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Reproductive biology of the speckled shrimp *Metapenaeus monoceros* (Fabricius)

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ABSTRACT

Based on the biological data of *Metapenaeus monoceros* collected from shrimp trawler landings at Cochin Fisheries Harbour during 1991-93, an account on the reproductive biology of this species is given in this paper. The shrimp is a continuous breeder with two major spawning periods during December - April and August - September. The minimum size at maturity in females and males was 114 and 95 mm respectively. Females in general, outnumbered males and the average sex ratio of females and males during the period was 57.1 : 42.9. The mature ova measured between 0.145 and 0.261 mm. Ovary weight in comparision with total length and total weight was found to be the best fit against fecundity in *M. monoceros*.

Introduction

The studies pertaining to reproductive biology of *M. monoceros* are limited. George (1959) made some preliminary observations on the breeding of this species. Based on the juvenile recruitment in the Cochin backwaters, George (1962) discussed the spawning season of the brown shrimp in the inshore waters. Nalini (1976) gave an account on stages of maturation and fecundity in female *M. monoceros* from Cochin region. Sasikala and Subramaniam (1987) described the composition of spermatophores in this species. Results of the studies on reproductive biology of the brown shrimp from Kakinada coast were given by Rao (1989). A detailed account on the spawning season, sex ratio, size at first maturity, process of maturation and fecundity of *M. monoceros* is given.

Materials and methods

Samples of *M. monoceros* for the study were collected from the trawl landings at Cochin fisheries harbour during 1991-'93. Total length of *M. monoceros* was measured from tip of rostrum to tip of telson. The total weight was taken to the nearest milligram. The ovaries were dissected out carefully and their nature, colour and size noted before they were preserved in 5% formalin. The maturity stages could be differentiated based on the colour and thickness of the ovary. However, the different stages of maturity were confirmed by microscopic examination. For the ova diameter studies, small portions of the ovary taken from different regions of the ovary were teased out on a glass slide and examined under the microscope. It was observed that the diameter of the ova collected from different regions of ovary did not indicate

any appreciable variation. Hence, for further studies on fecundity and the ova diameter, a portion of the ovary on the right side of first abdominal segment was removed and examined. The diameter of the ova was measured by using an ocular micrometer, where one division equals 0.0145 mm. The ova were irregular in shape and measurement of each ovum was taken in the same parallel plane using mechanical stage of the microscope in order to avoid errors due to distortion and subjective bias. From each ovary 300 ova were measured.

For fecundity estimates the preserved ovary after four or five days was removed, washed and dried by placing it between blotting papers. The weight of the ovary was taken to the nearest 0.001 gm and then a subsample of ovary segment was taken out and weighed to the nearest 0.0001 gm using an electronic balance. The mature ova present in the subsample were counted by using a counting slide. From the number of ova in the weighed subsample, total number of mature ova in the entire ovary was calculated based on total ovary weight. The relationships for fecundity on total length, total weight and ovary weight were found out by least square method (Snedecor and Cochran, 1966).

To determine the size at maturity, 150 numbers of males in the size range of 90 - 101 mm and 409 numbers of females (size range : 101-121 mm) were considered. The sex ratio of *M. monoceros* was studied based on the monthly estimated numbers for the period 1991-'93 as to get an actual representation of males and females in the population. Homogenity of the sex ratio (based on observed numbers) over months in different years has been tested using χ^2 test (Snedecor and Cochran, 1969).

Significant test at a probability level of P = 0.01 was carried out. Homogenity was tested for 1:1 ratio and for common ratios as observed from the data.

Results

Maturity stages of ovary

Based on the colouration and size of the ovary and ova diameter variations the five stages of maturity in females were fixed as follows : 1. immature. 2. early maturing 3. late maturing 4. mature and 5. spent-recovering. The size frequency distribution of maturing ova in different stages of maturity in females of *M. monoceros* is shown in Fig. 1. The general structure and colouration of the ovary in different stages of maturity in females of *M. monoceros* in the present work agree well with the earlier descriptions given by Nalini (1976) and Rao (1989).

In the immature stage of ovary, diameter of the ova varied between 0.0145 and 0.058 mm and in the early maturing stage, the ova measured between 0.056 and 0.116 mm.

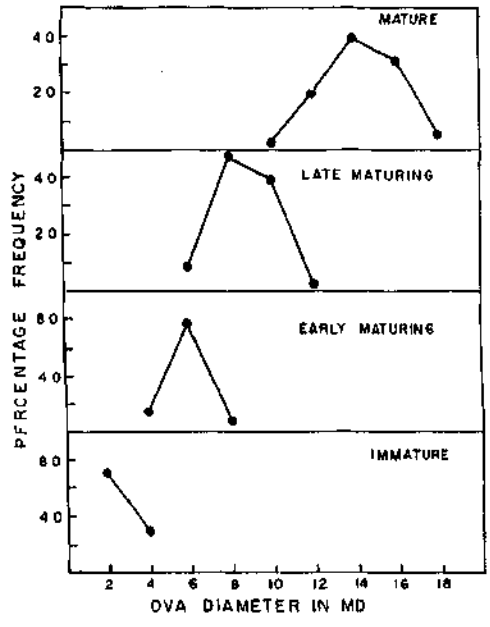

Fig. 1. Ova diameter frequency polygon of *M. monoceros*.

In the late maturing stage of the ovary, the developing ovum was opaque and the nucleus became completely invisible due to accumulation of yolk. Size range of the developing ova was 0.067 and 0.174 mm with majority of them distributed between 0.1015 and 0.1450 mm.

In the mature stage, the ovary was very clearly visible through the exoskeleton, dark green mostly and in a few cases brownish green. The anterior and middle lobes were well developed and the ovary contained immature and fully mature ova. The mature ova are opaque, fully yolked and measured between 0.1450 and 0.2610 mm with majority of them in the range of 0.1740 and 0.2320 mm.

In the spent recovering stage, the ovary contained ova which were similar to those in immature stage. This stage is therefore distinguishable from the immature virgin females mainly based on the relative size of the prawn.

Size at first maturity

The smallest male *M. monoceros* in fully mature condition with well developed petasma and having visible spermatophores in the terminal ampoules measured 90 mm in the present study. It was noticed that 50% of the observed males attained maturity at 95 mm (Fig. 2). All the males measuring 100 mm and above were fully mature. Hence the size at maturity in males of *M. monoceros* was fixed as 95 mm in total length.

The smallest female having ovary in fully mature condition was observed to be 101 mm in total length. The frequency distribution of the mature females indicated that the size at first maturity in females of *M. monoceros* was 114 mm (50 %) and all those measuring 120 mm and above were fully mature.

Spawning season

Females in advanced maturity were

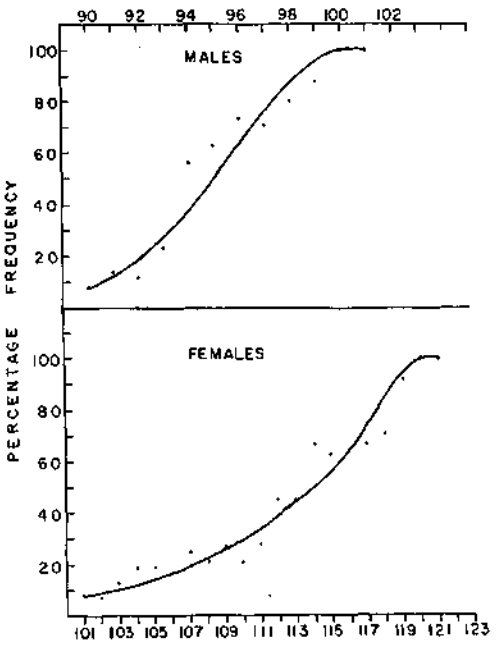

Fig. 2. Size at first maturity of *M. monoceros*.

noticed in all months during 1991-'93 indicating that *M. monoceros* is a continuous breeder. The peak spawning months varied between years. To obtain a better picture on the spawning period, the average monthly percentage of mature females in the catch for the entire period of study (1991-'93) was taken into account (Table 1). It could be seen that there were two main spawning periods for *M. monoceros* i.e. December-April and August-September. June-July which is the heavy monsoon period and the month of October were observed to be the lean periods for spawning when mature females constituted less than 10%.

Fecundity

The number of ova present in the ovary of mature females of *M. monoceros* in the size range of 101-165 mm has been estimated. The details on the total length, total weight, ovary weight and the estimated

TABLE. 1. *Monthly average percentage of females of* M. monoceros *in mature stage during 1991-'93.*

Months	Percentage of mature females	Total no. of prawns observed
January	30.83	733
February	24.10	834
March	24.34	715
April	30.06	672
May	14.26	610
June	5.58	251
July	0.00	108
August	16.76	340
September	28.98	352
October	9.60	125
November	13.00	277
December	24.17	455

number of ova are given in Table 2. The estimated number of ova in the mature ovary ranged from 47,930 in a female of 101 mm to 3,90,709 in a female measuring 163 mm in total length. Fecundity increased generally with the increase in size. However, when fecundity was compared with total length, total weight and ovary weight, wide variations were noticed. In order to identify the factor which could be used as a good predictor of fecundity, statistical analysis was carried out on the data. The data were subjected to log transformation as the coefficient of variation was found uniform. The correlation coefficient between fecundity and log total length, log total weight and log ovary weight (all transformed variables) are as follows:

	r	r^2
log total length	0.9255	0.8565
log total weight	0.9241	0.8540
log ovary weight	0.9309	0.8666

It could be observed that there was no significant difference in the coefficient of predictions (r^2) using these three variables namely log total length, log total weight and log ovary weight. The multiple regression fitted on the three variables gave an r^2 of 88%, which again is not very much different from r^2 obtained from regression on log ovary weight.

The correlation between log total length and log ovary weight and similarly between log total weight and log ovary weight was found to be 0.9546 and 0.9532 respectively. Thus the results obtained, indicate that ovary weight could be used as a single best predictor for fecundity of *M. monoceros* and the relation is given as:

log fecundity = 11.95298 + 0.87253 log ovary weight or fecundity = 155280.5 x ovary weight

Sex ratio

The monthly percentage composition of females and males in the *M. monoceros* catches landed by shrimp trawlers at Cochin fisheries harbour during 1991-'93 is given in Table 3. Females outnumbered the males generally throughout the study period. The percentage composition

TABLE. 2. *Fecundity data of females of* M. monoceros

Total length in mm	Total weight in grams	Ovary weight in grams	Fecundity (Number of ova)
101	6.82	0.4262	47930
102	6.99	0.5031	125622
103	7.36	0.3106	49696
114	12.00	0.4815	110307
119	11.30	0.6918	115300
124	13.13	0.7659	81792
125	15.50	1.0040	171032
127	14.50	1.2150	154913
133	20.00	1.8293	208769
138	21.60	1.9760	250713
139	19.53	1.7787	319515
142	23.34	2.4517	296765
146	22.50	1.6100	263775
147	26.20	1.6143	296134
145	21.79	2.0544	278987
151	24.65	1.7605	315790
155	30.00	1.9485	382760
158	30.25	2.8655	299613
154	25.72	2.5265	467403
161	31.94	3.1860	395974
163	34.62	3.6230	390708

of females in the catch ranged from 49.79 (July) to 64.71 (September) in 1991; between 52.51 (August) and 90.59 (September) during 1992 and from 50.00 (November) to 73.71 (September) in the year 1993. The representation of males during 1991 varied from 35.29% to 50.21%; between 19.41% and 47.49% in 1992 and from 26.29% to 50.00% in the year 1993. The maximum occurrence of males in the catch was noticed in July, August and November for the years 1991, 1992 and 1993 respectively. When the sex data of *M. monoceros* in the annual catch during 1991-'93 was pooled, the sex ratio of F : M was 57.10 : 42.90. The χ^2 test showed that the distribution of females and males in *M. monoceros* catch in various months was significantly different (Table 4).

Discussion

Majority of the ova in mature stage of ovary have diameter in the range of 0.174 and 0.232 mm. The largest ovum in mature ovary measuring 0.261 mm in the present study agree with the observation made by Mohamed *et al.*, (1979) where, the viable eggs of *M. monoceros* obtained by artificial spawning measured 0.26 mm. Rao (1999) observed similar size range (0.11-0.27mm) and mode (0.17-0.23mm) for the ova in mature female of the same species from Kakinada region. However, the size of the viable egg obtained by artificial spawning varied between 0.22

TABLE. 3. Monthly sex ratio in percentage of M. monoceros *during 1991-'93.*

Months	1991		1992		1993	
	Females	Males	Females	Males	Females	Males
January	60.03	39.97	55.09	44.91	55.94	44.06
February	60.78	39.22	60.58	39.42	59.83	40.17
March	54.10	45.90	53.23	46.77	53.51	46.49
April	52.86	47.13	53.97	46.03	52.50	47.50
May	52.11	47.89	57.52	42.48	59.62	40.38
June	55.25	44.75	56.00	44.00	52.88	47.12
July	49.79	50.21	61.11	38.89	no catch	-
August	54.87	45.13	52.57	47.49	56.72	43.28
September	64.71	35.29	80.59	19.41	73.71	26.29
October	61.94	38.06	71.04	28.96	no catch	-
November	63.31	36.69	60.45	39.55	50.00	50.00
December	58.09	41.91	63.53	36.47	61.07	38.92
Annual	57.02	42.98	57.26	42.74	57.06	42.94

mm (Liao *et al.*, 1969) and 0.35mm (Raje and Ranade, 1972). The observation by Gurney (1942) that size of the eggs of the same species occurring in different habitats and geographic localities varied considerably explains the variations in egg size of *M. monoceros* in different studies.

It was observed that the size at first (50%) maturity of *M. monoceros* at Cochin was 95mm in males and 114 mm in females, which is in close agreement with the studies of Rao (1999) from Kakinada waters. Slightly higher values as 120 and 118 mm were given as size at first maturity in females of *M. monoceros* by George (1959) and Nalini (1976) respectively from Cochin region. However George *et al.*, (1976) recorded the size at first maturity of *M. monoceros* at Karwar region as 135.5 mm inspite of recording the smallest prawn with fully mature ovary as 106 mm. The smallest mature female of this species measured 110 mm in Kakinada waters (Rao, 1969), whereas in the present study the smallest female with mature ovary measured 101 mm.

As the ovaries of spent recovery stage contained only immature ova of less than

TABLE. 4. χ^2 *values of sex ratios for* M. monoceros *during the period 1991-'93*

Year	1991		1992		1993	
Ratios tested F : M	1:1	57:43	1:1	57:43	1:1	57:43
Value of χ^2	30.57	31.17	24.65	25.41	31.50	32.50
Degrees of freedom	11	11	11	11	11	11
p	<.01	<.01	<.01	<.01	<.01	<.01

Significant at 1% level.

0.06 mm, it is possible that all the mature ova present in the ovary are liberated at a single spawning act within a short time. Fujinaga (1963) observed that spawning takes place within 2-3 minutes in penaeid prawns. Spawning within a short period and completely releasing all the mature ova present in the ovary were in confirmity with other studies on allied species like *M. affinis* and *M. dobsoni* (Thomas *et al.*, 1974a,b), *M. brevicornis* (Rao, 1978) and *M. moyebi* (Nanda kumar *et al.*, 1989).

In the present study, it was observed that the main spawning season for *M. monoceros* extends from December to April which is followed by a shorter period viz. August-September. George (1959,1962) mentioned two peak breeding periods namely July-August and October-December for *M. monoceros* at Cochin which do not compare well with the present work. Nalini (1976) and Srivatsa (1953) found October-April and February-April respectively, as the peak spawning periods for *M.monoceros*. Rao (1989) observed January-October as the spawning period for this species in Kakinada coast.

Liao *et al.*, (1969) have observed that *M. monoceros* releases about 1,00,000 eggs during artificial spawning. Rao (1968) recorded that fecundity of *M. affinis* and *M. dobsoni* ranged between 88,000 and 3,63,000 in the former species and between 34,500 and 1,60,000 in the latter. Nalini (1976) reported that the fecundity of *M. monoceros* (size range 146-175 mm) was between 1,55,000 and 3,38,000. Rao (1989) estimated the fecundity of brown shrimp at Kakinada waters and observed linear relationships between fecundity and total length, total weight and ovary weight. In the present work, the fecundity of *M. monoceros* in the size range of 101-163 mm varied between 47,930 and 3,90,708.

Females outnumbered males in the speckled shrimp landings by trawlers at Cochin fisheries harbour during 1991-'93 and formed 57% of the annual catch. The preponderance of females in the speckled shrimp population observed in the present study, might be due to sizewise seggregation and / or seggregation of females for spawning in the fishing grounds as reported by Menon (1957), George and Rao (1967), Ramamurthy *et al.*, (1978) and Rao (1989).

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