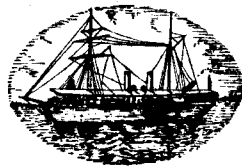


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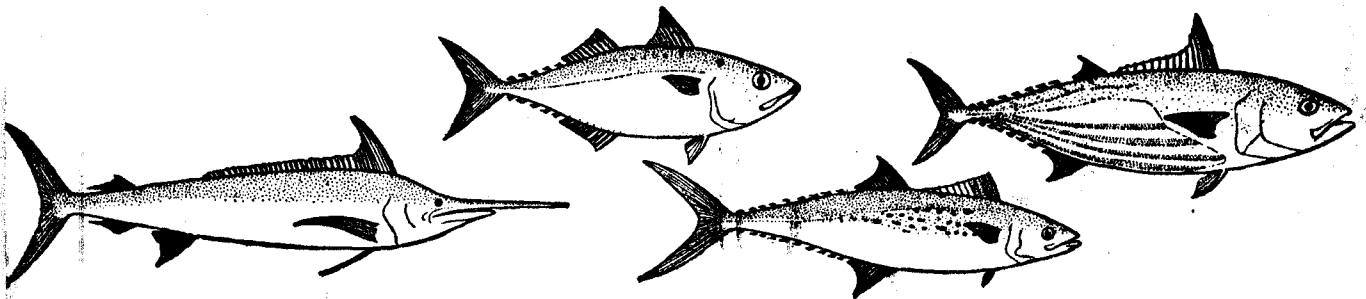
PART II



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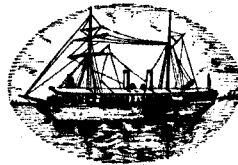
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PROCEEDINGS OF THE
SYMPOSIUM
ON
SCOMBROID FISHES

HELD AT MANDAPAM CAMP FROM JAN. 12-15, 1962

PART II



SYMPOSIUM SERIES I
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AN ACCOUNT OF THE RIPE OVARIES OF SOME INDIAN TUNAS*

By K. V. NARAYANA RAO

Central Marine Fisheries Research Institute, Mandapam Camp, India

VIZHINGAM, on the South-West Coast (Lat. 08° 22' N., Long. 76° 59' E.), is one of the important tuna fishing centres in India. Of the twelve species of tuna recorded from the Indian waters (Jones *et al.*, 1961 and Jones and Silas, 1961), seven species, *Euthynnus affinis* (Cantor), *Auxis thazard* (Lacépède), *A. thynnoides* Bleeker, *Sarda orientalis* (Temminck and Schlegel), *Kishinoella tonggol* (Bleeker), *Neothunnus macropterus* (Temminck and Schlegel) and *Katsuwonus pelamis* (Linnaeus), occur in the waters off Vizhingam. Out of these the first two species are of commercial importance, the rest being taken occasionally. At Vizhingam, they are caught in the drift nets and by hook and line. In certain months the schools of *Euthynnus affinis* come so close to the shore that they are captured sometimes in the shore-seines operated in the foreshore waters.

While the author was stationed at the Central Marine Fisheries Research Centre, Vizhingam, a good opportunity arose to study the biology of the tunas landed there during the period 1959-1960. At the suggestion of Dr. S. Jones, Director, Central Marine Fisheries Research Institute, detailed studies on the maturity and the spawning season of commercially important species were undertaken.

Among the several hundreds of gonads of the eastern little tunny (*Euthynnus affinis*), frigate mackerel (*Auxis thazard*) and oriental bonito (*Sarda orientalis*) examined during the course of this investigation, only twelve ovaries belonging to the above three species were in running-ripe condition. As there are no previous records on the occurrence of spawn-ripe individuals of the above species from the Indian waters they are dealt with in the present preliminary report.

MATERIAL AND METHODS

The material for the present study was collected from the drift net catches landed at Vizhingam, and included 12 ripe ovaries of which six belonged to the eastern little tunny, two to frigate mackerel and four to the oriental bonito.

After noting length (Furcal length) and weight of individual fish, ovaries were removed from their body cavity for detailed examination. Notes on the general appearance, colouration, vascularisation and maturity of the ovaries were taken. The fresh ovaries were then weighed to the nearest gram with the help of spring balance. After this a small portion of the ovaries was cut from the middle region of the left ovary (for the sake of uniformity) in each case. The ovary pieces, thus collected from each fish, were weighed to the nearest milligram in an analytical balance, before being fixed in 5% formalin for detailed studies.

After the ova in each sample were sufficiently hardened they were teased out to ensure complete separation from the ovarian follicles. All the opaque maturing ova and ripe translucent ova present in each sample were then counted separately under a binocular microscope, in order to get estimates of the total number of ova in both groups and in the ripe group present in each

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set of ovaries. The former gives the total number of ova that are likely to be spawned in a breeding season (fecundity) and the latter estimate represents the total number of ova liberated in each spawning by the individual fish. The above two estimates were obtained by multiplying the ratio of number of ova in both the groups and in the ripe group to the weight of the sample by the total weight of the ovaries.

The diameter measurements of ova from preserved samples were taken according to the procedure adopted by De Jong (1940) and Bunag (1956). This was done under a microscope at a magnification which gave each micrometer unit a value of 17.1μ . In this way about 1000 ova from each ovary were measured. Ova measuring less than 9 micrometer units were not considered since they represent the immature reserve stock.

It was realised at the beginning of this study that there was a considerable shrinkage in the ripe ova after preservation and the measurements taken on such material may not be of much help in comparing with the size of the planktonic egg of the respective species. Hence measurements of about 100 ripe ova in fresh condition were taken after keeping them in sea water for about 5 minutes. This process allowed ripe ova to absorb sea water and slightly increase in size in the same manner as they do when they are normally shed into the sea by the fish. Practically no difference in the size of the oil-globule was noticed, irrespective of its measurements being taken from fresh or preserved material.

NOTES ON RIPE OVARIES

Euthynnus affinis :

As stated earlier only six spawn-ripe ovaries of the above species could be collected during the period under investigation. Of these six ovaries, one was collected in May 1958, four in August 1959 and one in May 1960. The size of the fish from which the above ovaries were secured ranged from 48.0 cm. to 65.0 cm. The weight of the ovaries varied from 80 gms. to 350 gms. (Table 1).

TABLE 1

Details of the ripe specimens of the eastern little tunny (Euthynnus affinis) collected from Vizhingam

Fish No.	Date of collection	Fork-length (Cm.)	Wt. of fish (Kg.)	Stage of maturity	Wt. of the ovary (Gm.)
A. 1	3. V 1958	48.0	1.37	VI	80
A. 193	22. VIII 1959	58.2	3.20	VI	240
A. 215	25. VIII 1959	54.5	2.30	VI	126
A. 235	26. VIII 1959	55.5	2.35	VI	179
A. 236	27. VIII 1959	65.0	4.57	VI	350
A. 350	4. V 1960	52.5	2.06	VI	175

The ripe ovaries of *E. affinis* are moderately large and distended occupying its whole body cavity. In fresh condition they are very soft, delicate and well vascularized with conspicuous blood vessels. The ovaries in this stage are pale pinkish in colour and mottled all over due to the presence of ripe translucent ova among the opaque ones. The ripe ova were found spread out in the entire body of the ovaries and a large number of the ripe ova were found already dehisced into the central cavity. On the application of slight pressure on the sides of the ovaries several ripe ova could be extruded.

Each ripe ovum, in fresh condition, is perfectly spherical, transparent and possesses a rather large, single, more or less, colourless oil-globule. In fixed material, however, the ripe ovum appeared translucent and the oil-globule appears somewhat pale yellow in colour. The average

diameter of the ripe ovum was 0.99 mm. in fresh material and 0.81 mm. in preserved material. The oil-globule had an average diameter of 0.25 mm. (Table 4).

According to Schaefer and Marr (1948) the diameter of the ripe ovum of *Euthynnus lineatus*, a closely related species, from Costa Rica, measured 0.72 mm. to 0.81 mm. Their measurements

TABLE 2

Details of the ripe specimens of the oriental bonito (Sarda orientalis) collected from Vizhingam

Fish No.	Date of collection	Fork-length (Cm.)	Wt. of fish (Kg.)	Stage of maturity	Wt. of ovary (Gm.)
SO. 3	4. VI 1959	51.0	1.37	VI	162
SO. 10	26. VIII 1959	48.0	1.14	VI	105
SO. 11	do.	55.0	2.06	VI	271
SO. 16	4. IX 1959	54.0	1.83	VI	220

were based on preserved material. The largest ripe degenerating ovum of *E. yaito*, from Philippines, measured about 1.07 mm. and possessed a single oil globule having an average diameter of 0.24 mm. (Bunag 1956). It may be noted that the average size of the ripe ovum and the oil-globule of *Euthynnus affinis* closely approaches their sizes in *E. lineatus* and *E. yaito* described from elsewhere.

Auxis thazard :

In this species only two ovaries were in spawn-ripe condition. The details of the ovaries are given in Table 3. The fishes from which these two ovaries were examined measured 41.6 cm. and 44.2 cm. The smaller fish might have been captured while in the act of spawning since most of the ripe ova were already lost by the time it was examined.

The ripe ovaries of *A. thazard* are comparatively smaller than that of the previous species. In ripe condition the ovaries occupied the whole body cavity. As in the previous species, the ripe ovaries are very delicate, mottled and pinkish pale yellow in colour. The vascularisation was less intense.

TABLE 3

Details of the ripe specimens of the frigate mackerel, (Auxis thazard) collected from Vizhingam

Fish No.	Date of collection	Fork-length (Cm.)	Wt. of fish (Kg.)	Stage of maturity	Wt. of ovary (Gm.)
AT. 3	3. IX 1959	41.6	0.91	VI	52
AT. 12	7. IX 1959	44.2	0.92	VI	125

The ripe ova were freely flowing out of the ovaries on the application of slight pressure. The ripe ova, in fresh condition, were perfectly spherical with colourless homogeneous yolk mass. On preservation the ripe ova became somewhat translucent. The ripe ovum had an average diameter of 0.97 mm. and 0.86 mm. in fresh and preserved material respectively. Each ovum possessed fairly large, spherical, single oil-globule whose diameter averages about 0.22 mm. (Table 4).

There appears to be no previous records on the size of the ripe ovum of *Auxis thazard* either from Indian waters or from elsewhere.

Sarda orientalis :

Among the several ovaries of *S. orientalis* examined from Vizhingam during 1959-60, only four were in running-ripe condition. One of them was collected in June, two in August and one in September 1959. The ovaries weighed from 105 gms. to 271 gms. and the fish from which they were collected varied in size from 48 cm. to 55 cm. (see Table 2).

The ripe ovaries of this species were the biggest in the series and were greatly enlarged. In fresh condition they are soft and well supplied with thick blood vessels. The ovaries had very thin walls through which both maturing and ripe ova could be seen. The ovaries are pale pinkish yellow in colour and mottled all over as in *Euthynnus affinis* and *Auxis thazard*. The ripe ova were freely flowing out of the ovaries when the latter were gently pressed.

The ripe ovum of *S. orientalis* is very large. In fresh condition they are spherical, more or less transparent with homogeneous yolk while in preserved material the ovum appeared translucent and slightly pale yellow in colour. Its diameter in fresh and preserved condition averaged 1.13 mm. and 1.04 mm. respectively. Each ripe ovum contained a single, spherical and colourless oil-globule which had an average diameter of 0.29 mm.

Ehrenbaum (1924) mentions the range of the size of planktonic egg of *Pelamys sarda* (*Sarda sarda*) from Mediterranean, as 1.21 mm. to 1.27 mm. The diameter of the oil-globule in this species varies, according to him, from 0.31 mm. to 0.35 mm.

Kishinoella tonggol :

A few ripe residual ova could be collected from a spent ovary of the Indian long-tailed tunny *K. tonggol* which had a fork length of 81.0 cm. and a weight of 7.31 kilos. The fish was collected on 4-9-'59.

The ripe residual ovum of the above species is translucent and in fresh condition measured an average diameter of 1.09 mm. Each ripe ovum possessed an oil-globule whose diameter varied from 0.31 mm. to 0.33 mm. (Table 4).

TABLE 4

Size range of ripe ovarian egg and oil-globule in four species of the Indian tunas

Species	Diameter of ripe ovum in mm.				Diameter of oil globule in mm.	
	in preserved material		in fresh material			
	Range	Average	Range	Average	Range	Average
<i>Auxis thazard</i>	0.78-0.98	0.86	0.88-1.09	0.97	0.21-0.22	0.22
<i>Euthynnus affinis</i>	0.68-0.95	0.81	0.85-1.12	0.99	0.24-0.27	0.25
<i>Sarda orientalis</i>	0.88-1.15	1.04	1.02-1.19	1.13	0.29-0.31	0.29
<i>Kishinoella tonggol</i>	..	..	1.03-1.13	1.09	0.31-0.33	0.32

It is evident from the above account that the ovaries of *Euthynnus affinis*, *Auxis thazard* and *Sarda orientalis*, in running-ripe condition are remarkably similar in all essential external details. In all the three species the ripe ovum has a single, rather large and spherical oil-globule.

OBSERVATIONS ON THE SPAWNING SEASON AND MATURITY

The time of appearance of mature, spawning and spent individuals, in the commercial landings served to indicate the probable spawning period of the species under investigation. While the individuals of *Euthynnus affinis* could be examined for their maturity throughout the year, those of *Auxis thazard* and *Sarda orientalis* were available only in certain months.

The percentage of immature and maturing fish of *Euthynnus affinis* in the catches during the months January-March was highest as judged by the examination of their gonads. Individuals in advanced stages of maturity (V and VI) were most abundant in April, May and June landings. Mature and spawning fishes continued to occur until August. The spent individuals (Stage VII) were obtained in small numbers right from July, although they were highest in the landings in September. All the fish examined thereafter and until November were in spent condition. In December all fish were in spent recovered condition (Stage II).

As stated earlier, *Auxis thazard* were examined for their maturity only in certain months. In the first samples examined in March, the percentage of maturing and mature (Stages III and IV) was highest. While the majority of the fishes examined in August and September were actually in spawning condition (Stage VI); some individuals were, however, in completely spent condition (Stage VII). Samples examined subsequently in November comprised of spent fish only.

Stray individuals of *Sarda orientalis* examined in June were mostly in advanced stages of maturity (Stages V and VI). Many of the fish examined in August were in running-ripe condition (Stage VI). Spawning fish continued to appear in small numbers along with fully spent individuals (Stage VII) in September.

The above observations indicate that the eastern little tunny (*Euthynnus affinis*), frigate mackerel (*Auxis thazard*) and the oriental bonito (*Sarda orientalis*) spawn probably from April to September in the vicinity of their capture. The capture of several running-ripe individuals from May to August indicates that their peak spawning is confined to the above period.

According to Kishinouye (1923) the spawning of *Auxis hira* (*A. thazard*) takes place in summer and that of *Euthynnus yaito* occurs about May in Taiwan waters. Wade (1950) observes that the above two species spawn, in Philippine waters, during the major part of the year, with the peak spawning during December, January and February. Based on the occurrence of the juveniles of *Euthynnus alletteratus*, *Auxis thazard* and *Sarda sarda*, Klawe and Shimada (1959), on the other hand, conclude that these species spawn in the Gulf of Mexico from March through September. Records of spawning localities and spawning period of *Euthynnus affinis*, *Auxis thazard* and *Sarda orientalis* in the Indian waters, based on the collection of their larvae and juveniles, have been furnished by Jones (1960 a and b).

The variations in the time of spawning of the same species at different localities may be due to the fact that the species may not mature simultaneously over the entire range of its distribution.

SPAWNING PERIODICITY

The spawning periodicity of the individuals of the species under study was determined by the examination of ova-diameter frequency polygons of their ripe ovaries.

For this purpose three ovaries of *Euthynnus affinis*, one of *Auxis thazard* and two of *Sarda orientalis* were examined. The ova-diameter frequency polygons representing the running-ripe ovaries of the above three species are shown in figures 1, 2 and 3 respectively. They were based on the data given in Table 5.

TABLE
Percentage frequency of ova diameter measurements of

Species	Fish Number	Micrometer												
		9-10	11-12	13-14	15-16	17-18	19-20	21-22	23-24	25-26	27-28	29-30	31-32	33-34
<i>Euthynnus affinis</i>	EA. 350	3.65	3.67	9.30	7.70	5.90	7.70	5.15	9.30	5.15	3.96	3.66	..	..
	EA. 235	0.64	2.91	4.45	10.36	12.36	8.36	13.91	8.18	10.64	4.18	1.27	..	..
	EA. 236	1.68	1.96	4.95	5.98	8.97	6.64	7.57	6.26	13.27	8.97	4.95	1.68	..
	(Average)	1.99	2.85	6.23	8.01	9.08	7.57	8.88	7.81	9.69	5.70	3.29	0.56	..
<i>Sarda orientalis</i>	SO. 16	1.19	1.42	3.09	3.57	6.67	6.90	4.05	5.00	6.19	5.71	4.76	5.00	2.62
	SO. 10	3.22	3.55	5.12	8.92	8.68	5.95	4.63	5.70	9.26	4.30	5.70	3.80	4.63
	(Average)	2.20	2.49	4.10	6.24	7.68	6.42	4.34	5.35	7.73	5.00	5.22	4.40	3.62
<i>Auxis thazard</i>	AT. 12	2.12	2.50	3.42	8.32	5.70	9.64	13.82	10.06	14.85	10.18	3.82	0.42	..

It could be seen from the frequency distribution of the ova-diameters in the ripe ovaries of *Euthynnus affinis* (Fig. 1), *Auxis thazard* (Fig. 2) and *Sarda orientalis* (Fig. 3) that several modes of maturing and mature ova are there apart from the last mode representing the ripe ova.

It has been demonstrated by several workers, (June, 1953 and Bunag, 1956), by ova-diameter studies, that in several species of tuna all the ova destined to be spawned during the spawning season are not matured at once but they are developed and spawned in batches.

It seems likely that a similar phenomenon of ripening and spawning of several batches of ova occur in *Euthynnus affinis*, *Auxis thazard* and *Sarda orientalis*. The ripe batch of ova seen in the above species, in all appearances would be spawned soon. The maturing groups of ova that are present in the ripe ovaries represent, presumably, the batches of ova maturing for the next successive spawnings within the same spawning season.

FECUNDITY

To determine the number of ova spawned by the individual fish during breeding season and in a single spawning, estimations on 10 ovaries, which showed no evidence of previous spawning, were made. Out of these 5 ovaries belonged to *Euthynnus affinis* (weight 1.37-4.57 kilos), one to *Auxis thazard* (weight 0.92 kilos), and four ovaries to *Sarda orientalis* (weight 1.14-2.06 kilos).

In this study all the opaque ova measuring above 10 micrometer units were included, on the assumption that they all will be matured and spawned in the same season. The estimations of the ova spawned by the individual fish of the above species, during the breeding season and in a single spawning were made according to the procedure already described under material and methods. The data are presented in Tables 6, 7 and 8.

It could be seen from the data (Table 6) that the total number of ova liberated by the individual fish per spawning and during the breeding season varied from 0.21 to 0.68 millions and from 0.79 to 2.50 millions respectively in *Euthynnus affinis*. In *Sarda orientalis* the above two estimates ranged from 0.21 to 0.28 millions and from 0.91 to 1.15 millions respectively (Table 8). *Auxis*

5

ripe ovaries of Indian tunas collected from Vizhingam

Divisions

35-36	37-38	39-40	41-42	43-44	45-46	47-48	49-50	51-52	53-54	55-56	57-58	59-60	61-62	63-64	65-66	67-68	69-70
..	..	0.77	1.46	3.96	5.50	6.30	7.90	4.70	3.16	1.56	..	..	..	..	..	..	..
..	1.18	1.09	1.36	2.00	5.00	3.82	4.27	2.64	0.82	0.54	..	..	..	..	..	..	..
..	..	1.03	1.31	2.80	5.14	6.74	5.42	2.06	1.78	0.84	..	..	..	..	..	..	..
..	0.39	0.96	1.38	2.92	5.21	5.62	6.86	3.13	1.92	0.98	..	..	..	..	..	..	..
8.33	3.57	3.05	0.24	..	..	..	..	1.19	1.19	3.57	3.05	7.62	5.48	2.38	2.62	0.95	0.71
4.88	2.73	2.97	1.65	1.07	..	..	..	..	0.16	0.33	0.83	2.32	1.32	1.65	1.98	2.97	1.65
6.60	3.65	3.00	0.99	0.53	..	..	..	0.59	0.68	1.95	1.94	4.68	3.22	2.01	2.30	1.96	1.18
..	..	..	..	..	0.54	3.21	4.91	3.03	1.57	1.35	0.36	0.18	..	..	..	..	..

thazard of moderate size (0.92 kg.) appear to produce as many as 0.28 million ova per spawning and about 1.37 million ova during its breeding season (Table 7).

TABLE 6

Estimated number of ova produced per spawning and during the breeding season by the individual fish of the eastern little tunny (*Euthynnus affinis*)

Fish Number	Fish length (Cm.)	Fish weight (Kg.)	Number of ova produced per spawning (Millions)	Total number of ova produced during the breeding season (Fecundity) (Millions)
EA. 1	48.0	1.37	0.21	0.79
EA. 350	52.5	2.06	0.31	0.88
EA. 235	55.5	2.35	0.30	1.31
EA. 193	58.2	3.20	0.50	2.14
EA. 236	65.0	4.57	0.68	2.50

TABLE 7

Estimated number of ova produced per spawning and during the breeding season by the individual fish of the frigate mackerel (*Auxis thazard*)

Fish Number	Fish length (Cm.)	Fish weight (Kg.)	Number of ova produced per spawning (Millions)	Total number of ova produced during the breeding season (Fecundity) (Millions)
AT. 12	44.2	0.92	0.28	1.37

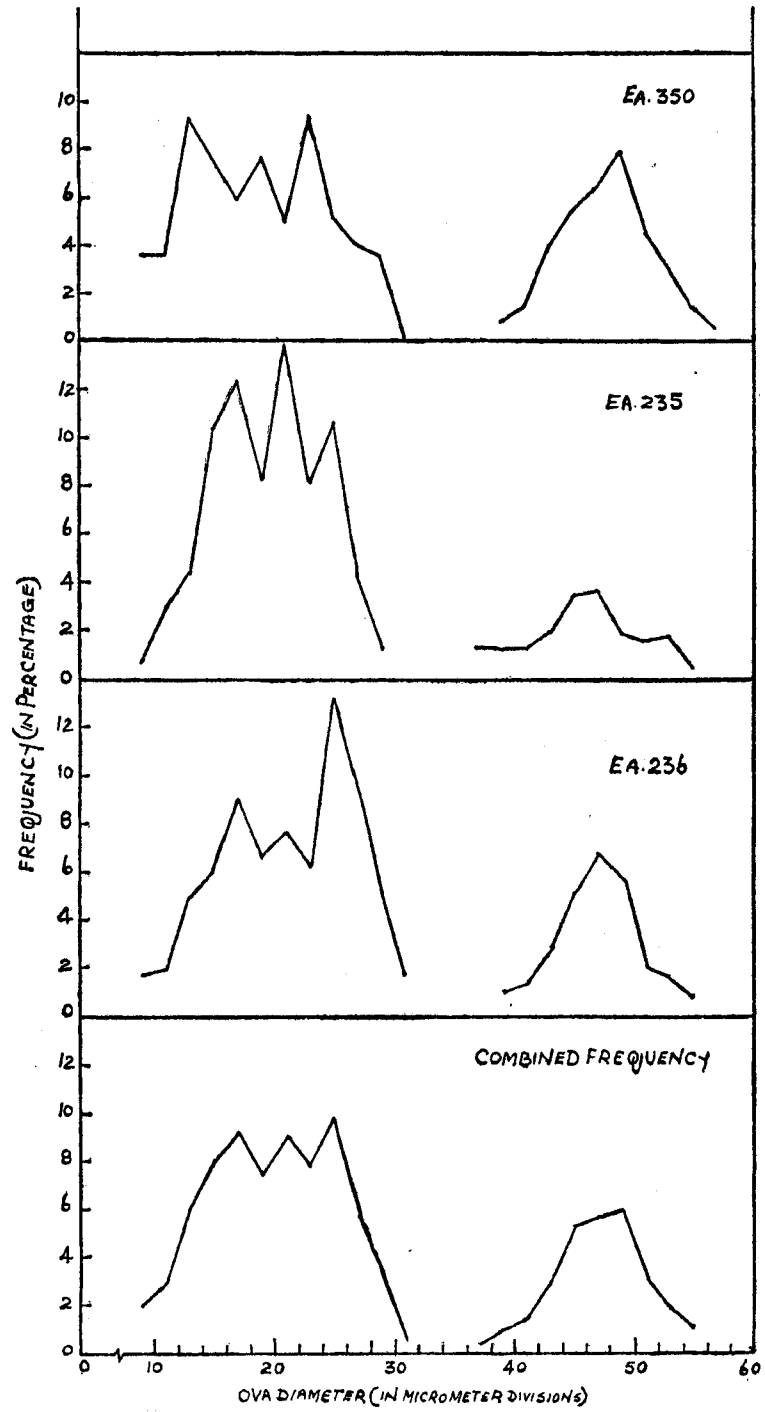


Fig. 1. Ova-Diameter Frequency Polygons of ripe ovaries of the eastern little tunny, *Euthynnus affinis*.

The data presented in Tables 6 and 8 would further indicate that the total number of ova produced by *Euthynnus affinis* and *Sarda orientalis* increases with the size of the fish. It may be noted, however, that the above observations were based only on a few ovaries.

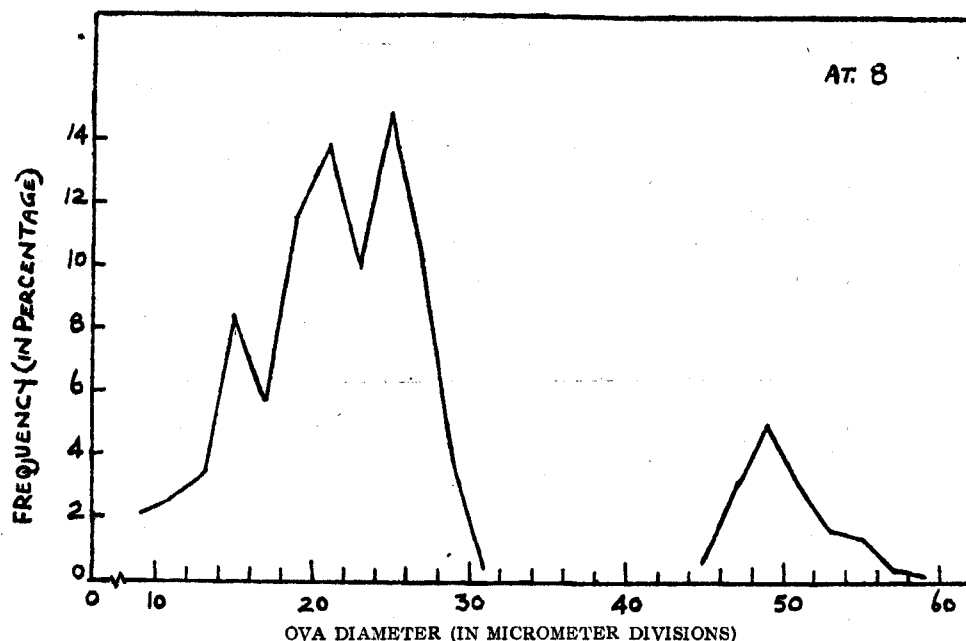


Fig. 2. Ova-Diameter frequency polygon of ripe ovary of the frigate mackerel, *Auxis thazard*.

TABLE 8

Estimated number of ova produced per spawning and during the breeding season by the individual fish of the oriental bonito (*Sarda orientalis*)

Fish Number	Fish length (Cm.)	Fish weight (Kg.)	Number of ova produced per spawning (Millions)	Total number of ova produced during the breeding season (Fecundity) (Millions)
SO. 10	48.0	1.14	0.21	0.91
SO. 3	51.0	1.37	0.23	0.93
SO. 16	54.0	1.83	0.25	1.03
SO. 11	55.0	2.06	0.28	1.15

SUMMARY

Several spawn-ripe ovaries of *Euthynnus affinis*, *Auxis thazard* and *Sarda orientalis* sampled from drift net catches at Vizhingam (Lat. 08° 22' N., Long. 76° 59' E.), were examined.

Descriptions and measurements of ripe ovaries, ripe ova of the above three species together with an account based on a few residual ripe ova collected from a spent ovary of the Indian long-tailed tunny *Kishinoella tonggol*, are given.

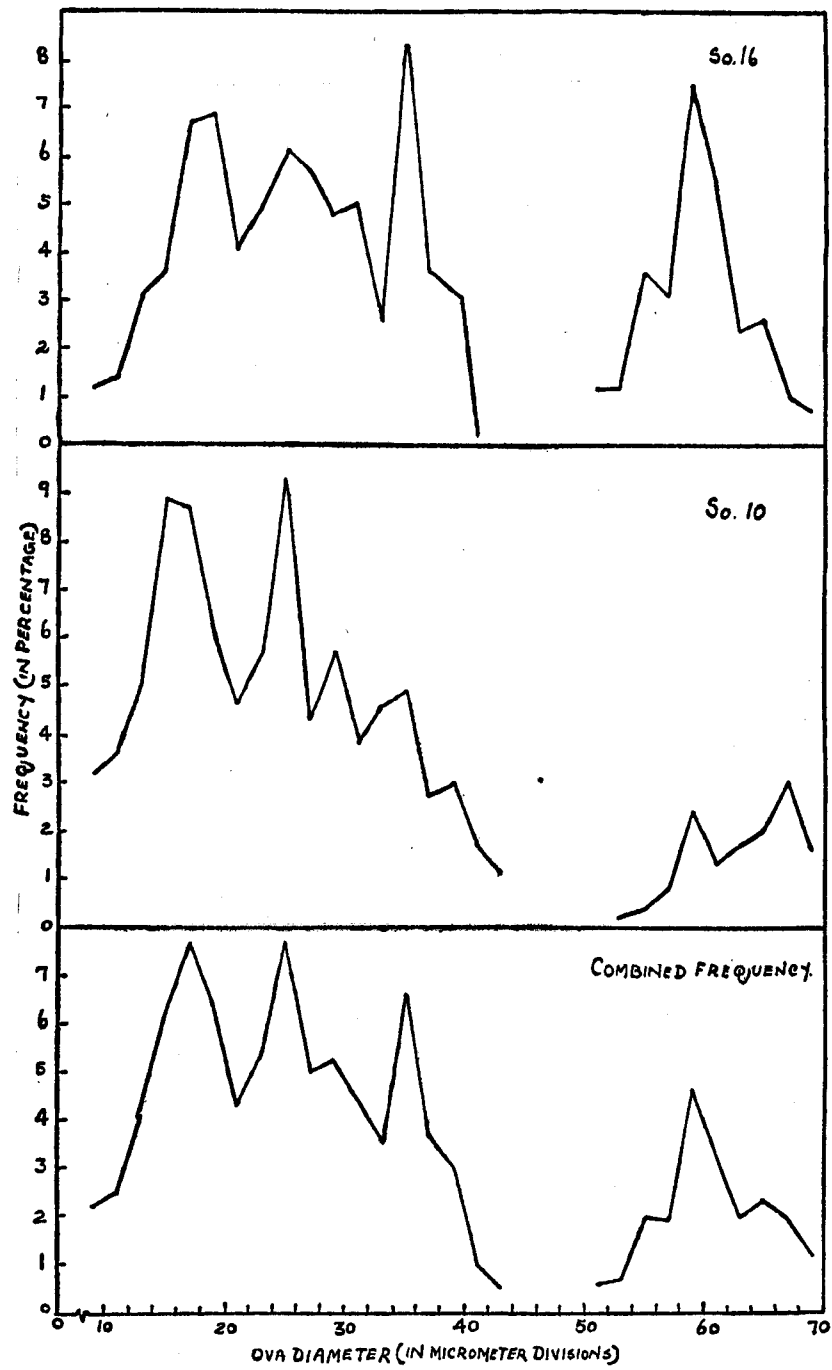


Fig. 3. Ova-Diameter frequency polygons of ripe ovaries of the oriental bonito, *Sarda orientalis*.

The available evidence indicates that the eastern little tunny (*Euthynnus affinis*), the frigate mackerel (*Auxis thazard*) and the oriental bonito (*Sarda orientalis*) spawn in the local waters from April to September, and possibly in other months of the year. The capture of spawn-ripe individuals of the above three species indicates the existence of an important spawning ground for them in the vicinity of fishing.

The evidence from the ova-diameter studies based on ripe ovaries, indicates the possibility that the individual fish of the species under investigation, matures and spawns several batches of ova during their spawning season.

Estimations of the total number of ova that are likely to be produced in a single spawning and during the breeding season by the individual fish of the above species, were given.

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