

OBSERVATIONS ON THE MATURITY AND SPAWNING OF INDIAN MACKEREL, *RASTRELLIGER CANAGURTA* (CUVIER) AT KARWAR

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THE present paper deals with the maturity and spawning of mackerel and incorporates the results of investigations carried out at Karwar from January 1955 to December 1958.

The ovary of the Indian Mackerel, *Rastrelliger canagurta* (Cuv.), is bilobed and at times asymmetrical, the right one being shorter than the left. The ducts from either side unite and open outside through a common opening. It is not possible to distinguish the sex from external appearance. The different stages referred to are based on the recommendations by the International Council for the exploration of the sea on Herring (Hjort, 1910).

MONTHLY SIZE RANGES AND STAGES OF MATURITY

The minimum and maximum sizes recorded for the period under report were 98 mm. (August 1956), and 307 mm. (January 1955) respectively. Juveniles in the size group 120–150 mm. were usually encountered in the catches during September. But stray specimens have been obtained at other months also, for example 90 mm. in August 1956, 100 mm. in June 1958 and November 1956, 120–130 mm. in October 1957 and 1958, in December 1956 and in January 1957. Generally towards the end of February, the percentage of larger size groups seems to be higher. A progressive increase in size was noticed from March to August, but during this period there was no fishery as such: only stray specimens were obtained.

The fishes examined in January and February were mostly immature with gonads in Stage II, the ovary being wine coloured. The length and breadth recorded during this period varied from 20–25 and 2–4 mm. respectively. The specimens examined in March were in Stages II and III. The gonads extended to about 2/3rd of the length of the body cavity. The colour was creamy to yellowish with the eggs granular in appearance. The pale white opaque ova were moderately bigger than those noted during the

previous month. The ranges in the length and breadth of the ovaries varied from 25–27 and 5–8 mm. respectively. The available material for April in Stage III showed all the characteristics seen for the previous month. The length and breadth of the ovaries varied from 24–32 and 5–10 mm. During May, the ovary occupied more than 2/3rd of the body cavity and was in Stage IV. The eggs when examined under microscope appeared to be opaque. The length and breadth respectively measured 30–35 and 10–14 mm. In June the ovary more or less filled the body cavity and was in late Stage IV. The colour was yellowish and blood vessels were clearly seen on its wall. Microscopic examination revealed that the ova were slightly translucent with one or two oil globules. The minimum and maximum length and breadth of the ovary were 42–47 and 9–19 mm. respectively. The specimens examined in July were in Stages IV, V and VI and practically filled the entire body cavity. The length and breadth varied from 43–62 and 12–24 mm. respectively. The colour was yellowish. In some individuals the ovaries contained transparent eggs also. A large oil globule measuring about 0.20–0.25 mm. in diameter was seen in the transparent ovum. Individuals in Stage VII were also netted during this month. August specimens were in maturity Stages V and VI, the length and breadth varied from 50–65 and 15–30 mm. Spent ones were also recorded. During September, the material examined was in Stage I. Juveniles with the sex not distinguishable were also obtained during this period. During October–December the individuals were in maturity Stages I and II. The length and breadth of the ovary varied from 10–15 and 1–3 mm. A good many partially or fully spent individuals were met with during these months. The size range of mackerel, stages of maturity and the range of size of the length and breadth of the gonads for the four-year period under study are shown in Table No. I.

SIZE AT FIRST MATURITY

The smallest individual with ovaries in spent condition measured 210–220 mm. in total length. Hence, it was inferred that the minimum size at which the mackerel mature is when they reach the above-mentioned size which more or less agrees with the findings of Pradhan (1956). Devanesan and John (1940) have remarked that mackerel attain maturity at about a length of 190 mm.

OVA SIZE FREQUENCY DISTRIBUTION

The frequency distribution of the ova in the ovaries during different months of the year was carried out on the same lines as Clark (1934), Prabhu

TABLE I

Particulars showing the size range of mackerel during different months, along with the stages of maturity, length and breadth of the gonads for the years from 1955-1958

Months	1955	1956	1957	1958	For the four-year period	Stages of the maturity							Length and breadth of the gonads (mm.)
						I	II	III	IV	V	VI	VII	
January ..	181-247	174-249	121-238	191-254	121-254	X	X	..	..	..	..	..	20-25/2-4
February ..	195-247	203-259	191-236	191-254	191-254	..	X	..	..	..	..	..	10-25/2-4
March ..	212-246	201-249	191-254	190-242	191-254	..	X	X	..	..	..	..	25-27/5-8
April ..	Nil	Nil	154-240	Nil	154-240	..	..	X	..	..	..	..	24-32/5-10
May ..	121-251	219-262	185-235	204-235	121-262	..	..	..	X	..	..	..	30-35/10-14
June ..	Nil	259	196-237	102-220	196-259	..	..	..	X	X	..	..	42-47/9-19
July ..	163-248	212-246	215-248	225-241	163-248	..	..	..	X	X	X	X	43-62/12-24
August ..	115-145	98-246	Nil	Nil	98-261	..	..	..	..	X	X	X	50-65/15-30
September ..	120-169	132-168	122-127	135	122-169	X	..	..	..	..	..	..	10-12/1-3
October ..	140-224	161-235	122-245	132-243	105-254	X	X	..	..	..	..	X	10-15/1-3
November ..	171-247	105-246	164-254	191-246	105-254	X	X	..	..	X	X	X	10-15/1-3
December ..	173-243	131-248	191-249	191-231	131-249	X	X	..	..	..	..	..	10-15/1-3

X denotes presence.

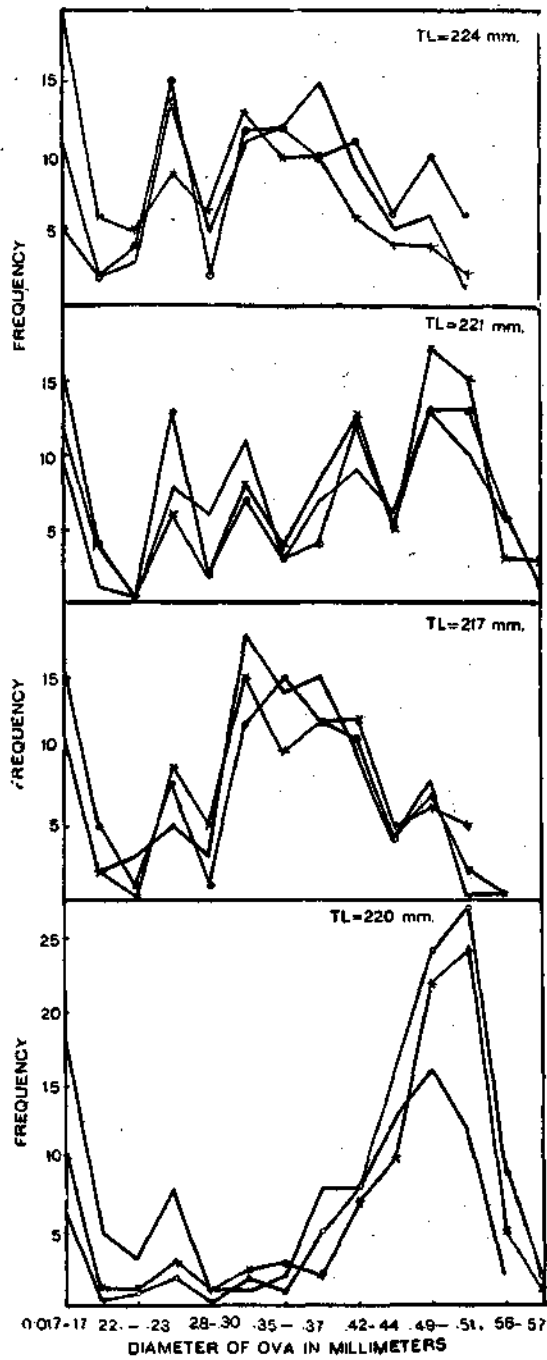


FIG. 1. Ova diameter frequencies from different regions of the ovary of four specimens of *Rastrelliger canagurta*.

(1956) and Qasim and Qayyam (1961). The classification of the intra-ovarian eggs used by Prabhu was adopted in the present study. Measurements of 200 eggs each, from the anterior, middle and posterior regions of the ovary were made. In order to find out whether there is any difference in the relative number of eggs in each size group in any of these regions, four fishes ranging from 217–224 mm. collected during May–June were taken for detailed analysis. The data thus collected are shown in Fig. 1. It is seen from the graph that the measurements of samples of ova from different parts of the ovary (anterior, middle and posterior) showed no significant differences.

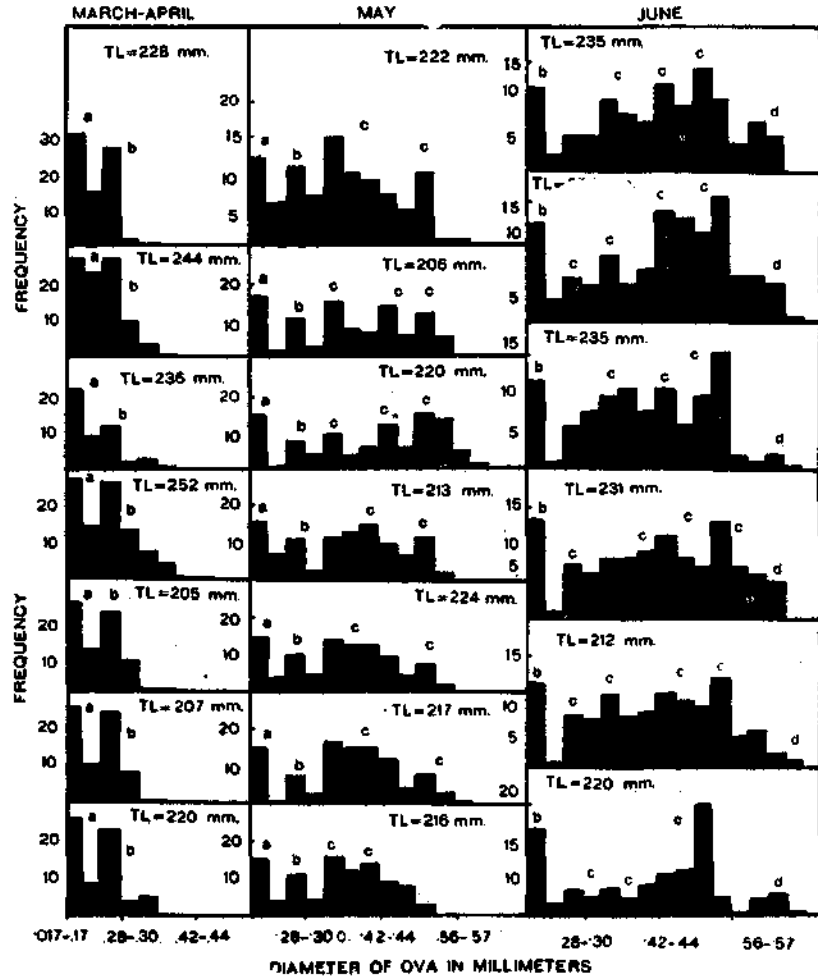


FIG. 2. Showing the frequency of ova in different size groups from ovaries of different individuals during March–April, May and June.

March-April.—Seven specimens ranging in length from 207–244 mm. were taken for detailed analysis. The ova diameter showed two peaks, immature (*a*) and maturing (*b*). The range of the former mode varied from 0.017–0.170 mm. and the latter 0.255–0.272 mm. All the specimens examined were more or less in the same state of maturity. The curves for ova size which showed two peaks are only to be expected in the early stages of maturation (Fig. 2).

May.—Measurements of ova from ovaries of seven specimens ranging from 206–224 mm. were made. Besides the two groups of ova (immature and maturing) a mature group (*c*) is also seen. The maturing group (*b*) remains at 0.255–0.272 mm. in all the fishes examined. The mature group with different minor modes varied from 0.323–0.510 mm. (Fig. 2).

June.—Six specimens with the size range 214–236 mm. were examined. It is seen from Fig. 2 that the mature group (*c*) predominates and it ranged from 0.425–0.544 mm. Indications of the ripe category (*d*) is also seen at 0.629–0.646 mm. The maximum size of the ova recorded for the month is 0.680 mm.

July.—Measurements from ten ovaries from individuals ranging from 227–256 mm. were collected. Besides the three modes immature, maturing

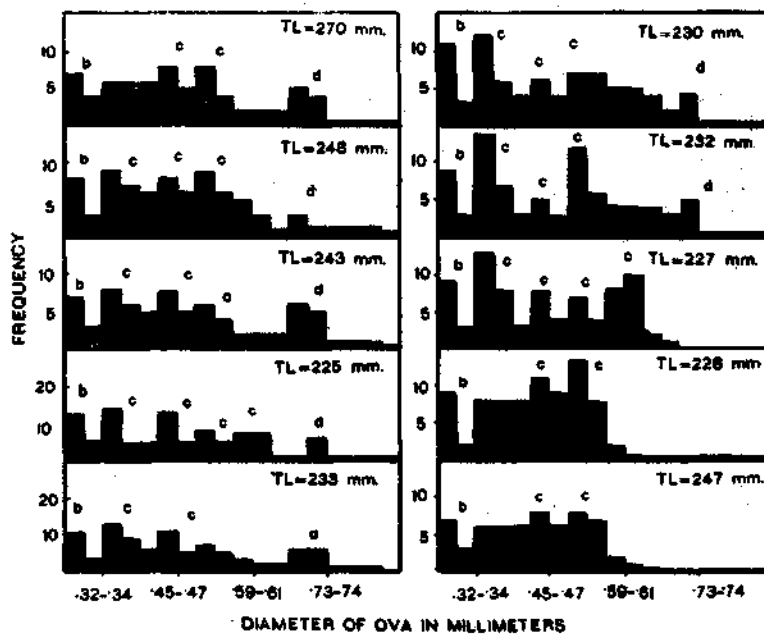


FIG. 3. Showing the frequency of ova in different size groups from ovaries of different individuals during July.

September.—During the month specimens ranging from 120–150 mm. were recorded. They were all juveniles and in most cases sex was not distinguishable.

October–February.—This period coincides with the mackerel season at Karwar and the author has pointed out earlier (1958) that the fishery of the Kanara coast is contributed by individuals in the maturity stages I and II. Fourteen fishes ranging from 189 to 223 mm. were examined. The immature (a) and maturing (b) groups were well represented (Fig. 4). The maximum size of the ova recorded during this period was 0.204 mm. During October–November spent ones and recovering individuals were usually obtained in the catches. In the spent ovaries a few residual ova measuring 0.799–0.816 mm. are also met with.

DISCUSSION

Qasim (1956 and 1957) in his studies on *Blennius pholis* L. and *Centronotus gennellus* L. has pointed out that "a study of the size distribution of the intra-ovarian eggs reveals successive groups of varying sizes, the discharge of which probably involves several spawning acts". He further added that "evidences of such a spawning behaviour under natural conditions can be obtained by studying the changing size frequency distribution of unspawned eggs during the breeding season". As the maturation and withdrawal of several groups of eggs from a definite quota goes on throughout, an analysis of the multiple modes should indicate the development of various batches and their final shedding. In Atlantic species, *Scomber scombrus* ova are ripened and released in batches. Sekharan (1958) has indicated the occurrence of such a phenomenon in the Indian mackerel as a possibility. From Figs. 2–4 presented here it is observed that within the mature group (c) which has a wide range, several minor modes were seen. Since the minor modes showed the same category of development (mature) the caption 'c' has been given for all. It is also noticed that even before the commencement of the shedding of the ova of ripe mode (d) there are indications of the formation of another group of eggs in mature condition (c). Since there is a well-marked differentiation of ova between the different modes a, b, c and d the shifting of mature group (c) may take place only after the ova at group (d) are shed. Similarly the ova at group (b) might develop and attain maturity by the time the ova of group (c) shift to group (d). Thus we see that different batches of eggs are constantly shifting from one stage to the other, thus releasing the ripe ova in batches. There are clear evidences of more than one batch of oocytes in the mature ovary. It is to be noted that owing to

the succession of spawning the breeding cycle of each individual takes an independent course. From these observations it could be inferred that the duration of shedding of ova is not restricted to a short period but a prolonged one. The ripe category of ova (*d*) seen during the months of June, July and August are indications of the commencement of spawning of this species in this region. Individuals in spent condition were recorded in July–August and October–November, further confirms that the duration of spawning is not a short one.

Most of the Indian workers have pointed out that the spawning period in Indian mackerel is a prolonged one extending over about six months. Devanesan and John (1940), Devanesan and Chidambaram (1953), Bhimáchar and George (1952), Panikkar (1952) and Pradhan (1956) believed that the spawning occurs during July–September period. Chidambaram *et al.* (1952) reported the ripening of gonads in March–April and May and stated that the months of April–September should be regarded as the spawning season. Sekharan (1958) says that the spawning would commence in March or at least April, though the height of the breeding activity might occur sometime later. Balakrishnan (1957) working at Vizhingam has observed the occurrence of post-larvae in late March and emphasised that the spawning starts “much earlier than hitherto believed”. Subsequent workers at Vizhingam have indicated the possibility of two spawning periods, November–March and May–August.¹ At Ratnagiri there are indications of a spawning at least in early May in 1956 and another at the end of September or the beginning of October. George, Dhulkhed and Rao (1959) indicated the possibility of a longer or subsidiary spawning season for the fish along the Mangalore coast. The investigations on mackerel carried out on the east coast of India have also been interesting. Day (1889) captured at Madras specimens with fully developed ova in March. Rao and Basheeruddin (1953) have recorded the occurrence of young mackerel ranging from 30–90 mm. in March–April 1953. Further occurrence of juveniles ranging in size from 40–100 mm. in the shoreseines during February–March has also been reported.² Basheeruddin and Nayar (1961) in their account on the juvenile fishes of the coastal waters off Madras City have indicated that “the occurrence of young mackerel during March–April months of 1954 and 1955 confirms the observations of Rao and Basheeruddin (1953) that the species

¹ Quarterly Scientific Report on the work of the Central Marine Fisheries Research Institute for the quarter ending 30th June 1958.

² Annual Report of the Director, Central Marine Fisheries Research Institute for the year ending 31st March 1957.

breeds during or after the north-east monsoon on the east coast." At Waltair, investigations during 1956-57 have shown that the juveniles were encountered in all the months except February 1957.³ At Porto Novo, gonadial studies indicate that the first spawning takes place in April or May.⁴ Results of the investigations at Mandapam have shown the possibility of there being two distinct spawning seasons, one during October-November and the other major spawning in May-June.³ From the above-mentioned observations it is seen that mackerel spawns at different localities at different times. Reference may be made here to the work on *Scomber japonicus* by Okkado (1955), who has shown that the spawning season in that species varies with the different latitudes. It remains to be studied whether such a variation occurs in India.

The fishery of the Indian mackerel is during October-March when the catch is composed of mainly immature specimens. During other periods only stray specimens are caught and they are in advanced stages of maturity. It is quite probable that the fish performs a spawning migration to offshore regions after March. The spawning might synchronise with the onset of the South-West Monsoon. Devanesan and John (1942) believed that the fish after spawning do not permanently retire to the deep sea but seek coastal waters and their spawning grounds are not very far from the coast. Bala-krishnan (1957) states that "there are evidences to believe that the spawning area is outside the present fishing limits but not too far from the 30 fathom area which is about 3 miles from the shore at Vizhingam". It can reasonably be assumed that the spawning of mackerel takes place not far from the coast as is evident from the occurrence of post-larvae at some of the centres along our coast. In this connection the general observation made by Delsman (1929) is to be noted. He says "That the favourable spawning places of these pelagic fishes are those where the ocean water of high salinity mix and where the places are at a safe distance from the coast so that the waters will not be liable to coastal pollution."

The investigations on the qualitative and quantitative, distribution of fish eggs along the Karwar coast were initiated in 1955 with a view to finding out the possible occurrence of mackerel eggs and larvae. The results were not successful. The maximum size of the intra-ovarian eggs noted at Karwar is 0.935 mm. and probably the fully ripe ova may be slightly

³ Annual Report of the Director, Central Marine Fisheries Research Institute, for the year ending 31st March 1957.

⁴ Annual Report of the Director, Central Marine Fisheries Research Institute, for the year ending 31st March 1959.

larger than the size mentioned above. Devanesan and John (1942) have recorded mackerel eggs from Chaliyam near Calicut. They identified this as those belonging to *R. kanagurta* by a process of elimination, general appearance and the diameter of the mature ovarian ova. However, they admitted that the inference cannot be conclusive in the absence of artificially fertilized eggs. Balakrishnan (1957) working at Vizhingam has collected the eggs of this species (the diameters ranging from 0.84–1.009 mm.) but admitted that the identity cannot be established since his attempts to rear them had failed. The inference made so far by other workers on our coast were not conclusive and positive identification of mackerel eggs may not be possible, until spawning fishes are secured in large numbers, and artificial fertilization is carried out. The occurrence of young ones is very rare in Karwar and mackerel less than 90 mm. have not been recorded during the course of this investigation. Recruitment of young ones 120–150 mm. to the fishery are seen during most of the years in August–September. It is certain that the smaller sizes do not occur in the inshore grounds at Karwar during the season, October–March, as the Rampan net is too efficient to exclude the smaller sizes in the catches. Along the east and west coasts of India during the months of March–September the occurrence of young ones has been noted by various workers [Bhimachar and George (1952), Basheeruddin and Nayar (1961), Balakrishnan (1957), Chidambaram *et al.* (1952), George and Annigeri (1960), Kuthalingam (1956), Pradhan (1956), Rao and Basheeruddin (1953) and Sekharan (1958)].

SUMMARY

The results of the investigation carried out at Karwar from January 1955 to December 1958 are presented. The range of size of mackerel together with the maturity stages of the gonad and their length and breadth during the different months of the year are given. The monthly size progression of the ova is illustrated by frequency polygons. The description given denotes the changes taking place in the development of the intra-ovarian eggs stage by stage. Measurements of samples of ova from the anterior, middle and posterior regions showed no significant differences. The period of spawning of this species in North Kanara region has been observed to be a prolonged one commencing from June–July. There are indications that the ova are shed in batches. The maximum size of the intra-ovarian eggs noted at Karwar is 0.935 mm. The fully transparent ovum has a single large oil globule measuring 0.20–0.25 mm. The minimum size at which the mackerel mature is when they reach a total length of 210–220 mm. The occurrence of young ones less than 90 mm. have not been

recorded during the period of study. The existing knowledge on maturity and spawning of Indian mackerel are discussed in the light of data obtained at Karwar.

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