

OBSERVATIONS ON THE MATURITY AND SPAWNING OF *METAPENAEUS MONOCEROS* (FABRICIUS) AT COCHIN

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ABSTRACT

Maturation and spawning of the penaeid prawn, *Metapenaeus monoceros* from Cochin area have been studied. Five maturity stages, namely, immature, early maturing, late maturing, mature and spent-recovering, are recognised in the development of the ovary. The maturation process of the intra-ovarian eggs is described in detail. The minimum size at first sexual maturity is found to be 118 mm. *Metapenaeus monoceros* breeds throughout the year with intensive spawning during October to April. The nature and distribution of ova in the mature stage indicate that the spawning of individuals of the species is restricted to a short and definite period and the occurrence of mature females in various size groups suggests that the species spawns more than once during its life-time. The fecundity of the species has been estimated to be varying between 155,000 at 146 mm and 338,000 at 175 mm. The relationship between the length of the prawn and fecundity is found to be logarithmic.

INTRODUCTION

Among the penaeid prawns constituting the commercial prawn fishery of India, *Metapenaeus monoceros* (Fabricius), locally called "Choodan chemmeen" (Malayalam), forms an important species accounting for nearly 10% of the total marine prawn landings of the country (Mohamed 1967). The species also contributes to a substantial portion of the prawn catches from the estuaries and backwaters all along the coast and is cultured extensively in the low-lying brackishwater fields in the coastal areas. Some aspects of the fishery and biology of the species in the Cochin region have been dealt with by George (1959) and George, Raman and Nair (1961), and in the Godavari estuarine system by Subrahmanyam (1973). George (1967) has given a synopsis of the available biological data on the species. Information on the maturity and spawning of the species is scanty and is restricted to a few observations on the spawning seasons at different regions and spawning grounds (George and George 1964). In view of the importance of the species in the capture as well as culture fisheries, detailed investigations on the maturation process and spawning behaviour of the species were taken up in 1972 and the results of the studies are presented here.

MATERIAL AND METHODS

Material for the present study was collected from commercial prawn catches landed by the trawlers operating in 10- to 40-m depth off Cochin. Samples were analysed in the laboratory. The total length, measured from tip of rostrum to tip of telson, was recorded. The ovaries from representative specimens, ranging in size from 100 mm to 180 mm, were dissected out carefully and observations were made on their general nature, colour and size before they were preserved in 5% formalin and allowed to harden. Small portions taken from different regions of the ovary were teased out on a glass slide and examined with the aid of a compound microscope. Since there was no appreciable difference in the characteristic of ova at various parts of the ovary (Fig. 1) further studies were based on the samples taken from the middle region of the ovary. The diameter of ova was measured by using an ocular micrometer (0.014 mm per division). The ova being irregular in shape, measurement of every ovum was taken in the same parallel plane using mechanical stage of the microscope in order to avoid error due to distortion and personal bias. From each ovary 500 ova were measured at a time.

For fecundity estimates, the entire ovary was dissected out and fixed in 5% formalin after recording the total length of the prawn. Four to five days later, the preserved ovary was superficially dried by placing it in between blotting papers, and then weighed in a chemical balance. A small portion from the middle region, weighing not less than 0.1 g was taken from the ovary and weighed carefully. All the mature ova contained in the sample were counted by using a counting slide. From this the number of mature ova in the entire ovary was calculated.

MATURITY STAGES AND MATURATION PROCESS OF THE OVARY

Based on the observations, the following five maturity stages have been distinguished for *Metapenaeus monoceros*.

Stage I — Immature

Ovary is formed of developing anterior lobes which are confined to the posterior half of the cephalothorax and posterior lobes which are situated on the dorsal aspect of the abdomen, extending up to the middle of the sixth abdominal segment. It is thin, strand-like and whitish. Ova are small and spherical with clear cytoplasm and conspicuous nuclei. The diameter of ova is less than 0.08 mm (Fig. 2A).

Stage II — Early maturing

Ovary increases in size; the anterior lobes further develop and extend forward in the cephalothorax, the middle lobes and the rudiments of their lobules develop. The posterior lobe increases in girth and minute brown pigments appear

on the dorsal surface. The general colour of the ovary is yellowish. The ovary now contains two groups of ova, an immature group and of developing ones. The developing ova are translucent due to the accumulation of yolk in the cytoplasm. The nuclei are not clearly visible. The developing ova measure between 0.08 mm and 0.16 mm (Fig. 2 B & C).

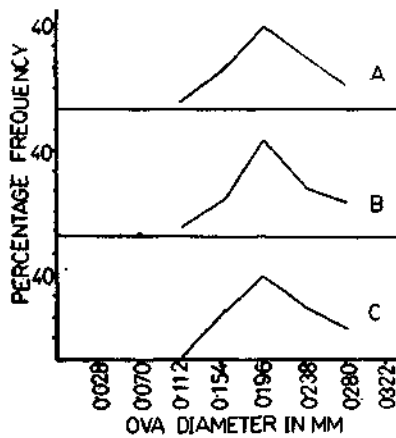


FIG. 1. Size-frequency distribution of maturing ova in (A) anterior lobe, (B) middle lobe, (C) posterior lobe of the ovary of *M. monoceros*.

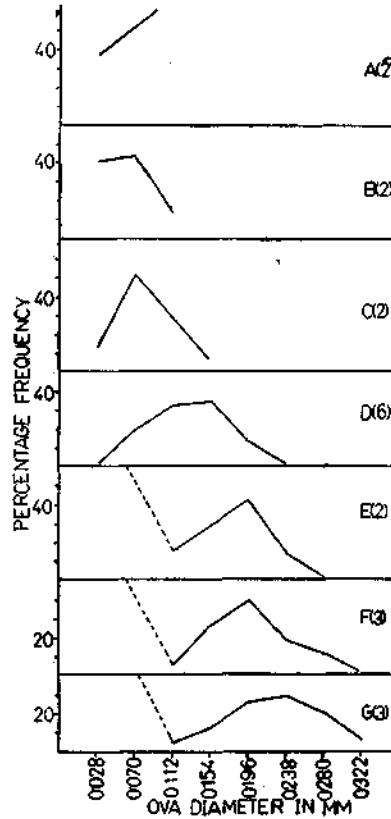


FIG. 2. Size-frequency distribution of maturing ova of (A) immature, (B and C) early maturing, (D-F) late maturing, (G) mature *M. monoceros*. (Number of specimens examined shown in brackets.)

Stage III — Late maturing

The ovary develops further, the anterior, middle and posterior lobes are fully formed. However, the anterior and middle lobes do not fill the cephalothorax completely. The ovary is generally light green, with branched brownish

chromatophores distributed over the entire dorsal surface. It is now visible through the exoskeleton. The developing ova are opaque and the nuclei become completely invisible due to the accumulation of yolk. Size of the developing ova ranges between 0.11 mm to 0.23 mm, majority being distributed within 0.15 mm and 0.23 mm (Fig. 2 D, E & F.)

Stage IV — Mature

The structure of the mature ovary of the species has been described by Nalini (1975). The ovary is dark green or brownish green and is clearly visible through the exoskeleton. The anterior and middle lobes are fully developed and occupy the space available in the cephalothorax. Branched brownish pigments are densely distributed over the dorsal surface of the entire ovary. The ovary now contains immature and mature ova. The mature ova are opaque, fully yolked and measure between 0.19 mm and 0.32 mm (Fig. 2 G).

Stage V — Spent recovering

At this stage the ovarian lobes are flaccid and appear whitish. The ovary contains immature ova which are similar to those in the early maturing stage.

SIZE AT FIRST SEXUAL MATURITY

Since late-maturing (stage III) and mature (stage IV) females belonging to various size groups occur throughout the year, the usual method of determining the size at first maturity at 50% level was not feasible in this species. To estimate the minimum size at first sexual maturity of the species the late-maturing and mature females in the samples are grouped in 5mm size-class intervals and the percentage in each group is found out. From these data a regression is fitted based on the least-square method. The minimum size at first sexual maturity obtained by this method is 118 mm (Fig. 3). The smallest mature specimen actually encountered during the present study is also 118 mm. George (1970) has recorded that the species matures when it attains a size of 120 mm. From these observations it can be concluded that the individual specimens may become mature for the first time when they are in the size group 116-120 mm.

Spawning season

The occurrence of late-maturing and mature females in almost all the months (see Table 1) indicates that the population breeds throughout the year. The peak spawning season is from October to April, as indicated by the highest percentage of late-maturing and mature prawns occurring in this period. In January about 60% consisted of late-maturing and mature females. These observations, in general, confirm the findings of George (1959, 1962) on the breeding of the species based on the seasonal distribution of larvae in Cochin backwaters. However, George (1962) has suggested a secondary peak during July-August, which has not been observed in the present study. Srivatsa (1953) has recorded that

the spawning season of the species extends from February to April in the Gulf of Kutch, while in Taiwan waters the species breeds actively from August to October according to Liao *et al* (1969).

Spawning population

The sizewise distribution of mature females in different months during 1972 and 1973 is given in table 1. Mature prawns are encountered in all the size groups above 116-120 mm, but majority of them fall in size groups between

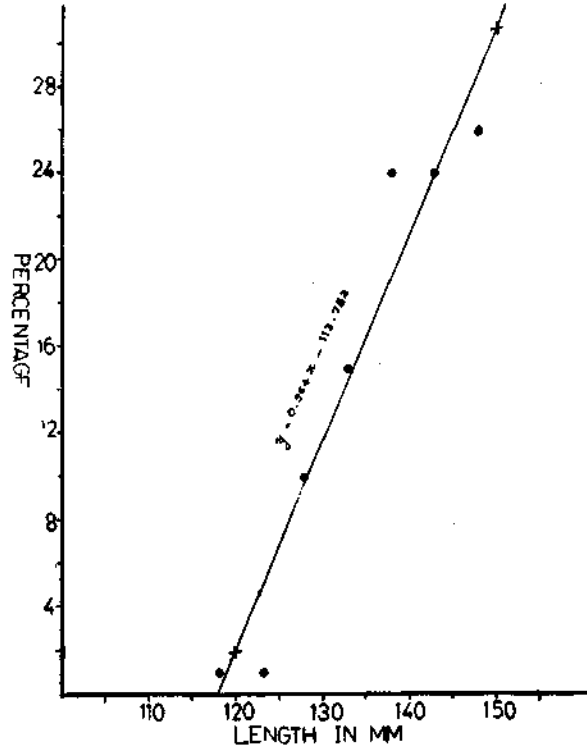


FIG. 3. Percentage distribution of maturing and mature females of *M. monoceros* plotted against total length. The regression line cuts the length axis at a value corresponding to the minimum length at first maturity.

131 and 165 mm. Based on the age of the species as determined by George (1959), it can be considered that the species matures in the first year of its life, while the spawning population is mostly composed of prawns belonging to higher age-groups.

FECUNDITY

Fecundity of 10 mature females ranging in size from 146 mm to 175 mm was estimated (Table 2). The number of eggs produced by the females within

TABLE 1. Percentage size distribution of late maturing and mature females in the commercial catches — 1972 and 1973.

Size groups in mm	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
116-120	0.8	—	—	—	—	—	—	—	—	—	—	—
121-125	2.3	—	—	—	—	—	—	—	—	—	—	5.6
126-130	7.8	—	8.8	1.5	—	25.0	—	11.1	—	—	6.3	11.3
131-135	13.2	18.2	10.0	10.8	3.7	25.0	—	1	4.8	13.8	3.1	2.8
136-140	15.5	27.3	16.3	20.0	3.7	25.0	—	—	9.5	15.5	15.7	13.3
141-145	15.5	18.2	12.5	13.8	18.5	25.0	66.6	11.1	19.0	12.0	15.7	9.9
146-150	17.1	9.1	13.7	15.4	11.1	—	—	22.1	19.0	12.0	21.9	22.6
151-155	10.9	9.1	18.7	9.2	3.7	—	—	22.2	9.5	6.9	9.4	12.7
156-160	6.2	18.2	6.3	10.8	18.5	—	33.3	22.2	9.5	12.0	6.2	5.6
161-165	8.5	—	5.0	7.7	18.5	—	—	—	14.3	10.4	12.5	7.1
166-170	0.8	—	2.5	7.7	11.1	—	—	—	4.8	3.5	3.1	4.2
171-175	0.8	—	6.3	3.1	11.1	—	—	—	4.8	3.5	3.1	4.2
176-180	0.8	—	—	—	—	—	—	—	4.8	—	—	1.4
181-185	—	—	—	—	—	—	—	—	—	—	—	2.6

the size range varies between 155,000 and 338,000 and the number of eggs increases with the size of the prawns. The relationship between the length of the prawn and fecundity (F) is logarithmic and can be expressed as:

$$\text{Log F} = -4.21938 + 4.3509 \text{ Log L.}$$

Liao *et al* (1969) have observed that the species releases about 100,000 eggs during the artificial spawning under controlled conditions. Rao (1968) has recorded the fecundity of allied species, *M. affinis* and *M. dobsoni* as between 88,000 and 363,000 and 34,500 and 160,000 respectively.

DISCUSSION

Five or six distinct stages have been recognised in the development of the ovary of most of the penaeid prawns (King 1948, Rao 1968, Lindner and Cook 1970, Cook and Lindner 1970). However, in *Penaeus setiferus* Renfro and Brusher (1964) have observed seven maturity stages while Oka and Shirhata (1965) classified the maturity stages of *P. orientalis* Kishinouye into eight stages based on histological studies. The maturation of the ovary from immature to mature stage is accompanied by distinct changes in colour, size and appearance and the process is almost similar to that described by Rao (1968) for the allied species occurring in the Cochin region. The ovaries in the maturing and mature stages contain only two widely separated groups of ova, one representing the immature stock and the other mature stock. This indicates that the spawning of individuals of *M. monoceros* is restricted to a short and definite period. In the population the majority of prawns get mature for the first time as they attain

TABLE 2. *Fecundity of M. monoceros.*

Serial No.	Length of the females in mm.	Observed No. of ova	Calculated No. of ova
1.	146	154688	157800
2.	151	189107	183200
3.	153	193529	194500
4.	155	200895	203700
5.	160	233325	235000
6.	163	248368	254700
7.	165	267505	270400
8.	168	296423	289700
9.	170	315695	304800
10.	175	338273	348300

a size of 116-120 mm as indicated by the observed and calculated values, Since mature prawns are seen in all the length groups from 116-120 mm onwards it is quite likely that the species breeds more than once during its life time.

The largest intraovarian egg recorded in the present study measures 0.32 mm, although the majority of mature eggs are found between 0.25 mm and 0.28 mm (Fig. 2 G). Liao *et al* (1968) report the size of viable eggs of the species obtained by artificial spawning as 0.22 mm which is considerably smaller than the size of mature ovarian egg recorded at present. It is well known that the size of the eggs of the same species occurring in different habitats and localities varies considerably (Gurney 1942), and it is quite possible that the eggs of *M. monoceros* in the tropical region are larger than those in the temperate region. Rao (1974) has observed that the free eggs of the allied species *M. dobsoni*, *P. stylifera* and *P. indicus* occurring in the Cochin waters are relatively larger than those of most of the penaeid prawns studied elsewhere.

The fact that all maturity stages are encountered in most of the months indicates that the species breeds throughout the year as in the case of the other commercial prawns of the area. However, the observations made on the peak spawning season of the species by earlier authors (Srivatsa 1953, George 1959, 1962, Liao *et al* 1969) as well as in the present study show variations and it differs from place to place and year to year. The species spawns in the sea but only small percentages of mature prawns are encountered in the present fishing area. George and George (1964) have located the spawning ground of the species at 50 to 60 meters in depth off Cochin.

ACKNOWLEDGEMENT

The author is highly grateful to Dr E. G. Silas, Director, Central Marine Fisheries Research Institute, Cochin, for guidance and encouragements and to

Dr K. V. Sekharan, for going through the manuscript critically. Her sincere thanks are also due to Mr K. H. Mohamed and Dr P. Vedavyasa Rao for their helps throughout the course of this work and for suggesting improvements in the manuscript.

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