text Figure 3). In December the mode remained at the same position as it was for the preceding months.

1958: Landings were not reported for April, June and August. Only stray specimens were noted during July and September and hence these have been discarded from the analysis. The size ranges noted for the year are as follows:—

January	191—254 mm.	July	225—241 mm.
February	191—254 mm.	August	Nil landings
March	190—242 mm.	September	135 mm.
April	Nil landings	October	132—243 mm.
May	204—235 mm.	November	191—246 mm.
June	Nil landings	December	191—231 mm.

January to March: (The latter half of the 1957/58 season): The mode "L" seen during October to December of last year remained at the same position *i.e.*, at 215 mm. during these months.

April to September: An increase of 10 mm. is registered by the mode "L" for May 1958 because it has shifted to 225 mm. For September the dominant group noted was at 175 mm. "M". (Text Figure 4).

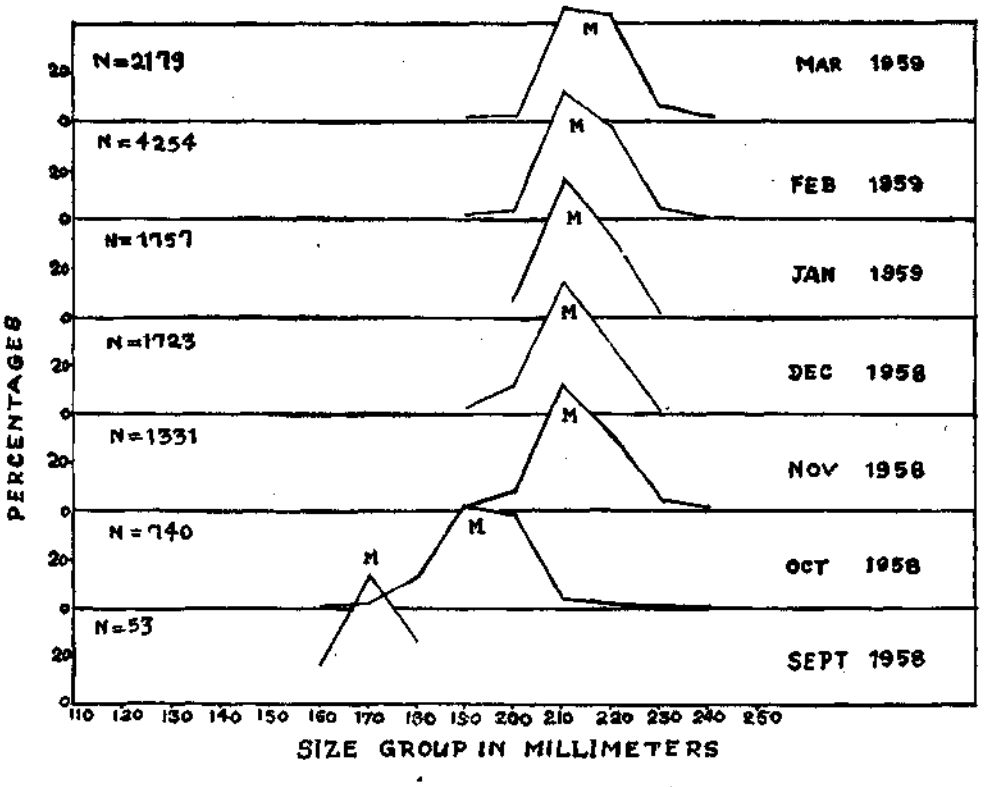
October to December (The first half of the 1958/1959 season): From the frequency curve, it is seen that mode "M" has shifted to 195 mm. in October, 215 mm. in November. For December this mode remained at the same position at 215 mm.

1959: The size ranges recorded for January, February and March were 200-239 mm., 180-249 mm. and 180-249 mm. respectively. The mode "M" remained at the same position at 215 mm. for the three months under investigation.

Discussion

Viewing the data as a whole it is seen that the 120 to 150 mm. size group generally form the fishery only during the first week of September though they are caught from April to September. The size range during the commence-

ment of the fishing season *i.e.*, October is 180 to 210 mm. and an increase to 210 to 230 mm. is noticed towards the end of the season (February-March). Large sized individuals 230-250 mm. are recorded at Karwar during May-July. In the course of the present investigation, the occurrence of small sized individuals were noted only on a few occasions. Mackerel measuring more than 240-250 mm. in total length contribute very little to the fishery at Karwar. Stray specimens larger than the size mentioned above have been recorded by the various workers in recent years (Table I). Owing to the lack of sufficient data on the size groups above 250 mm. in total length, it is difficult to decide the question of the total life span of the fish.



TEXT FIG. 4.—Length frequency distribution of the Indian mackerel in each month from September 1958 to March 1959.

TABLE I

Size of certain specimens of mackerel recorded at different observation centres

Author	Size of the specimen. (Total length in mm.)	Place of occurrence
Day (1958)	250	..
Sekharan (1958) . . .	290	Mandapam Camp
Pradhan (1956)	280	Bombay
Radhakrishnan (1958) . . .	307	Karwar
G. Seshappa (P.C.) . . .	312	Mandapam Camp
V. Balakrishnan (P.C.) . .	310	Vizhingam
Beaufort & Chapman (1953). .	390	..
K. V. N. Rao (P.C.) . . .	320	Vizhingam

P. C.————Personal Communication

Pradhan (1956) has concluded that "the juvenile mackerel ranging between 60-110 mm. recorded occasionally during July to September are presumably the offspring of fish which have spawned in the previous season and that this group does not contribute to the fishery of the succeeding months of the mackerel season but leaves the inshore waters." According to Sekharan (1958) the mackerel of 120 to 140 mm. group seen in July support the fishery of the same year for the months of October to March. As far as this investigation is concerned, certain modes could be well traced as far as possible from the beginning to end. The following points are clear from the present analysis. (1) The inshore markerel fishery is obviously the one that depends upon the movement of mackerel towards the inshore waters during the season. (2) There are several broods in the year class and for a proper assessment of growth of this species, it is necessary to identify each brood and trace its growth and (3) Since these are schooling fish, one or other of the brood may appear or may not appear at the same time.

The shifting of the different modes as shown in Text Figure 1, 2, 3 and 4 are obviously clear indications of the progressive growth of this species, *Viz.*,

"A" from 195 mm. in January 1954 to 245 mm. in July 1955,

"B" from 215 mm. in January 1954 to 235 mm. in November 1954,

"C" from 135 mm. in July 1954 to 205 mm. in November 1954,
"D" from 145 mm. in September 1954 to 205 mm. in January 1955,
"E" from 195 mm. in September 1954 to 225 mm. in March 1955,
"F" from 155 mm. in May 1955 to 235 mm. in December 1956,
"G" from 135 mm. in August 1955 to 185 mm. in October 1955,
"H" from 145 mm. in September 1955 to 235 mm. in March 1957,
"I" from 115 mm. in August 1956 to 185 mm. in October 1956,
"J" from 115 mm. in November 1956 to 185 mm. in January 1957,
"K" from 175 mm. in November 1956 to 215 mm. in March 1957,
"L" from 205 mm. in October 1957 to 225 mm. in May 1958, and
"M" from 175 mm. in September 1958 to 215 mm. in March 1959.

In view of the long spawning season and probably due to the periodicity in spawning of mackerel (Radhakrishnan 1962) it is likely that the recruitment in the fishery may occur at different times of the year, *viz.*, "A" and "B" in January 1954, "C" in July 1954, "D" and "E" in September 1954, "F" in May 1955, "G" in August 1955, "H" in September 1955, "I" in August 1956, "J" and "K" in November 1956, "L" in October 1957 and "M" in September 1958.

Pradhan (1956) was of the opinion that the Indian mackerel attains a length of 10 cm. in one year and that when it enters the fishery in October it is 18 cm. or more completing its second year. According to Sekharan (1958) as cited earlier the mackerel attains a size of 120 to 150 mm. after completing one year and 210-230 mm. after the second year. However, the present observations appear to be quite contrary to these findings. It is clear from the present analysis that the growth in the initial stages of its life is very fast and that the broods encountered in the fishery between 115 to 155 mm. are, obviously the products of the current years spawning. This is further clear if we examine the data for 1956/1957 season when several new broods enter the fishery between August 1956 to January 1957. The group ("I") at 115 mm. in August 1956 has grown to 155 mm. in September and 185 mm. in October of the same year. So also "J" at 115 mm. in November 1956 to 145 mm. in December 1956, and 185 mm. in January 1957. Similar shifting of modes were noticed for 1954/1955 and 1955/1956 seasons. *Viz.*, Mode "C" from 135 mm. in July 1954 to 175 mm. in September, 195 mm. in October and 205 mm. in November of the same year: "D" from 145 mm. in September 1954 to 195 mm. in December 1954; Mode "F" from 155 mm. in May 1955 to 215 mm. in December 1955; Mode "G" from 135 mm. in August 1955 to 165 mm. in October 1955. Since the spawning of this species commences during the earlier part of each year, it is easier to

visualise the 115 to 155 mm. fish as arisen from current years spawning, showing considerable growth rate for which there are ample evidence from the data presented. The analysis has further shown that the monthly growth rate of a brood immediately after it enters the fishery is about 20 mm. or more. The growth has also been found to vary from year to year. Pradhan (1956) after a study of the length frequency distribution observed that the average length of mackerel appeared to fluctuate during the season (October to March) by 20 to 30 mm. with an increase of 10 to 20 mm. in the following months. Sekharan (1958) made it clear that the growth was more rapid during July-September period and that there are hardly any increase in length during January-June.

Based on the data presented, it is reasonable to believe that the fishery of Indian mackerel is largely dependent on O and I year class individuals. The author has earlier indicated (1958) that the mackerel in the maturity stages I and II constitute the fishery along the west coast and that the fishery draws its support mainly from a single age group. Panikkar (1952) pointed out that the mackerel fishery comprises second year class individuals. Pradhan and Rao (1958) stated that the mackerel catches during the season are composed very largely of the second year class only. Sekharan (1958) believed that the fishery is dependent on one year old fish.

The length-wise distribution of the catches obtained in the mackerel fisheries at various centres on the east and west coast of India is given by Rao (1962). Many workers today utilise Petersen's method on large samples together with check samples of scales or otoliths. Reference may be made here in this connection to the views expressed by the *Rastrelliger* Sub-committee of the Indo-Pacific Fisheries Council in 1956*. Seshappa's (1958) observation on scales of Indian mackerel is worth mentioning. It may be possible to establish a reliable method of age determination only after some more extensive work is done.

Notes on the Mackerel Fishery at Karwar

In the economy of the fishing villages around Karwar there is no other fishery of greater importance than that of mackerel, locally known as *'Bangada'*. Pradhan (1956) has given a detailed account on the mackerel fishery at Karwar from 1948 to 1953 and Radhakrishnan (1958) has made some further observations on this fishery for the years 1954 to 1956. Beginning in October, the fishery extends up to March-April. The fishing is confined mainly to a narrow belt not exceeding 1 to 1½ miles from the shore. The collection of intensive data on mackerel landings was initiated in 1955/1956 season and observations were carried out at seven centres in the North Kanara coast *i.e.*, Majali, Karwar,

*Proceedings of the Indo-Pacific Fisheries Council *Rastrelliger* Sub-committee session, Penang Singapore 1956.

Bingae, Chendia, Ankola, Kumta and Murdeshwar. These centres were visited once a fortnight and the catch statistics referred to, deals with the day-to-day hauls of the *Rampan* net. Thus, the magnitude of the fishery and its fluctuations from year to year at a particular centre could be ascertained from an unbroken series of records.

It is seen from the landing figures (Table II) that there is much variation from year to year and that during certain seasons there is a considerable decline in the fishery. During 1956/1957 season the fishery was at its lowest at Karwar followed by a bumper season in 1958/1959. In this particular season, the catch at Karwar was said to be the highest ever recorded. The previous best season of mackerel at Karwar was reported in 1951/1952 (Pradhan 1956).

The monthly mackerel landings at the seven observation centres during 1956 to 1959 seasons are shown in Table II. The estimated average landings for the three seasons at different centres are as follows:—

Karwar	1838.756	metric tons
Majali	793.013	,,
Bingae	793.211	,,
Chendia	1069.201	,,
Ankola	171.910	,,
Kumta	98.132	,,

The average catch at Murdeshwar for 1957/1958 and 1958/1959 works out to 189.066 metric tons. Viewing the figures we find that the Karwar production is the highest. The other three centres in the order of abundance were Chendia, Bingae and Majali.

There seems to be an almost sudden concentration of shoals all along the coastal waters in October and November. The high level of abundance of mackerel for one or two months is followed by a sudden decline in the fishery. Radhakrishnan (1958) while dealing with the 1954/1955 and 1955/1956 seasons at Karwar has indicated two peak periods in the fishery based on catch per unit of effort (Catch per piece in the *rampan* net). As production depends both on abundance and input of effort, which in turn is influenced by economic considerations, discussions given below are in terms of abundance (*i.e.*, catch per unit of effort). Some considerations in the study of pelagic fish stocks with special reference to Indian mackerel, *Rastrelliger kanagurta* has been given recently by Banerji (1962).

The primary and secondary peaks as noticed at Majali, Karwar, Bingae and Chendia during different seasons are shown in Table III.

TABLE II

Mackerel catch at the different observation centres in North Kanara during the seasons from 1956/1957 *to* 1958/1959

(*All figures mentioned below are in kilograms*)

Months	MAJALI			KARWAR		
	1956-57	1957-58	1958-59	1956-57	1957-58	1958-59
October	2,59,998	1,27,979	..	1,32,902	30,253	34,200
November	49,622	4,17,299	3,76,425	70,579	11,74,571	7,45,067
December	..	2,07,490	3,28,417	18,597	9,88,735	6,84,014
January	..	95,457	2,11,028	1,21,180	53,977	1,76,265
February	32,001	10,496	1,37,619	45,540	2,721	6,14,751
March	9,244	..	1,15,965	10,750	..	4,66,654
April	..	..	..	..	..	1,45,512
TOTAL	3,50,865	8,58,721	11,69,454	3,99,548	22,50,257	28,66,463

TABLE II—*contd.*

Months	BINGAE			CHENDIA		
	1956-57	1957-58	1958-59	1956-57	1957-58	1958-59
October	1,57,377	51,800	16,790	1,04,326	3,62,610	52,163
November	7,302	3,53,637	4,05,053	10,521	2,54,387	3,65,081
December	15,332	2,90,785	2,48,137	57,448	5,27,561	2,90,651
January	51,202	40,537	1,85,289	45,684	1,26,991	2,05,445
February	36,180	8,274	2,60,242	67,243	20,775	5,25,093
March	19,917	..	2,31,779	15,873	..	1,74,752
April	..	..	..	..	..	..
TOTAL .	2,87,310	7,45,033	13,47,290	3,01,095	12,92,324	16,14,185

TABLE II—*concld.*

Months	ANKOLA			KUMTA			MURDESHWAR	
	1956-57	1957-58	1958-59	1956-57	1957-58	1958-59	1957-58	1958-59
October . . .	81,646	..	1,08,862	5,887	..	..	33,302	..
November . . .	..	1,18,750	1,20,654	..	..	95,254	39,564	57,315
December . . .	..	80,376	..	8,618	5,897	45,359	37,319	74,951
January . . .	..	5,443	..	13,608	6,804	40,823	18,769	12,183
February . . .	..	..	..	..	2,993	36,568	12,792	50,611
March	..	..	..	..	..	32,586	3,441	27,885
TOTAL .	81,646	2,04,569	2,29,516	28,113	15,694	2,50,590	1,55,187	2,22,945

1956/1957 *season*

At all the centres the season commenced in October. At Ankola and Kumta the fishery lasted only for a few months. The primary peak is noticed at most of the centres in October excepting Majali where it was in November. Secondary peaks were recorded at Karwar in December, at Bingae in January and at Chendia in February.

1957/1958 *season*

At most of the centres the first half of the season showed good landings but in the latter half the fishery was on the decline. The season commenced at Majali, Karwar, Bingae and Chendia in October and lasted up to February. At Ankola and Kumta the season appeared to have started late in November and December respectively, and the duration of the fishery was also short, lasting only for about three months. The primary peak was noticed in November for all the centres of observation except Chendia where it was in October. Secondary peak was observed only at Chendia where it was seen in December.

1958/1959 *season*

Increased exploitation was possible during the season and a bumper mackerel yield was recorded at all observation centres. At Karwar, the season was rather prolonged beginning from the third week of October and lasting up to April 1959. The mackerel fishery at Karwar which normally ends by February or March had unusually continued up to the third week of April. The season commenced at all centres in October except Majali, Kumta and Murdeshwar where the same was recorded in November. At Ankola the season lasted only for two months (October to November). The primary peak of the fishery was recorded in November at all places except Chendia and Ankola where it was in October. The secondary peak has been found to vary from centre to centre, *i.e.*, Chendia and Murdeshwar in February, Bingae in March and Kumta in January. Such a peak was not observed at Majali. It is further noted that the maximum landings were recorded at the time of secondary peak at Chendia. Pradhan's (1956) earlier observation at Karwar for the 1951/1952 season also showed a similar trend.

The total number of pieces in the *rampan* net, number of men employed, number of *rampan* hauls, total mackerel caught, catch per piece and the catch per haul for the different seasons at the various centres under review are given in Table IV and the monthwise analysis in Table V. It is clear that all the seven observation centres in North Kanara recorded a bumper mackerel season during 1958/1959. It is interesting to note that even though the catch for the 1958/1959 season was said to be the highest in the living memory, the catch per piece and the catch per haul showed better figures

TABLE III

Particulars showing the primary and secondary peaks in productions (as per catch per piece of the Rampan net) during 1956-1957, 1957-1958 *and* 1958-59 *seasons at Majali, Karwar, Bingae and Chendia in North Kanara*

Observation Centre	1956/1957			1957/1958			1958/1959		
	Season	Primary peak	Secondary peak	Season	Primary peak	Secondary peak	Season	Primary peak	Secondary peak
Majali .	October to March	Novem-ber	Not observed	October to February	Novem-ber	Not observed	Novem-ber to March	Novem-ber	Not observed
Karwar .	October to March	October	Decem-ber	October to February	Novem-ber	Not observed	October to April	Novem-ber	February
Bingae . .	October to March	October	January	October to February	Novem-ber	Not observed	October to March	Novem-ber	March
Chendia .	October to March	October	February	October to February	October	Decem-ber	October to March	October	February

TABLE IV

Details showing the total Mackerel catch, number of pieces operated in the rampan net, number of men employed, number of hauls, catch per piece and catch per haul at Karwar, Majali, Bingae, Chendia, Ankola, Kumta and Murdeshwar for 1956/57, 1957/58 and 1958/59 *seasons*

Seasons	Total Mackerel catch (kg.) 'N'	Number of pieces operated 'P'	Number of men employed 'M'	Number of rampan hauls 'H'	Catch per piece N/P	Catch per haul N/H
M-KARWAR						
1956/57	3,99,548	36,455	4,946	70	10.96	5,707
1957/58	22,50,257	47,166	5,472	94	47.70	23,938
1958/59	28,66,463	91,475	12,282	189	31.33	15,166
MAJALI						
1956/57	3,50,865	24,308	3,713	53	14.43	6,620
1957/58	8,58,721	40,945	6,254	100	20.97	8,587
1958/59	11,69,454	50,393	8,144	115	23.20	10,169

TABLE IV—*Contd.*

Seasons	Total Mackerel catch (kg.) 'N'	Number of pieces operated 'P'	Number of men employed 'M'	Number of rampan hauls 'H'	Catch per piece N/P	Catch per haul N/H
BINGAE						
1956/57	2,87,310	32,700	4,087	63	8.78	4,560
1957/58	7,45,033	21,091	3,556	49	35.32	15,204
1958/59	13,47,290	48,900	7,235	99	27.55	13,608
CHENDIA						
1956/57	3,01,095	32,850	4,572	63	9.16	4,779
1957/58	12,92,324	49,650	6,892	91	26.03	14,201
1958/59	16,14,185	57,150	7,371	97	28.27	16,641
ANKOLA						
1956/57	81,646	2,100	318	5	38.87	16,329
1957/58	2,04,569	5,600	760	12	36.53	17,047
1958/59	2,29,516	2,200	444	7	104.32	32,788

KUMTA						
1956/57	28,113	8,000	784	16	3.51	1,757
1957/58	15,694	2,800	315	7	5.60	2,242
1958/59	2,50,590	15,250	2,222	51	16.43	4,913
MURDESHWAR						
1957/58	1,55,187	17,100	3,534	57	9.07	2,722
1958/59	2,22,945	19,065	8,452	140	11.69	1,592

TABLE V

Particulars of the monthwise analysis of the total number of pieces operated in the rampan net, number of men employed, number of hauls, total mackerel caught, catch per piece and catch per haul at Karwar, Majali, Bingae, Chendia and Murdeshwar for 1956-57, 1957-58 *and* 1958-59 *seasons*

Seasons	Months	Number of pieces operated 'P'	Number of men employed 'M'	Number of hauls 'H'	Total mackerel caught (kg.) 'N'	Catch per piece N/P	Catch per haul N/H
KARWAR							
1956-57 .	October . .	5,260	710	11	1,32,902	25.26	12,082
	November . .	5,570	756	11	70,579	12.67	6,416
	December . .	910	160	2	18,597	20.43	9,298
	January . .	11,145	1,431	20	1,21,180	10.87	6,659
	February . .	10,980	1,537	21	45,540	4.14	2,168
	March . .	2,590	352	5	10,750	4.15	2,150
1957-58 .	October . .	5,160	622	10	30,253	5.86	3,025
	November . .	18,047	2,126	37	11,74,571	65.08	31,745
	December . .	15,248	1,684	30	9,88,735	64.84	32,957
	January . .	8,236	1,005	16	53,977	6.55	3,373
	February . .	475	35	1	2,721	5.72	2,721

1958-59 .	October . .	1,200	170	3	34,200	28.50	11,400
	November . .	18,800	2,473	39	7,45,067	39.63	19,104
	December . .	17,900	2,356	36	6,84,014	38.21	19,000
	January . .	11,500	1,521	23	1,76,265	15.32	7,663
	February . .	17,500	2,396	35	6,14,751	35.12	17,564
	March . .	15,350	2,216	35	4,66,654	30.40	13,332
	April . . .	9,225	1,150	18	1,45,512	15.77	8,084
MAJALI							
1956-57 .	October . .	13,152	2,007	29	2,59,998	19.76	8,965
	November . .	2,219	346	5	49,622	22.36	9,924
	February . .	5,675	900	12	3,001	5.63	2,666
	March . .	3,262	460	7	9,244	2.83	1,320
1957-58 .	October . .	8,450	1,376	20	1,27,979	15.14	6,398
	November . .	13,875	1,628	33	4,17,299	30.07	12,645
	December . .	8,505	1,405	20	2,07,490	24.39	10,374
	January . .	8,475	1,577	23	95,457	11.26	4,150
	February . .	1,640	268	4	10,496	6.40	2,624

TABLE V—*contd.*

Seasons	Months	Number of pieces operated 'P'	Number of men employed 'M'	Number of hauls 'H'	Total mackerel catch (kg.) 'N'	Catch per piece N/P	Catch per haul N/H
1958-59 .	November . .	12,430	2,033	29	3,76,425	30.98	12,980
	December . .	11,104	1,727	25	3,28,417	29.57	13,136
	January . .	8,810	1,472	20	2,11,028	23.95	10,551
	February . .	8,670	1,391	19	1,37,619	15.87	7,243
	March . .	9,379	1,521	22	1,15,965	12.36	5,271
BINGAE 1956-57 .	October . .	6,700	902	13	1,57,377	23.48	12,105
	November . .	2,050	280	4	7,302	3.56	1,825
	December . .	3,100	485	6	15,332	4.94	2,555
	January . .	6,750	726	13	51,202	7.58	3,938
	February . .	8,200	975	16	36,180	4.41	2,261
	March . .	5,900	719	11	19,917	3.37	1,810

1957-58 .	October . .	3,545	526	8	51,800	14.61	6,475
	November . .	5,266	902	12	3,53,637	67.15	29,468
	December . .	6,010	1,056	14	2,90,785	48.38	20,770
	January . .	4,500	768	11	40,537	9.00	3,685
	February . .	1,770	304	4	8,274	4.67	2,068
1958-59 .	October . .	500	56	1	16,790	33.58	16,790
	November . .	9,300	1,358	19	4,05,053	43.55	21,318
	December . .	11,300	1,653	23	2,48,137	21.95	10,788
	January . .	10,800	1,578	22	1,85,289	17.15	8,422
	February . .	10,500	1,640	21	2,60,242	24.78	12,392
	March . .	6,500	950	13	2,31,779	35.65	17,829
CHENDIA 1956-57 .	October . .	2,375	407	5	1,04,326	43.92	20,865
	November . .	1,900	225	3	10,521	5.53	3,507
	December . .	5,875	875	12	57,448	9.77	4,787
	January . .	6,725	850	12	45,684	6.79	3,807
	February . .	9,450	1,375	19	67,243	7.11	3,539
	March . .	6,525	840	12	15,873	2.43	1,322

TABLE V—*contd.*

Seasons	Months	Number of pieces operated 'P'	Number of men employed 'M'	Number of hauls 'H'	Total mackerel caught (kg.) 'N'	Catch per piece N/P	Catch per haul N/H
1957-58	October	10,210	1,455	19	3,62,610	35.51	19,084
	November	7,860	1,070	14	2,54,387	32.36	18,170
	December	16,200	2,293	30	5,27,561	32.56	17,585
	January	12,060	1,632	22	1,26,991	10.52	5,772
	February	3,320	442	6	20,775	6.25	3,462
1958-59	October	1,020	172	2	52,163	43.46	26,081
	November	13,500	1,663	23	3,65,081	27.04	15,873
	December	10,100	1,331	17	2,90,651	28.77	17,097
	January	11,750	1,478	20	2,06,445	17.56	10,322
	February	13,950	1,815	24	5,25,093	37.64	21,878
	March	6,650	912	11	1,74,752	26.27	15,886
ANKOLA							
1956-57	October	2,100	318	5	81,646	38.87	16,329

1957-58 .	November . .	3,200	444	7	1,18,750	37.10	16,964
	December . .	1,900	250	4	80,376	42.30	20,094
	January . .	500	66	1	5,443	10.88	5,443
1958-59 .	October . .	950	188	3	1,08,862	114.59	36,287
	November . .	1,250	256	4	1,20,654	96.52	30,163
KUMTA							
1956-57 .	October . .	1,500	147	3	5,887	3.92	1,962
	December . .	2,500	245	5	8,618	3.44	1,723
	January . .	4,000	392	8	13,608	3.40	1,701
1957-58 .	December . .	1,200	135	3	5,897	4.91	1,965
	January . .	800	90	2	6,804	8.50	3,402
	February . .	800	90	2	2,993	3.74	1,496
1958-59 .	November . .	2,400	348	8	95,254	39.68	11,906
	December . .	4,050	555	13	45,359	11.19	3,489
	January . .	2,850	381	9	40,823	14.32	4,535
	February . .	3,400	536	12	36,568	10.75	3,047
	March . .	2,55	402	9	32,586	12.77	3,620

TABLE V—*contd.*

Seasons	Months	Number of pieces operated 'P'	Number of men employed 'M'	Number of hauls 'H'	Total mackerel caught (kg.) 'N'	Catch per piece N/P	Catch per haul N/H
MURDESHWAR							
1957-58 .	October . .	2,400	496	8	33,302	13.87	4,162
	November . .	4,500	930	15	39,564	8.79	2,637
	December . .	4,200	868	14	47,319	11.26	3,379
	January . .	2,700	558	9	18,769	6.95	2,085
	February . .	2,700	558	9	12,792	4.73	1,421
	March . .	600	124	2	3,441	5.73	1,720
1958-59 .	November . .	3,645	1,640	27	57,315	15.72	3,122
	December . .	5,620	2,496	41	74,951	13.33	1,828
	January . .	2,125	966	16	12,183	5.73	761
	February . .	4,450	1,894	32	50,611	11.37	1,581
	March . .	3,225	1,456	24	27,885	8.64	1,161

for the 1957/1958 season at Karwar and Bingae. Further, the monthly analysis revealed that the catch per piece and the catch per haul were generally high during the beginning of the seasons.

Summary

The length frequency distribution of mackerel at Karwar during January 1954 to March 1959 is presented and discussed. The mackerel catch statistics of the seven observation centres in North Kanara for the three seasons commencing from 1956/1957 are analysed.

Acknowledgements

The author wishes to express his indebtedness to Dr. S. Jones, Director, C.M.F.R.I. for the kind interest and encouragement. He is grateful to Shri S. K. Banerji, Dr. M. S. Prabhu, Dr. G. Seshappa of the C.M.F.R.I. and to Dr. S. Z. Qasim, Scientist, Indian Ocean expedition for going through the manuscript and offering helpful criticism. My thanks are also due to Shri L. B. Pradhan, Research Officer, C.M.F.R.I. for permitting me to make use of the data from January to September 1954 for the present analysis. Shri S. B. Harikantar, Field man of the C.M.F.R. Substation, Karwar has rendered valuable assistance in collection of catch data and the author would like to thank him for it.

References

Beverton, R.J.H., & Holt, S.J. 1957 . . On the dynamics of exploited fish populations *Fish. Invest., London.*, Ser. 2, **19**:533p.

Banerji, S. K. 1962 . . . . . On some considerations in the study of pelagic fish stocks with special reference to Indian mackerel, *Rastrelliger kanagurta. Proc. Symposium on scombroid fishes.* Part I, 469-482.

De Baufort, L. F. & Chapman, W. M. 1953 *The Fishes of the Indo Australian Archipelago.*9. *E.J. Brill, Leiden.*

Day, F. 1878 . . . . . *The fauna of British India.* Fishes I. *William Dawson & Sons, London.*

Pradhan, L.B. 1956 . . . . Mackerel fishery at Karwar. *Indian J. Fish.*, 3 (1), 141-185.

——— & Rao, K. V. 1958 . . . "The Mackerel". *Fisheries of the west coast of India.* Published on the occasion of the opening of the new building of the CMFRS at Calicut. 38-44.

Panikkar, N. K. 1952 . . . . Fisheries research in India. Part I. *Jour. Bombay nat. Hist. Soc.* **50**, 741-65.

18—1 DCM/FRI/67

Radhakrishnan, N. 1958 . . . Observations on the mackerel fishery at Karwar for the seasons 1954/1955 and 1955/1956

Indian J. Fish. 5(2), 258-269.

———1962 . . . . . Observations on the maturity and spawning of Indian mackerel, *Rastrelliger canagurta* (Cuvier at Karwar.

Indian J. Fish. 9 (2), 512-524.

Rao, K. V. 1962 . . . . . Distribution of the young stages of the mackerel, *Rastrelliger kanagurta* (Cuvier) in the Indian inshore waters.

Proc. Symposium on Scombroid fishes, Part II, 565-567.

Sekharan, K. V. 1958 . . . . On the South Kanara coastal fishery for mackerel, *Rastrelliger canagurta* (Cuvier) with notes on the biology of the fish.

Indian J. Fish. 5(1), 1-31.

Seshappa, G. 1958 . . . . . Occurrence of growth checks in the scales of the Indian mackerel, *Rastrelliger canagurta* (Cuv.) *Curr. Sci.*, 27, 262-63.