

STUDIES ON THE MATURITY AND SPAWNING OF SILVER  
POMFRET, *PAMPUS ARGENTEUS* (EUPHR.)  
IN THE ARABIAN SEA

by U.K. GOPALAN\*

*National Institute of Oceanography, New Delhi*

Maturity and spawning of the Silver Pomfret, *Pampus argenteus* (Euphr.) have been studied in an area between the Gulf of Kutch and the Gulf of Cambay. The method of studying were: direct observation on the occurrence of maturity stages, measurements of the diameter frequency of oocytes, seasonal variation in the condition factor and the gonadosomatic index. The results have indicated that the species has a prolonged spawning season—commencing from February and lasting till August. This has been verified by the seasonal abundance of post-larvae and juveniles. A general tendency amongst the fish to migrate from the northern waters of Gujarat towards the Gulf of Cambay has also been noticed.

INTRODUCTION

Pomfrets form one of the principal groups of edible fishes of India. They are caught in considerable quantities from all along the east and west coasts and form a major fishery in the states of Gujarat and Maharashtra. This fishery is contributed by three species viz. the Silver Pomfret, *Pampus argenteus* (Euphr.), Brown Pomfret, *Parastromateus niger* (Bloch) and the Chinese Pomfret, *Pampus chinensis* (Euphr.). Of these, the Silver Pomfret constitutes the main bulk of India's total pomfret landings which in 1962 was 25678 metric tons.

Based on several years of observation on the fishery in Gujarat, certain specific problems which require special attention have been pointed out by Gokhale (1960) and Lakumb (1961). One of the main features of their findings is the occurrence of large numbers of undersized fishes (juveniles) in the commercial catches in recent years when the fishing effort has become many-folds by the introduction of modern gears and techniques. The exploited range of this fishery along Gujarat and Maharashtra continues to remain almost the same—the conventional pomfret grounds extending between the depths of 25 and 50 metres. Some possibilities of a separate fishery of large sized pomfrets beyond the present exploited radius in deeper waters have been expressed by Kewalramani and Pathak in 1964. These observations suggest the need for a systematic investigation on the biology and fishery of this species.

Till now, we have very little information on the Indian Pomfrets. Short accounts of a general nature have been given by Spence and Prater (1931), Chidambaram and Venkataraman (1946), Moses (1947) and Devanesan and Chidambaram (1948). Preliminary attempts to study the biology of *Pampus argenteus* in Maharashtra waters have been made by Rege (1958) and Kewalramani and Pathak (1964). Siva-prakasam (1965) has made a study of the maturity and spawning of *Parastromateus*

---

\*Present Address: National Institute of Oceanography, Karikkamuri Cross Road, Cochin-11.

*niger* in Saurashtra waters. In the Arabian Sea, the richest Silver Pomfret grounds are in the coastal waters extending between the Gulf of Kutch and the Gulf of Cambay. The present communication forms part of the author's studies on the fishery and biology of the Silver Pomfret in this area during the period 1961-64.

#### MATERIALS AND METHODS

Fortnightly samples collected from Veraval (Lat. 20°54' N; Long. 70°22' E) and other representative samples collected from various fishing centres between the Gulf of Kutch and Gulf of Cambay formed the material for the present study. Most of the samples came from the catches of a traditional gear, *Dhakkal* (bottom drift net) whose operational range was limited to 30-50 metres depth. A few samples were also obtained from the *Dol* (bag net) operated off Nawabundar and Jafarabad.

After making various morphometric measurements and counts, the fishes were weighed on a single-pan Salter balance and then dissected to remove the gonads. In fresh condition the gonads were examined to determine the sex and the stages of maturity. They were then weighed on a sensitive balance, their volumes noted by displacement method and finally these were preserved in 5% formalin for subsequent studies.

Samples could not be made available for the months of June and July because of the suspension of fishing, due to the onset of south-west monsoon, which is a usual feature. Occasionally a few samples collected from the market were also used for the study of the condition of gonads. More details regarding the methods adopted for studying the various aspects have been given under pertinent sections of this paper. Total length referred to here is the length from the tip of the snout to the end of the upper caudal lobe.

#### DESCRIPTION OF GONADS

The ovaries of *Pampus argenteus* are paired L-shaped organs and occupy a postero-dorsal position in the viscera, underneath the kidneys. The two lobes lie close together with their posterior ends extending very near the cloaca. The ovaries are fused together at their posterior ends from where a short oviduct runs forward and opens into the cloaca. The testes are relatively small, paired and elongated organs occupying a similar position in the viscera. They become milky white on attaining maturity. The ovaries and testes could be distinguished easily by the naked eye in fishes measuring 14 cm and above.

#### CLASSIFICATION OF MATURITY STAGES

The macroscopic and microscopic variations in the ovaries caused by seasonal changes in the degree of maturity gave clear indications to draw the following seven arbitrary stages of maturity. Similar classification could not be made in males because of difficulties in assigning correct maturity stages to testes. The macroscopic appearance of various maturity stages of ovaries have been diagrammatically shown in Fig. 1.

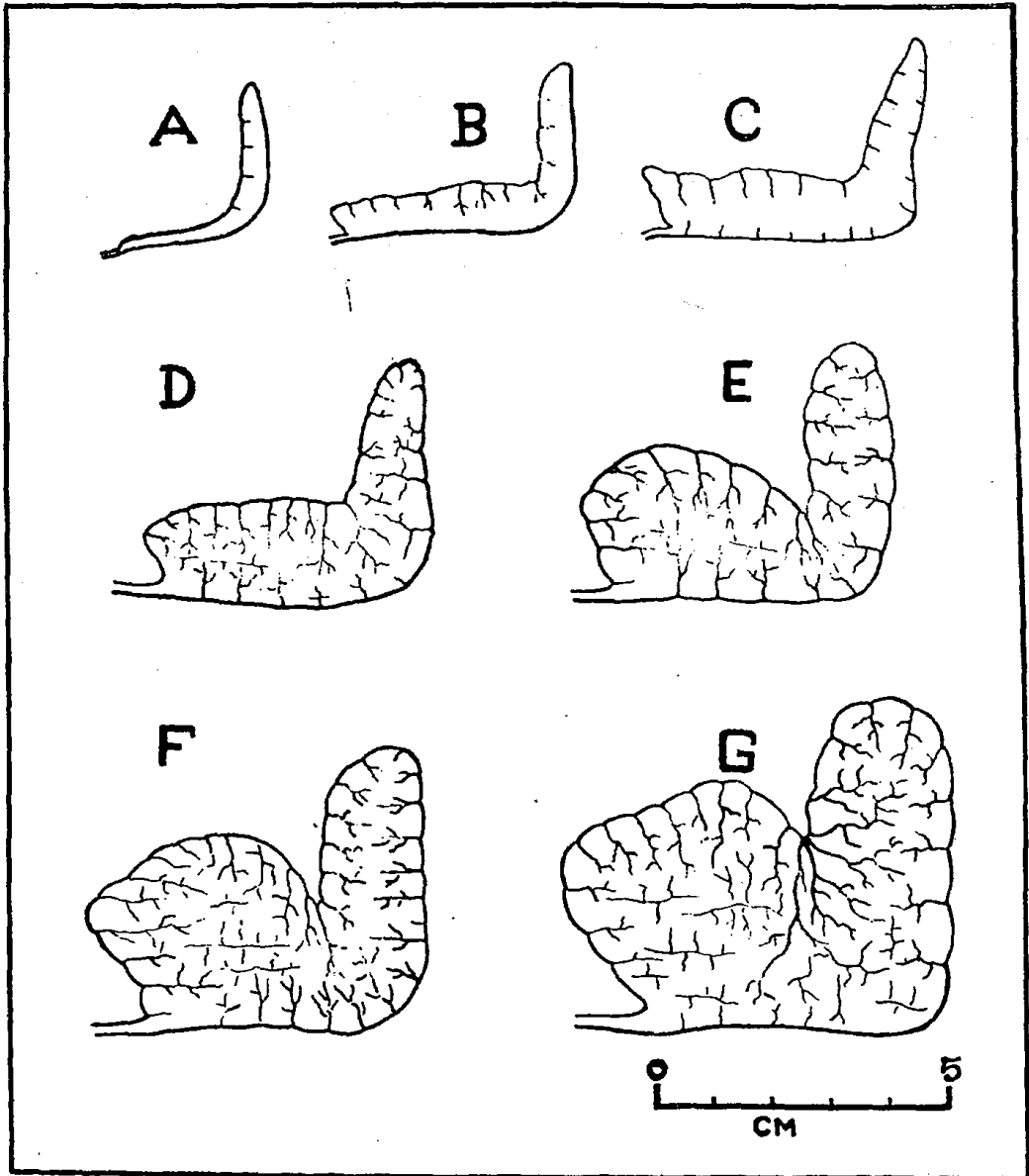


FIG. 1. Macroscopic appearance of ovaries of *Pampus argenteus* in various stages of maturity.

- A. Immature virgin 24 cm in length
- B. Maturing virgin 26.5 cm in length
- C. Recovering spent 30 cm in length
- D. Maturing (intermediate), , ,
- E. Mature " "
- F. Ripening " "
- G. Ripe " "

*Stage I (Immature)*

Ovaries thin, translucent strips of tissue weighing less than 0.5 g. Microscopic and transparent ova with nucleus at the centre and having diameters less than 5 md (1 md-0.021 mm).

*Stage II (Maturing virgin and recovering spent)*

Creamy to pale yellow ovaries, weight not exceeding 4 g. Maturing group of ova not sharply separated from the immature (reserve stock). Largest ova with diameters 12-15 md. Recovering spent ovaries could be distinguished from the newly maturing by the presence of a lumen and their flaccid nature.

*Stage III (Intermediate)*

Ovaries slightly swollen, light yellow with a reddish hue due to branching blood vessels. Weighing 4-8 g and having large ova with diameters 24-27 md.

*Stage IV (Mature)*

Ovaries large, bright yellow, with conspicuous blood vessels and weighing between 8 and 16 g. Diameter of the largest ova 33-36 md.

*Stage V (Ripening)*

Ovaries very much enlarged, yellowish or speckled, weighing 16-30 g. Largest eggs vacuolated, with diameters 42-45 md.

*Stage VI (Ripe and Running)*

Ovaries very much distended and jelly like weighing up to 45 g. Large ripe ova seen through the thin tunica. Transparent ova having oil globules are extruded with a slight pressure. Largest ova have diameter between 60 and 63 md.

*Stage VII (spent)*

Ovaries blood shot, shrunken and flaccid, weighing less than 2.5 g with some residual eggs, empty follicles and some oocytes in stage II.

## OVA DIAMETER MEASUREMENTS

Maturation and spawning habits were studied by the method of ova diameter measurements as given by Clark (1934) and Hickling and Rutenberg (1936). This method has been previously applied to several Indian species by Palekar and Karandikar (1950, 1952 and 1953), Prabhu (1956) and others.

The eggs from a portion of the preserved ovary was separated on a microscopic slide and their diameters were measured indiscriminately with the help of an ocular micrometer having a magnification of 1 md-0.021 mm. Ova measurements from various individuals having the same stage of maturity showed no significant difference in the frequency distribution. Measurements from various parts of the ovary revealed similar frequencies which indicate that these were uniformly distributed throughout the ovaries. Immature oocytes of diameter less than 5 md were not measured. Approximately 500 ova were measured from the ovaries of each

of the four individuals which were taken to account for a typical condition at each stage. Percentage frequencies of each 3 md. interval have been presented in separate polygons in Figure 2. It can be seen from the figure that in stage II there is single batch of eggs represented by the mode at 5-8 md. The biggest ova of this stage have traces of yolk granules in the cytoplasm. As the eggs get more and more laden with yolk the mode A shifts to the position of mode B<sub>1</sub> in stage III and thereafter to mode B<sub>2</sub> in stage IV. A fully mature batch of eggs likely to be spawned during the ensuing spawning season gets very sharply differentiated into a distinct mode B<sub>3</sub> in stage V. About half of this mature stock of ova suddenly increases in size and becomes completely transparent as the ovary ripens fully (stage VI). Thus the mode C, at this stage, represents the first batch of eggs to be spawned. The other mature eggs represented by the mode B<sub>4</sub> are shifted to the position of mode C after the withdrawal of mode C, and are spawned. The interval between these two spawnings does not seem to be more than a few weeks since the ova at mode B<sub>4</sub> are already in vacuolated condition. A small batch of eggs which gets differentiated from the general egg stock is represented at mode B. But owing to the fact that this remains far separated from the mature stock and does not show much progression it is most likely that this may not be spawned.

Thus from the withdrawal of eggs in successive batches it seems that the fish has a succession of spawnings but, as the fully mature eggs get very sharply differentiated soon from the smaller eggs, the spawning in this species may be restricted to a definite period. Since only half of the mature eggs attain complete ripeness at a time, it can be inferred that each individual has at least two spawnings. Prabhu (1956) observed that in some species which have prolonged spawning seasons the range in the size of mature ova is much larger than what has been noted here. Qasim (1956) while studying the spawning habits of *Blennius pholis* confirmed by aquarium studies that the presence of multiple batches of ova in the unspawned ovary gives rise to more than one spawning.

#### SPAWNING SEASON

Direct observations on the occurrence of fishes at various stages of maturity during the fishing seasons of 1962-63 and 63-64 have been made in order to determine the spawning season. The distribution of 537 females of various maturity stages in different months is expressed quantitatively in Table I.

TABLE I  
Percentage frequency of the number of females in the various maturity stages during the period 1962-64

Maturity stages	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	Number Examined
I*											
II	47.5	73.8	88.4	85.8	44.5	41.6	34.0	10.0	14.1	10.6	273
III	37.5	17.8	5.7	12.6	55.5	44.4	37.2	31.0	22.4	21.1	116
IV	10.0	8.2	2.8	1.2		13.8	29.5	41.3	18.9	20.4	80
V	2.5						9.0	17.2	29.3	32.8	50
VI								3.4	6.6		8
VII	2.5						2.0		11.7	8.2	10

\*Immature fishes in stage I occur throughout the year and not included in this table.

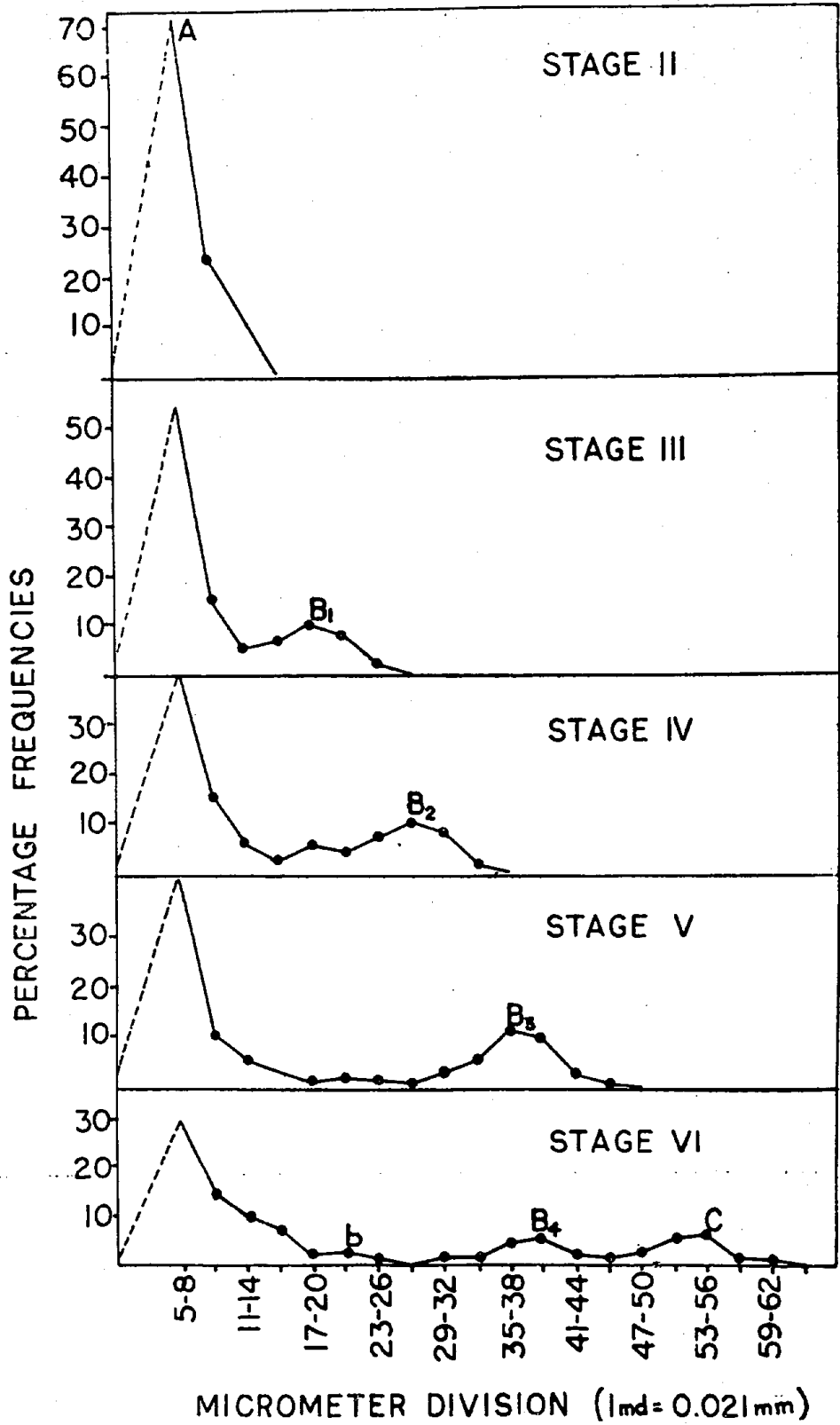


FIG. 2. Frequency polygons of ova diameters at various maturity stages of *Pampus argenteus*.

It can be seen from the table that maturity stages II and III occur throughout the year. From August to November there is a steady increase in the percentage of fishes of stage II. This gradually declines from December when the fishes of stage III become more predominant. By January, fully mature fishes of stage IV are common in the catches and their percentage gradually increases and reaches the maximum in March. The fishes with ripening ovaries begin to appear from February onwards and their frequency of occurrence continues to increase until May, when the fishing season comes to a close. A few fishes with ovaries fully ripe and in running condition were collected from Nawabundar and Jafarabad, during April and May.

When the fishing season starts in August, spent fishes in stray numbers are seen in the catches, and thereafter they are not found till February when they start re-appearing. They become common in the catches in April-May. Some of the fishes in seemingly advanced stages of maturity examined during August showed that their ovaries contained mature ova in various stages of resorption indicating that they are not likely to be spawned in the current season. They may be similar to the matured non-spawners of Norway Pout with resorbing eggs described by Gokhale (1957).

It becomes apparent from the increasing occurrence of ripe and spent fishes during April and May that the spawning activity is in progress in these months. Stray numbers of spent fishes observed in late February indicate that the spawning has already started in this month. The appearance of a large number of recovering spent fishes along with a few spent ones in August suggests that the spawning season extends as far as August. Thus the spawning in this species seems to be considerably prolonged, extending between February and August with a peak between April-June.

It has also been observed that larger fishes attain maturity earlier than the smaller ones.

#### CONDITION FACTOR AND SEASONAL CYCLE IN GONAD WEIGHT

The fluctuations in the condition factor or the ponderal index has been attributed to various biological features such as fatness, suitability of an environment or the gonad maturity and spawning. It has also been used as an index of the spawning season of fish by many earlier investigators. The ponderal index is calculated by using the following formula (see Hart 1946; Menon 1950).

$$K = \frac{W}{L^3} \times 100$$

where W=average weight of fish in g

L=mean length in cm

K=condition factor to be calculated

Average weight for each cm group was worked out in each month and from this the average ponderal index was calculated. Fishes measuring less than 25 cm were found to be immature and hence not considered in this study. The monthly average 'K' values for females have been plotted (Fig. 3).

The curve shows that the condition factor is poorest in September. From October onwards it gradually ascends and reaches its maximum in February. A sudden decline from the peak condition occurs in March. This point of inflexion of the curve coincides with the beginning of spawning which agrees with the direct

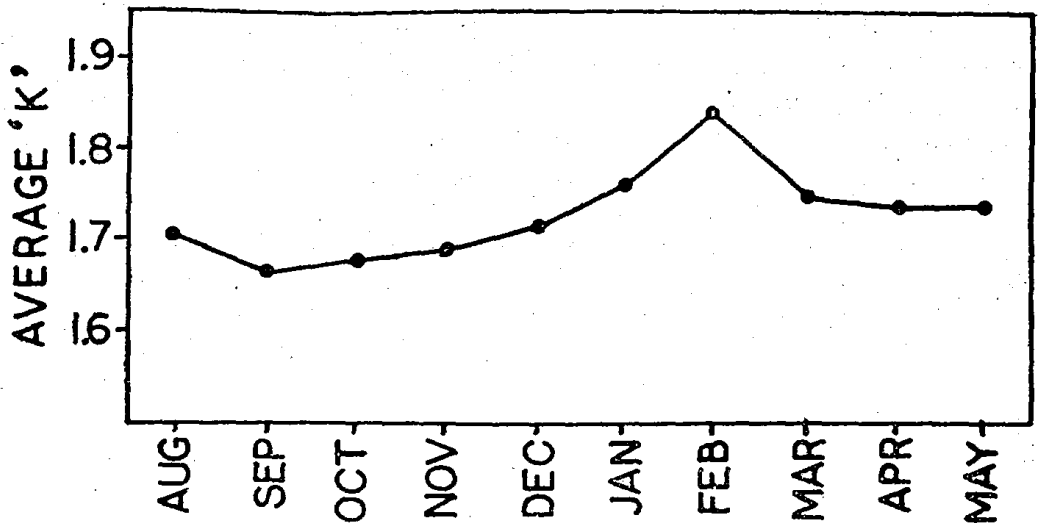


FIG. 3. Seasonal variation in the condition factor "K" of females of *Pampus argenteus*.

observations of gonads. From the values obtained in April and May it can be assumed that no drastic change in the condition of fish is brought about in these months. The values in August also indicate that the downward trend in the curve is not sharp as has been found in fishes with short duration of spawning season.

Gonad weight expressed as percentage of body weight (gonadosomatic index) was calculated and the mean percentage for females in each month is presented in the Table II. Gonadosomatic index of females below 25 cm long was found to be fairly constant throughout the year and therefore these were not included here. It can be seen from the table that the minimum values occur in November when more than 85% of the fishes are in Stage II. From the quiescent stage, the gonads start developing from December onwards till the maximum value (2.38) is reached in March. The downward trend in the gonadosomatic index from March onwards probably indicates the loss of gonad weight due to spawning. As has been found in the condition factor, the decline in the gonadosomatic index is also not sharp. The descending values of the index from August to November can be attributed to the loss of ovary weight due to the progressive resorption of unspawned eggs in the ovaries during this period.

TABLE II  
Seasonal variation in the Gonadosomatic Index

Month	Average length of fish in mm	Average weight in g	Average weight of ovary in g	Gonadosomatic index*
August	310.0	512.0	5.57	1.080
September	311.6	523.0	5.12	0.970
October	313.2	542.9	2.98	0.548
November	313.0	509.0	2.14	0.420
December	319.0	559.0	2.77	0.495
January	309.0	518.0	4.65	0.897
February	306.0	473.0	8.63	1.820
March	322.0	590.0	14.05	2.380
April	314	544.0	12.03	2.210
May	310	547.0	11.54	2.10

$$*\text{Gonadosomatic index} = \frac{\text{Wt. of ovary}}{\text{Wt. of body}} \times 100$$



A close relation between the cycle of the gonad weight and the seasonal changes in the relative condition has been observed by Le Cren (1951) in his study on *Perca fluviatilis*. A similar trend is seen in the present study of *Pampus argenteus* also.

#### SIZE AT FIRST MATURITY

To determine the size at first maturity, data pertaining to 394 fishes caught in the trawl during February-March were used. The appearance of milt in the testes and the yolk granules in the ova of females, were taken as an indication of their maturation. Percentages of maturing individuals in each cm size group have been plotted in Fig. 4.

It can be seen that 5.5% of the male fishes mature at 20 cm, and all the males above 24 cm were either mature or in maturing condition. Maturing females first appear in 24 cm group and their percentage increases thereafter. All of them were found to be maturing or mature at length between 26 and 27 cm, minimum length of the spent female observed was 27 cm. Thus the males seem to mature at a size smaller than that of the females.

#### LARVAE AND JUVENILES

Large numbers of juveniles of *Pampus argenteus* with length ranging between 5 and 19 cm were available throughout the fishing season in the bag net catches from Diu Head (20°43'N, 70° 59'E) and Jafarabad (20° 52'N, 71 22'E). Pillai (1948) while

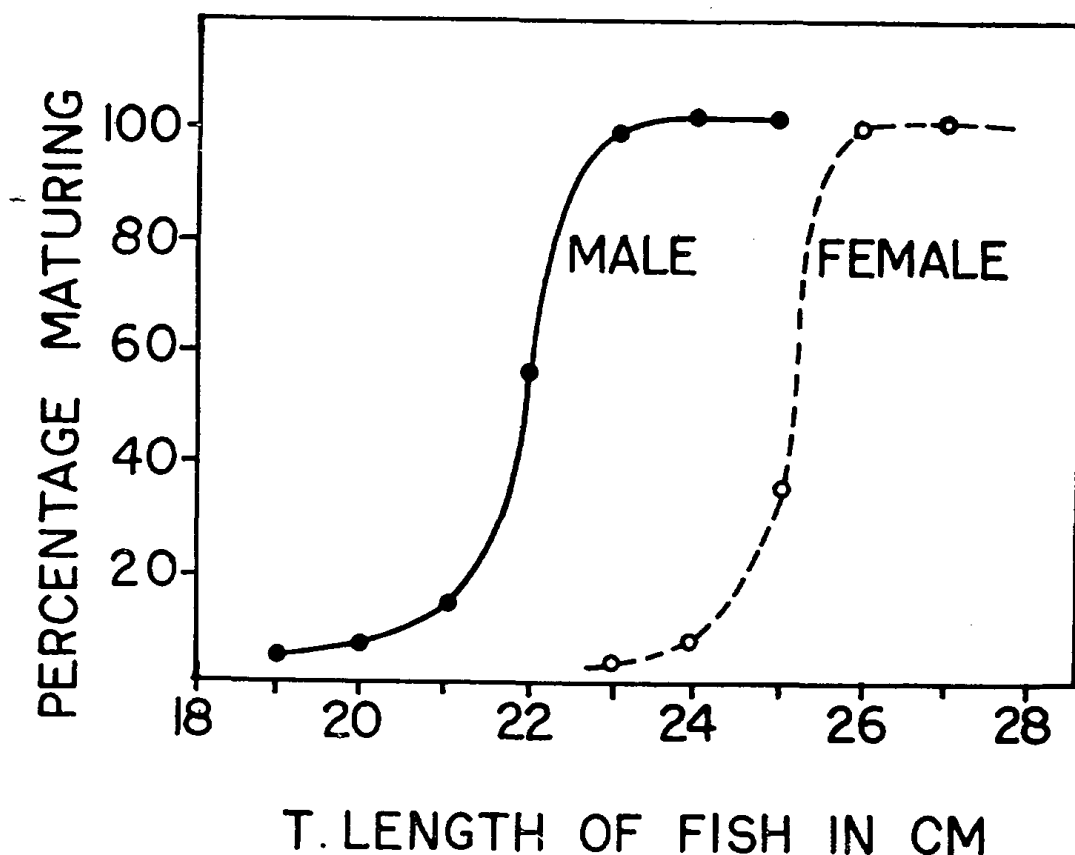


FIG. 4. Size at first maturity of *Pampus argenteus* as indicated by the percentage of maturing fishes in every 1 cm in length.

mentioning about the destructive effect of the bag net on the fishery of this region has pointed out that enormous quantities of young ones of pomfrets, measuring 2"-3" in length are landed regularly along with juveniles of other food fishes.

Examination of the trawl catches during 1961-64 showed that immature pomfrets are caught in grounds off Gujarat and Maharashtra, especially during December-March. Minimum size recorded in the trawl catch was 5 cm long. Monthly observation on the bag net catches at Madhwad, Nawabundar and Jafarabad reveal that post-larvae of Silver Pomfret measuring 2-4 cm appear in large numbers from March onwards. The field identification of these post-larvae were not difficult as fishes of almost all sizes ranging from 5-19 cm were available in the collections (Fig. 5). In the post-larvae, pre-dorsal and pre-anal spines were absent and no dissimilarity between the upper and lower caudal lobes was observed. In the juveniles these characters were conspicuous. The occurrence of the post-larvae in March gives a further indication of the spawning season of the fish noted earlier. The wide range in the size of young ones *i.e.* from 2 to 19 cm, may be because the spawning season is highly protracted.

#### MIGRATION AND SPAWNING GROUNDS

Landing statistics of the past several years reveal that in the northern parts of the Kathiawar Peninsula, pomfret landing is at its peak between October and December. Fishermen from various parts of Gujarat and Maharashtra migrate to Porbundar and nearby places to take advantage of the fishery during this period. A sharp rise in the catch rate is recorded at Veraval during December-February. In the southern most part of the Peninsula the fishery is relatively more in early March and the peak landings are recorded in April-May.

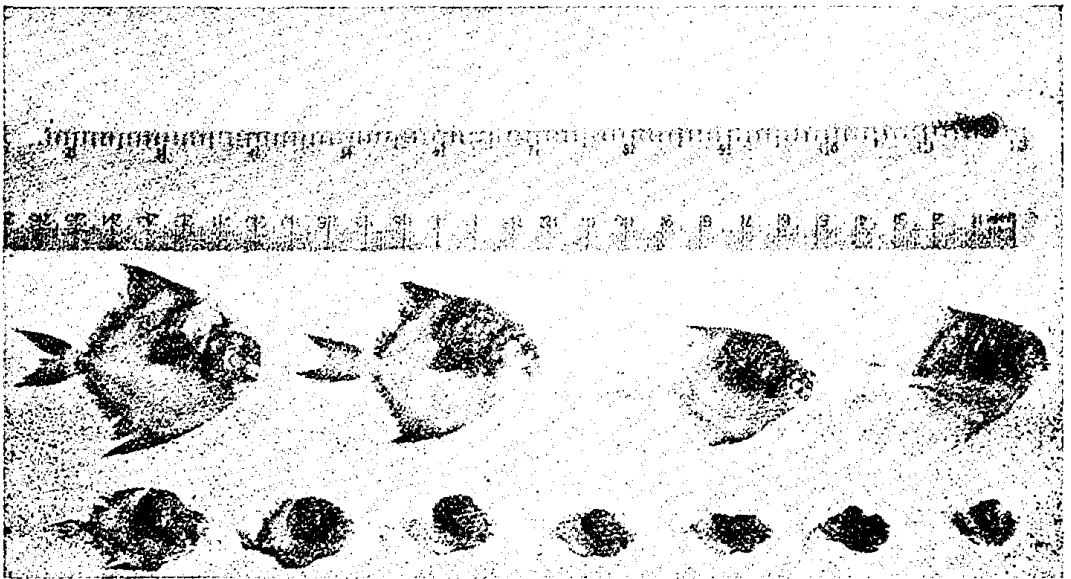


FIG. 5. Post-larvae and juveniles of *Pampus argenteus*.

There seems a general tendency of migration amongst the fish from the northern waters of Gujarat towards the mouth of the Gulf of Cambay. The period of congregation of fish in this region coincides with the period of ripening of gonads. Fully ripe and running females were available only in small numbers in the commercial landings between Diu Head (20° 43' N, 70° 59' E) and Jafarabad (20° 52' N, 71° 22' E). This might be because of the migration of the fully ripe and running fishes into deeper waters of this region for spawning. The availability of large quantities of post-larvae and juveniles of *Pampus argenteus* along with those of many other fishes like Polynemids, Sciaenids and *Harpodon* in the more inshore waters of this region indicates the suitability of this area as a breeding and nursery ground of many species.

The most striking hydrological feature in the mouth of the Gulf of Cambay during this period is the low values of salinity which was 28.35‰ off Jafarabad (*INS DARTHAK* cruise, March 1966). Interior in the Gulf, the values fall below 25‰. Temperature structure in the inshore waters showed no significant variation from surface to bottom. It varied between 28.61 and 25.20° C at different stations in the Gulf. In the fishing ground off Jafarabad it was 25.5° C in March 1966.

Density of plankton was found to be fairly high in this region during March-May.

#### SUMMARY AND CONCLUSION

Results of investigation on the maturation and spawning of Silver Pomfret, *Pampus argenteus* (Euphr.) in an area between the Gulf of Kutch and Gulf of Cambay indicate that the fish has a prolonged spawning season lasting from February to August with peak spawning occurring during April-June. The minimum size at first maturity is 22 cm in males and 26 mm in females.

There is a general tendency in the fish to migrate from the northern waters of Gujarat towards the Gulf of Cambay during February-May. In this season large numbers of post-larvae and juveniles occur in the inshore waters of Jafarabad and Nawabundar. This indicates that the spawning ground of this fish is somewhere in this area.

#### ACKNOWLEDGEMENTS

I am grateful to the Director of Fisheries, Gujarat, for providing the facilities and to Dr. S. V. Gokhale, former Assistant Director of Fisheries, for his keen interest and guidance during the course of this work. Thanks are also due to Dr. N. K. Panikkar, Director, National Institute of Oceanography, for the encouragement offered during the preparation of this paper and to Dr. S. Z. Qasim, for reading through the manuscript offering useful suggestions.

#### REFERENCES

- Chidambaram, K., and Venkataraman, R. S. (1946). Tabular statement of the natural history of certain marine food fishes of the Madras Presidency, West Coast. *Madras Govt. Publication*, No. 15.
- Clark, F. N. (1934). Maturity of California Sardine (*Sardinella Caerulea*) determined by ova diameter measurements. *Fish. Bull.*, Sacramento No. 42.

- Devanesan, D. W., and Chidambaram, K. (1948). The common food fishes of the Madras Presidency. *Madras Govt. Publication*, No. 38.
- Gokhale, S. V. (1957). Seasonal histological changes in the gonads of the whiting (*Gadus merlangus* L.) and the Norway pout (*G. esmarkii* Nilsson). *Indian J. Fish.*, **4**, 92-112.
- (1960). Need for Fisheries Research in Gujarat. The Fishing Industry of Gujarat, Ahmedabad.
- Hart, T. J. (1946). Report on trawling surveys on the Patagonian continental shelf. 'Discovery' *Rep.*, **13**, 223-408.
- Hickling, C. F., and Rutenberg, E. (1936). The ovary as an indicator of spawning period in fishes. *J. mar. biol. Ass. U. K.*, **21**, 331-417.
- Karandikar, K. R., and Palekar, V. C. (1950). Studies on the ovaries of *Polynemus tetradactylus* in relation to its spawning habits. *J. Univ. Bombay*, **19**, 21-24.
- Kewalramani, H. G., and Pathak, S. D. (1964). A note on silver pomfret fishery. *Bull. Indo-Pacif. Fish. Coun.*, **40**, 5-6.
- Lakumb, N. C. (1961). Need for Research on Fishing Gear of Gujarat. Souvenir Fish. of Gujarat, Ahmedabad 70.
- Le Cren, E. D. (1951). The length-weight relationship and seasonal cycle in the gonad weight and condition in the perch (*Perca fluviatilis*). *J. Anim. Ecol.*, **20**, 201-219.
- Menon, M. D. (1950). Bionomics of the poor-cod (*Gadus minutus*) in the Plymouth area. *J. mar. biol. Ass. U. K.*, **29**, 185-229.
- Palekar, V. C., and Karandikar, K. R. (1952). Maturity and spawning period of *Thrissocles purava* (Ham.) as determined by ova diameter measurements. *Proc. Indian Acad. Sci.*, **35**, B 143-154.
- (1953). Maturity of *Coilia dussumieri* (Cuv. and Val.) in Bombay waters during different months of the year. *J. zool. Soc. India*, **5**, 217-226.
- Prabhu, M.S. (1956). Maturation of intra-ovarian eggs and spawning periodicities in some fishes. *Indian J. Fish.*, **3**, 59-90.
- Qasim, S.Z. (1957). Biology of *Blennius pholis* L. (Teleostei). *Proc. zool. Soc. Lond.*, **128**, 161-208.
- Rege, M. S. (1958). A study of the stromateid fishes of Bombay. Ph. D. thesis, University of Bombay.
- Sivaprakasam, T. (1965). Observation on the maturation and spawning of Brown Pomfret, *Parastromateus niger* (Bloch) in Saurashtra Waters. *J. Bombay nat. Hist. Soc.*, **62**, 245-253.
- Spence, R., and Prater, S. H. (1931). Fish supply of the West coast of India. *J. Bombay nat. Hist. Soc.*, **34**, 973-991.