MATURATION OF THE INTRAOVARIAN EGGS AND THE SPAWNING PERIO DICITIES IN FEW FISHES OF MANGALORE AREA BASED ON OVA-DIAMETER MEASUREMENTS

By. G. G. ANNIGERI

(*Central Marine Fisheries Research Institute*)

INTRODUCTION

Ova-diameter studies have now become an integral part of fishery biological research. It is well known that in most fishes there is a marked seasonal periodicity in egg production. Clark (1934) and Hickling and Rutenberg (1936) have shown that it is possible to determine the time of spawning and the spawning periodicity of fishes by ova-diameter frequency studies. Karandikar and Palekar (1950, 1952 and 1953), Prabhu (1956), Dharmamba (1959) and Karekar and Bal (1960) among others have shown that this method is applicable in regard to the fishes they studied. This account deals with the determination of the time and periodicity of spawning of four common food fishes of the South Canara coast viz., *Nematalosa nasus*, *Anodontostoma chacunda* (Family Clupeidae); *Otolithus argenteus* (Family Sciaenidae), and *Saurida tumbil* (Family Scopelidae), based on the frequency distribution of the diameter of the intraovarian eggs.

MATERIAL AND METHODS

This study was conducted during the period January 1960 to February 1961. Samples were collected from the catches of indigenous craft as also mechanised vessels operating in the Mangalore zone. The important fishing centres visited in this connection, were Ullal, Mangalore, Tannirbhavi, Baikampady and Malpe. After recording the total length of the fishes the ovaries were removed in the field itself and preserved in 5% formalin. They were allowed to harden for several days.

Ova from the anterior, middle and posterior regions of ovary were removed and the diameters measured according to the methods recommended by Clark (1934). Under the magnification used each ocular micrometer division was equal to 19·23μ. Ova-diameters from ovaries of the same state of maturity were combined and the average was used in plotting the graphs.

The maturity scale adopted for herring, by the International Council for the Exploration of the Sea was followed in determining the maturity stage of fishes referred to in the study. The intraovarin eggs were classified as stage A,A'; 'B,B',' C and D on the basis of size and yolk formation (Table 1).

Most of the authors have used only stage VI ovaries in their ova-diameter studies. But for the proper understanding of the maturation phenomenon, it is obviously necessary to study the earlier stages also. In this investigation ovaries from stage III, onwards have been

TABLE I

The Classification of Intra ovarian Eggs in Different Species

Stage of Ova	Stage of maturity	Appearance of eggs under microscope	POSITION OF THE LAST MODE OF OVA DIAMETER FREQUENCY (in mm.)			
			Anodontostoma chacunda	*Nematalosa nasus*	*Otolithus argenteus*	*Saurida tumbil*
Stage A	Immature	Small transparent ova yolkless with clearly visible nucleus in them. Yolk accumulation has just started at the periphery in eggs above 5 micr. div.	1 to 6 micr. div. (0·019 to 0·11 mm.)	1 to 6 micr. div. (0·019 to 0·11 mm.)	1 to 6 micr. div. (0·019 to 0·11 mm.)	1 to 7 micr. div. (0·019 to 0·13 mm.)
Stage A′.	Immature	Yolk deposition has taken place in the eggs. Ova small opaque a central semi-transparent area can be made out, nucleus visible or invisible.	9 to 12 micr. div. (0·17 to 0·22 mm.)	7 to 10 micr. div. (0·13 to 0·19 mm.)	7 to 10 micr. div. (0·13 to 0·19 mm.)	8 to 12 micr. div. (0·15 to 0·22 mm.).
Stage B.	Maturing .	Medium sized opaque ova. Yolk formation is more than those of the above stage.	13 to 16 micr. div. (0·24 to 0·30 mm.)	13 to 16 micr. div. (0·24 to 0·30 mm.)	11 to 14 micr. div. (0·20 to 0·26 mm.)	13 to 16 micr. div. (0·24 to 0·30 mm.)
Stage B′.	Maturing .	Large sized opaque ova densely packed with yolk granules.	19 to 26 micr. div. (0.36 to 0·49 mm.)	17 to 20 micr. div. (0·32 to 0·38 mm.)	15 to 19 micr. div. (0·28 to 0·36 mm.)	17 to 22 micr. div. (0·32 to 0·42 mm.)
Stage C.	Mature .	Large sized opaque ova densely packed with yolk. In most of the eggs periphery has become clear.	27 to 34 micr. div. (0·51 to 0·64 mm.)	21 to 26 micr. div. (0·39 to 0·49 mm.)	20 to 26 micr. div. (0·38 to 0·49 mm.)	25 to 36 micr. div. (0·47 to 0·68 mm.)
Stage D.	Mature .	Large transparent ova free from the follicle. Yolk vacuolated except eggs of *S. tumbil*. Yolk in this fish has diffused in to a paste like semi-fluid mass, without oil globules in the case of *N. nasus*.	45 to 50 micr. div. (0·85 to 0·95 mm.)	27 to 35 micr. div. (0·51 to 0·66 mm.)	33 to 37 micr. div. (0·62 to 0·70 mm.)	37 to 40 micr. div. (0·70 to 0·76 mm.)

taken in to account. The total number of eggs measured from each ovary in case of *A. chacunda*, *N. nasus* and *S. tumbil* ranged from 300 to 500 whereas in case of *O. argenteus* from 300 to 700.

The total number of ovaries studied and the ova measured for *A. chacunda*, *N. nasus* *O. argenteus* & *S. tumbil* were 17, 29, 35, 30, and 6171, 6789, 27862, 9398 respectively.

1. *Maturation and Spawning Habits*

1. *Anodontostoma chacunda* (*Ham. Buch.*).—This fish is locally known as *Kurandadi-Swadi* and according to Day (1878) attains a total length of about 200 mm. Specimens collected during the study ranged from 145 to 179 mm. in total length. They were collected from the catches of trawls and *Kanthabale* (bottom-set gill net) which were operated in 8 to 12 fathoms area.

Fig. 1 shows the frequency diagrams of ova-diameter measurements of ovaries in different stages of maturity. Fig. 1(B) pertains to the ovaries in stage III. Here mode '*a*' shows the differentiation and withdrawal of a batch of eggs from the general egg stock. Further development of the batch of eggs '*a*' is seen in the frequency curve 1(B′) which refers to ovaries in stage IV. In stages V and VI two distinct batches of mature eggs represented by modes '*a*' and '*b*' are distinguishable. Perhaps this appearance of two modes of mature eggs in stages V and VI but not in stages III and IV ovaries, is the result of the quick growth of eggs in the higher stages of maturity. Fish in spawning condition were available in November and December. The frequency of ova-diameter of the ripe ovaries is shown in Fig. 1(D). The batch of eggs in mode '*a*' is in the stage D of maturity. Ripe ovum in this stage is provided with one big oil globule measuring 10 to 11 micr. div. (0·19-0·21 mm) and numerous small ones.

After this first batch of eggs '*a*' is released it is likely that those represented by the mode '*b*' will also ripen and be shed during the same spawning season, especially as mode '*b*' shifts to the right with progress in the maturity of the fish. [Fig. 1(C) and 1(D).] Mode '*b*' in stage VI has almost the same value as that of '*a*' when it was in stage V. It is not possible with the available data to determine the time interval between two successive spawnings.

Ripe individuals were observed only during the period November-March which probably is the spawning season. The presence of two batches of eggs in stage VI ovaries appears to indicate that spawning in this fish is restricted to a definite period although individuals may spawn twice during the same spawning season. Jacob (1943) also states that spawning period of this fish is November-March.

De Jong (1939); during his investigation of the spawning habits of fishes of Java Sea distinguishes three types of spawning. In the first type of spawning, there is only one batch of maturing eggs. In the second one, in addition to the mature batch, there is another batch of maturing eggs. In the third type of spawning there are not less than three batches of developing eggs. *Anodontostoma chacunda* falls in the second catagory as is the case in *Clupea fimbriata*, *Lactarius lactarius*, *Caranx leptolepis* and *Caesioerythrogaster* referred to by De Jong.

2. *Nematalosa nasus* (*Bloch*)—*Nematalosa nasus* is locally known as *Hole swadi*. According to Munro (1955) this fish grows to about 229 mm. in total length, but the largest fish

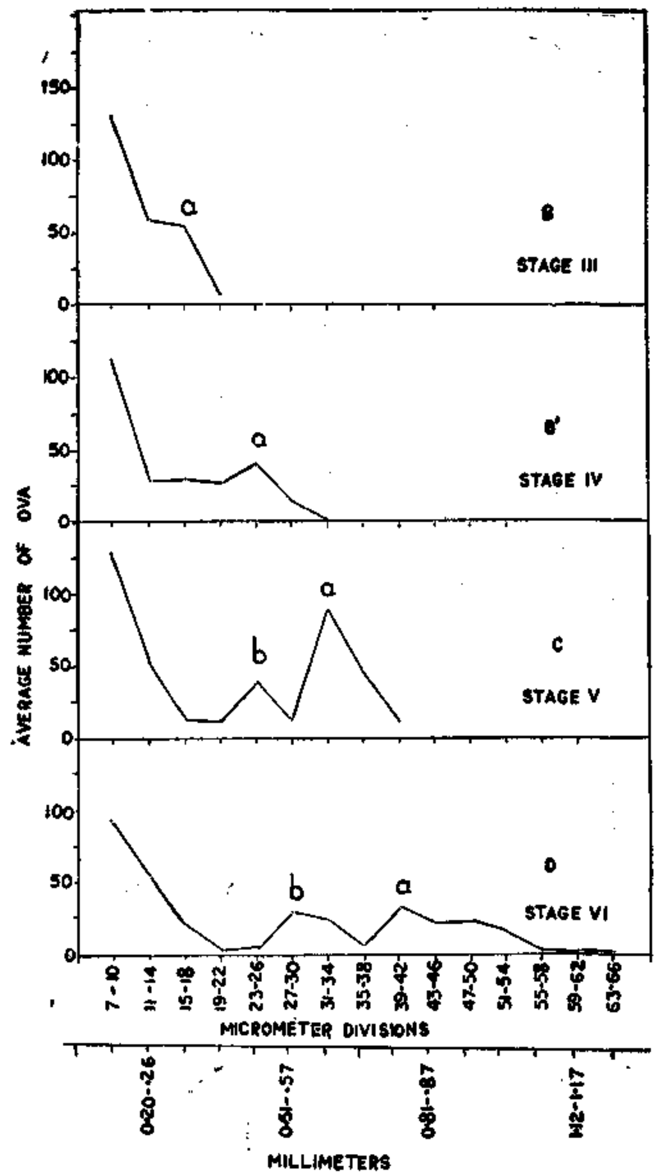

FIG. 1. Ova-diameter frequency polygons of *Anodontostoma chacunda*.

collected during this study was 320 mm. The size range available for this study was 103-320 mm. The samples were collected from *Manangubale* (gill net) and small *Rampani* (small shore seine) operated in the Netravati estuary of Mangalore.

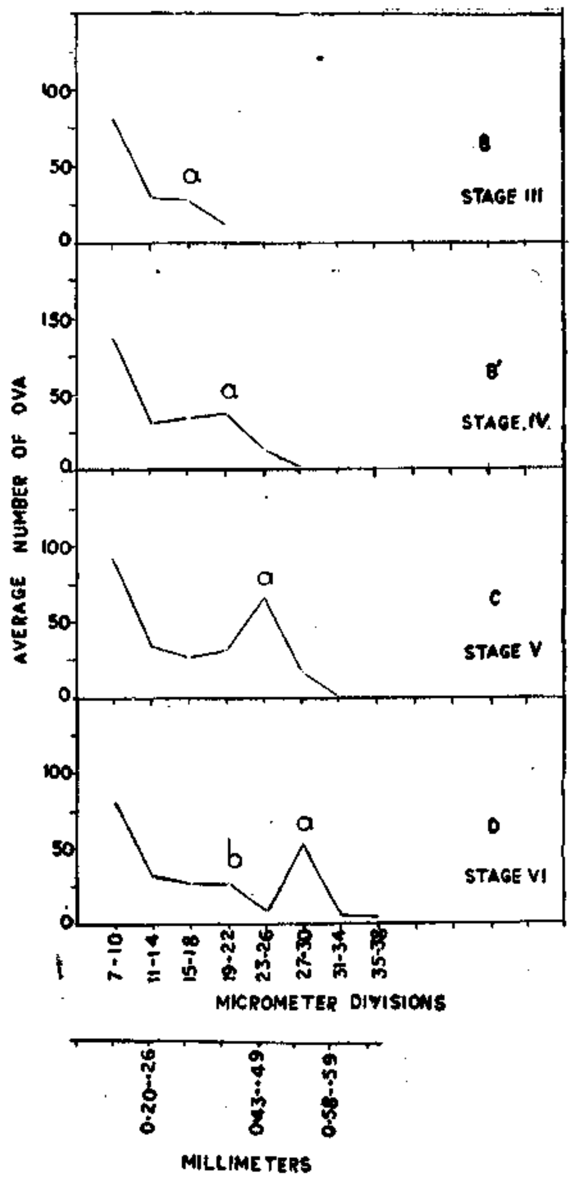

FIG. 2. Ova-diameter frequency polygons of *Nematalosa nasus*.

Fig. 2(B) represents frequency polygon of ova-diameter measurements of ovaries in stage III. The group represented by the mode '*a*' at 15-18 micr-div. refers to the batch of ova which has just been withdrawn from the general egg stock and is developing.

In stage IV ovary the mode has shifted to 19-22 micr. div. In Fig. 2(C) there is a well defined mode '*a*' which is situated at 23-26 micr. div. Further growth of the batch '*a*' is shown by its shift to 27-30 in Fig. 2(D) and this batch may be shed during the ensuing season. In Fig. 2(D) there is an indication of small mode '*b*' at 19-22 micr. div. Detailed microscopic examination showed that the eggs of both these batches '*a*' and '*b*' belong to the same stage of maturity although they differ in diameter. These eggs were transparent at the periphery and were brittle and mostly vacuolated. Also the eggs represented by the mode '*b*' were comparatively less in number than those in mode '*a*'. In fact these two batches of eggs did not differ from one another in regard to their maturity stage. As the mode '*b*' appears only in stage VI and since both '*a*' and '*b*' are in same stage of maturity, and the difference in the diameters of the two batches is small, it appears probable that both batches will be shed in the same spawning season. This is in conformity with the observation made by Prabhu (1956), in the case of *Therapon jarbua.*

As the mature ova (Fig. 2(D)) in modes '*a*' and '*b*' are sharply separated from the rest of the stock of ova, spawning is likely to be periodic and restricted to a definite and short period. Since modes '*a*' and '*b*' are very near to each other, it is possible that, the fish may spawn only once during the season. The specimens with mature ovaries were available from October to November, marking this period as the spawning period of this fish. Spent individuals were collected in the month of December. As the mature individuals were not available in other months, it is quite possible that this species has only one spawning season in a year.

3. *Otolithus argenteus (Cuvier)*—*Otolithus argenteus*, locally known as *Kalluru* is one of the common sciaenids occurring in *Rampani* (shore-seine) catches. Sometimes it is also recorded in the catches of trawl and *Kanthabala*, operated at 10-30 fathoms depth. Specimens collected for the study ranged from 141-370 mm. in total length.

Fig. 3(B) gives the ova-diameter frequency curve of stage III ovaries.

Ovaries in stage V are represented in Fig. 3(C). In this frequency polygon mode '*a*' lies at 19-22 micr. div. showing further growth of eggs as compared to that of ova in stage B. Fig. 3(D) referes to ovaries in stage VI. Here ripe eggs are transparent and as a general rule each has single big oil globule varying from 8-13 micr. div. (0·15 to 0·24 mm.). Sometimes however, each ripe egg has also 5-6 smaller oil globules varying from 2-5 micr. div. (0·038-0·095 mm.) surrounding the big one. The sudden onset of ripening might have caused the mature eggs to differentiate into two groups '*a*' and '*b*' in this frequency curve. Here the presence of the second batch of eggs is indicated by the mode '*b*' . This batch of ova is likely to be absorbed in the ovary subsequent to the spawning of the first batch of eggs, as indicated by the following observations :—

Comparision of Figs. 3(C) and 3(D) shows that the mode '*b*' of stage VI is at the same position as mode '*a*' in stage V. Fish with ripe ovaries were collected during the period October-January. These ovaries showed two modes '*a*' and '*b*' for mature ova as indicated in Fig. 3(D). In specimens collected after December the mode '*b*' persists at the same position as shown in Fig. 3(D) and does not show any shift to the right; the number of eggs in this group also gradually becomes less and less and finally the ovary assumes a sac-like appearance from March onwards. It is therefore quite probable that the eggs under mode '*b*' do not develop further and are absorbed.

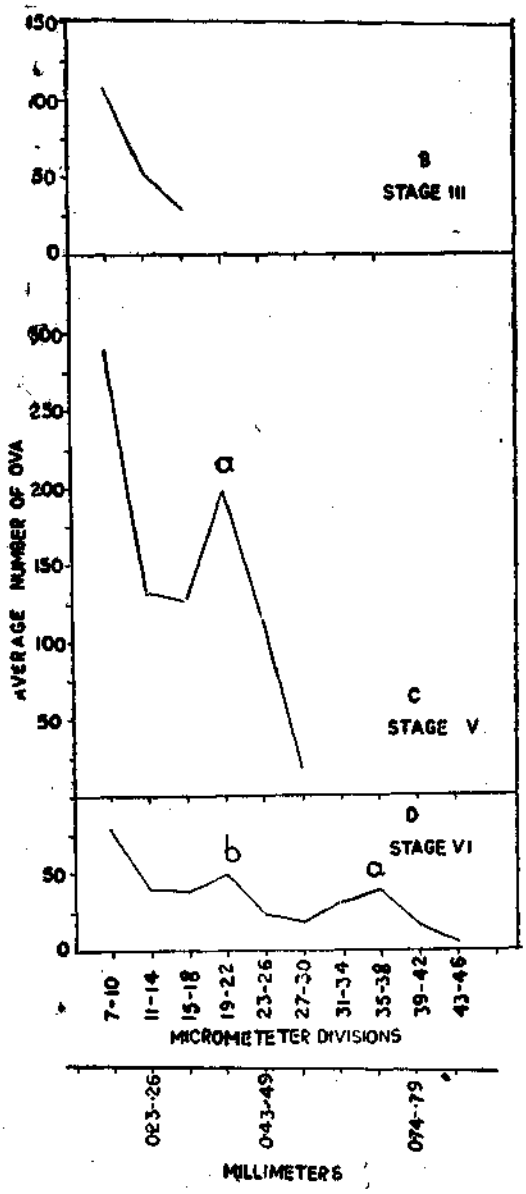

FIG. 3. Ova-diameter frequency polygons of *Otolithus argenteus*.

Since mature ovaries were collected from October-January, it is quite likely that the spawning takes place during these months. Also as there is no indication of any other batch withdrawn from the general stock, there is no probability of a second spawning season in a year.

4. *Saurida tumbil* (*Bloch*)—This fish locally known as *Arcnamenu* is observed in the catches of trawls operated at depths of 10 to 30 fathoms. During this study fish ranging from 113 to 404 mm. in total length were collected. Ripe gonads were available in the months of November to January. Spent individuals first appeared in the catches in December and their percentage increased subsequently.

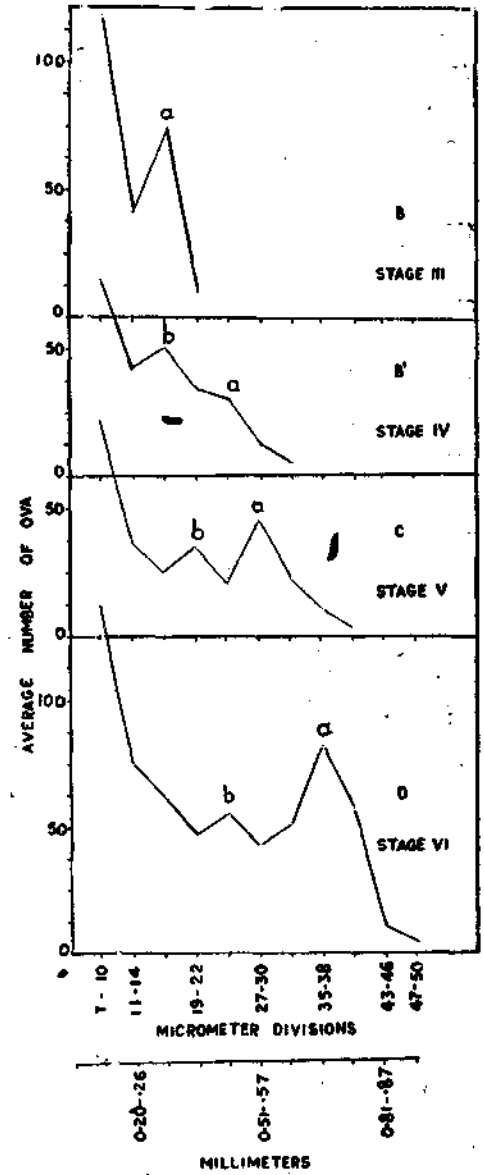

FIG. 4. Ova-diameter frequency polygons of *Saurida tumbil*.

The size range of the intraovarian eggs was 1 to 48 micr. div. (0·019 to 0·92 mm.). In stage III ovary, only one mode is seen for the maturing eggs (see mode 'a' Fig. 4 (B)), while in higher stages there are two modes ('a' and 'b'). As the ovary advances from stage IV to stage VI, the two modes '*a*' and '*b*' progressively shift to the right. In stage VI ovary, Fig. 4 (D) '*a*' is at 35-38 micr. div. and '*b*' at 23-26 micrometer divisions. The batch of eggs under mode '*a*' are ripe ova ready to be shed. These eggs on microscopic examination appeared to be semitransparent rather than transparent, probably due to the breaking of the vacuolated yolk into a paste like semifluid diffused mass, surrounded by a thin clear perivitelline space. A similar condition was also noticed in the case of *Polynemus tetradactylus* (Shaw) by Karandikar and Palekar (1950). Ripe eggs of this fish were very delicate and therefore, were easily broken by the slightest pressure applied to them. The ova had pinkish yellow oilglobule varying in size from 2 to 7 micr. div. (0·038 to 0·13 mm.) . The second batch of ova at '*b*' is likely to be shed subsequent to the spawning of the first batch. But towards the close of the pawning season, a number of unhealthy, opaque eggs with diameters comparable to those of mode '*b*' were observed in spent ovaries of this fish. Therefore, it is also quite possible that eggs under mode "*b*' may undergo degeneration and resorption. From January onwards spent individuals marked by blood shot ovaries weie obtained in the catches. Hence it can be concluded that spawning period of this fish commences from October and ends in December or January with the individual fish spawning twice during the season in case the second batch of eggs does not degenerate.

CONCLUSIONS

The study of spawning periodicity of four fishes mentioned above reveals that they exhibit definite periodicity in spawning. But the duration and frequency of spawning varies from species to species depending on number of modes in the frequency polygon of ova. In he present study *N. nasus and A. chacunda* both of the same family Clupeidae show different behaviour in their spawning. This is in accordance with the observation, made by Prabhu (1956) in the Fam. Theraponidae. The following types of spawning are exhibited by the four fishes studied.

TYPE I.—*Spawning taking place only once a year during a definite short period :*

This type of spawning is exhibited by *N. nasus*. In the ovaries of the fishes which spawn only once a year, the mature stock of eggs will be found to have differentiated from the general egg-stock, and in the whole ovary there will be a single batch of eggs to be shed during the ensuing season.

TYPE II.—*Spawning taking place only once a year and with a longer duration :*

This type is represented by *A. chacunda*, *O. argenteus* and *S. tumbil*. Two modes 'a' and '*b*' are present in the penultimate stages of ovaries studied.

(A) The second batch of eggs (mode '*b*') are shed only after shedding of '*a*' batch of eggs. This type is observed in *A. chacunda.*

(B) The second batch of eggs (mode '*b*') instead of being spawned, may undergo resorption and degeneration. This tendency is seen in *O. argenteus* and *S. tumbil.*

In species exhibiting this type of spawning, the range in size of the mature ova, irrespective of the number of modes was found to be nearly half the total range in size of the entire intraovarian eggs as also mentioned by Prabhu, 1956. In both the types referred to above, there is only a single spawning season in a year.

SUMMARY

Spawning periodicity of four fishes viz. *N. nasus*, *A. chacunda*, *O. argenteus*, and *S. tumbil* was determined based on their ova-diameter measurements. *N. nasus* has a short spawning season, whereas *O. argenteus*, *A. chacunda* and *S. tumbil* have a prolonged one. All four fishes pawn only once a year.

ACKNOWLEDGEMENTS

I am greatly indebted to Dr. S. Jones for going through the type-script and making useful suggestions. My thanks are due to Dr. R. Velappan Nair for suggesting the problem and for his guidance and to Shri S. K. Banerji and Shri K. V. Sekharan for their suggestions.

REFERENCES

1. Clark, F. N. 1934. Maturity of california sardine (*Sardina caerulea*) determined by ova-diameter measurement. *Fish. Bull.*, Sacramento. **42**, 1-49.
2. Day, F. 1878. *The fishes of India.* vol. 1, London. William Dawson & Sons Ltd. 1958.
3. De Jong, J. K. 1939. A preliminary investigation of the spawning habits of some fishes of Java sea. *Treubia.* **17**, 307—30.
4. Dharmamba, M. 1959. Studies on the maturation and spawning habits of some common clupeicids of Lawson Bay, Waltair. *Indian. J. Fish.* **6** (2), 374—88.
5. Hickling, C. F. and Rutenberg, E. 1936. The ovary as an indicator of the spawning period of fishes. *J. Mar. biol. Assoc., U. K.*, **21**. 311-17.
6. Ian S. R. Munro, 1955. *The Marine and Fresh water Fishes of Ceylon,* Canberra.
7. Jacob, P. K. 1943. Natural history of the Gizzrad shad, *Anodontostoma chacunda* (Ham. Buch.) and its fishing on the west coast of Madras province. *J. Bombay. Nat. Hist. Soc.* **48** (1), 159—60.
8. Karandikar, K. R. and Palekar, V. C. 1950. Studies on the ovaries of *Polynemus tetradactylus* (Shaw) in relation to its spawning. *Curr. Sci.* **19**, 154—55.
9. Karekar, P.S. and Bal, D. V. 1960. A study on maturity and spawning of *Polydactylus indicus* (Shaw). *Ibid.*, **7** (1), 147—64.
10. Ling, J. K. 1958. The sea Gar fish, *Reporhamphus melanochir* (Cuv. and Val.) in South Australia, Breeding; age determination and growth rate. *Australian. J. Mar. Fresh. W. Res.* **9**, 60—110.
11. Prabhu, M. S. 1956. Maturation of Intra-ovarion eggs and spawning periodicities in some fishes. *Indian J. Fish.* **3** (1), 59—90.