

## RESOURCE ASSESSMENT OF THE PENAEID PRAWN *METAPENAEUS DOBSONI* (MIERS) ALONG THE MANGALORE COAST

S. RAMAMURTHY, G. G. ANNIGERI<sup>1</sup> AND N. S. KURUP<sup>2</sup>  
*Central Marine Fisheries Research Institute Centre, Mangalore*

### ABSTRACT

The fishery and certain aspects of the population characteristics of *M. dobsoni* from 1962 through 1971 are reported. The fishery was generally bimodal with peaks during March-April and September-October and showed wide annual fluctuations. The total catch showed a gradually diminishing increase when the fishing effort reached a level of about 14,000 boat days. The catch per boat day also showed a downward trend, in general. It would appear, therefore that any additional increase in effort would be of little consequence in raising the yield. The fishery was dominated by larger size groups (above 95 mm) during July-November. Recruitment of smaller size groups (60 mm onwards) was observed during December-January. The maximum number of broods entering the fishery was five. Age and growth studies indicated that the males and females attain a length of 85 and 105 mm and 95 and 120 mm at the end of one and two years respectively. Thereafter very little growth seems to take place. The late 'O' and the one year class formed the mainstay of the fishery. The mean length showed considerable annual fluctuations but these changes appear to be only due to natural causes. Females preponderated in all the years except during 1965-66. They often tended to exceed the males by more than 1.5 times during April-May and November-December which more or less coincided with periods of intense breeding activity. The average annual instantaneous rate of mortality between one and two year olds was found to be 4.18 and 4.61 for males and females respectively. The fluctuations in the annual rainfall seem to bear a direct relation to the magnitude of the fishery. No clear-cut relationship between the juvenile abundance in the estuary and the marine fishery was discernible.

### INTRODUCTION

Among the exportable penaeid prawn *M. dobsoni* ranks high and constitutes more than 50% of the prawn catch by the trawlers at Mangalore, an important landing centre on the Karnataka coast. It forms an appreciable fishery in the indigenous catches too, especially during the south-west monsoon. Juveniles of this species are caught in considerable numbers in the estuaries during August-February.

Present address:

1. Central Marine Fisheries Research Institute, Sub-station, Karwar.
2. Central Marine Fisheries Research Institute, Cochin - 682018.

The fishery was observed to be of a fluctuating nature. The number of trawlers had also increased from a mere 20 during 1962-63 to about 1,000 at present, resulting in an appreciable reduction in the catch rate. The results of the investigation on the catch trends and certain population characteristics of *M. dobsoni* over ten seasons from 1962 through 1971 are reported here, since such an information is necessary for a scientific management of the resources. The studies have also covered the relationship between the rainfall, estuarine catch and marine fishery.

Earlier accounts on the various aspects of the biology and fishery of *M. dobsoni* related to the Kerala coast, particularly of the Cochin region (Menon 1955, George 1961 and Rao 1968).

#### MATERIAL AND METHODS

The trawl fishing commences from October and closes in early June with the onset of monsoon. However, during 1968-69 and 1970-72 trawling was resumed from September. The trawlers make single day cruise usually from 05.00 to 1400 hrs. A coastal belt up to 22 m depth is fished. The prawns were generally sorted out before landing. Thrice a week 10-20% of the boats were randomly sampled. The catch and catch per unit effort (boat day) in weight and numbers and the maturity stages were estimated as described in an earlier account (Ramamurthy et al in press). The catch by the indigenous gear at Ullal and Baikampady (near Mangalore) which were visited on most of the working days, was determined, according to the method followed by Sekharan and Dhulkhed (1963). For studies on the length frequency, sex ratio and maturity, the data in respect of the non-selective gear (cast net, shore-seine and boat-seine) are also taken into account.

In the Netravathi and Gurpur estuaries at Mangalore, *kairampani*, a shore-seine consisting of 10-15 pieces is the most important gear operated. Weekly data were collected from July 1963-June 1968 for estimating the catch and catch per haul. Subsequently a smaller departmental *kairampani* of 5 pieces was operated fortnightly.

#### CATCH AND EFFORT

The catch fluctuated considerably between the years as well as within the season (Table 1). The landings varied from 194.86 tonnes during 1963-64 to as high as 967.29 tonnes during 1968-69 whereas the catch/boat day declined from 85.5 kg during 1962-63 to 17.2 kg during 1969-70. The decline in the catch rate in the latter years appears to be due to the increase in fishing fleet. The fishery was generally bimodal with a primary peak during March-April and secondary one during September-October. However, during 1970-71 the best catch was recorded in October.

TABLE 1. *Monthly catch of M. dobsoni in tonnes and catch per effort in kg (in parenthesis) by the trawlers at Mangalore during different years.*

Month	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68	1968-69	1969-70	1970-71	1971-72	Average
September				No fishing			1.40 (55.5)	No fishig	120.52 (312.2)	149.52 (114.0)	27.14 (158.4)
October		3.13 (68.1)	0.66 (13.4)	No fishing		0.81 (3.3)	19.50 (24.5)	72.74 (104.3)	353.08 (93.0)	143.78 (75.2)	59.37 (78.4)
November	1.10 (4.2)	0.00 (0.5)	0.15 (0.4)	1.50 (2.1)	0.56 (1.1)	2.53 (1.6)	11.44 (4.4)	0.36 (0.3)	12.76 (5.5)	1.98 (0.6)	3.27 (2.4)
December	5.15 (4.8)	2.94 (2.7)	15.79 (14.3)	20.23 (19.1)	4.02 (2.3)	9.53 (3.4)	9.97 (3.6)	33.90 (22.8)	2.84 (1.2)	24.14 (8.1)	12.85 (6.9)
January	11.49 (9.8)	29.31 (31.7)	2.77 (12.7)	55.52 (32.4)	0.42 (0.2)				14.11 (4.5)	29.44 (13.0)	22.07 (10.7)
February	131.57 (119.4)	22.28 (29.1)	6.52 (6.6)	111.90 (61.1)	31.33 (16.2)	101.75 (38.3)	121.66 (37.5)	16.76 (7.0)	8.63 (4.7)	31.04 (12.7)	58.34 (30.4)
March	239.18 (209.0)	14.23 (16.9)	99.54 (77.2)	100.40 (48.3)	202.15 (70.5)	131.82 (49.4)	560.93 (115.0)	102.72 (29.9)	57.23 (14.4)	124.78 (38.7)	163.60 (62.0)
April	55.94 (110.1)	30.10 (45.4)	82.86 (71.6)	136.44 (66.1)	78.28 (33.0)	61.09 (25.4)	160.57 (44.0)	57.99 (13.3)	58.35 (8.7)	178.06 (35.1)	89.57 (31.0)
May	239.18 (209.0)	14.23 (16.9)	133.91 (135.1)	73.89 (55.9)	20.58 (11.9)	10.19 (3.6)	50.77 (21.5)	4.53 (2.3)	44.66 (12.8)	149.28 (34.1)	61.55 (30.9)
June		No fishing			0.42			No fishing		0.18	0.06
Total	479.56 (85.5)	194.86 (35.7)	342.20 (48.9)	499.88 (46.4)	337.76 (25.7)	354.41	967.29	298.92	672.18 (24.1)	832.20 (30.7)	497.82 (31.8)
% in the prawn catch	60.5	52.3	59.3	46.8	43.5	37.3	59.0	45.4	67.7	51.1	52.3

To study the trend of the fishery over the years, the catch and catch/boat day are plotted against effort in Fig. 1. The smoothed lines are drawn visually through the points (Gulland 1972). The figure shows initially a steep decline in the catch rate though there was a steep increase in the total catch as could be expected in any 'accelerating phase' of the fishery. However, this declining trend in the catch rate became moderate and steady once the effort reached a level of about 14000 boat days (i.e., about 70 boats calculated at an average of 200 fishing days per boat per season). Similarly the total catch registered a gradually diminishing increase with increasing effort. Therefore, it appears that any further rise in the effort is not likely to increase the total catch but on the contrary would reduce the average catch/boat day which could be uneconomic. A relatively high level of fishing is liable to remove a substantial part of the stock resulting in a reduction in the mean length of the prawns caught. However, the present study does not indicate any clear decrease in the amount of larger prawns caught, as could be seen later.

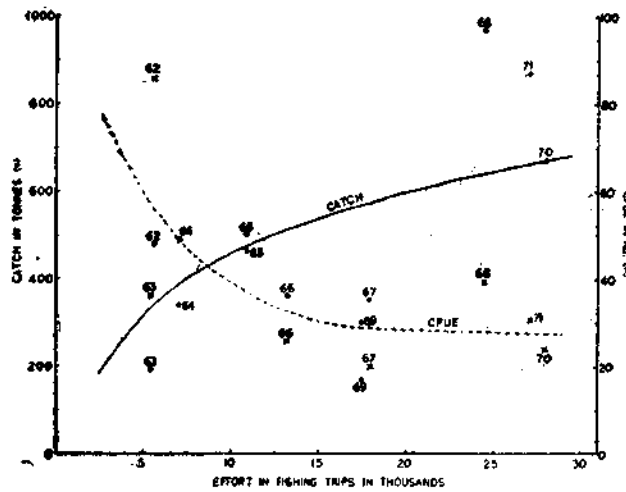


FIG. 1.

LENGTH FREQUENCY

Figures 2-6 present the length frequency distribution (in 5 mm group intervals) of males and females respectively. The percentages are based on catch in numbers per boat day. The year-classes of 1961-71 are designed according to the alphabetical order. The fishery during July-October/November was predominantly composed of size groups above 95 mm and 110 mm in the case of males and females respectively. During 1964-65 these size groups continued to dominate in December. Smaller size groups (60 mm onwards) were seen to

enter the fishery though in few numbers, during December-January and the fishery picked up in the subsequent months. These observations are in agreement with the findings of George et al. (1968) who noticed seasonal size-oriented movements in the fishing grounds.

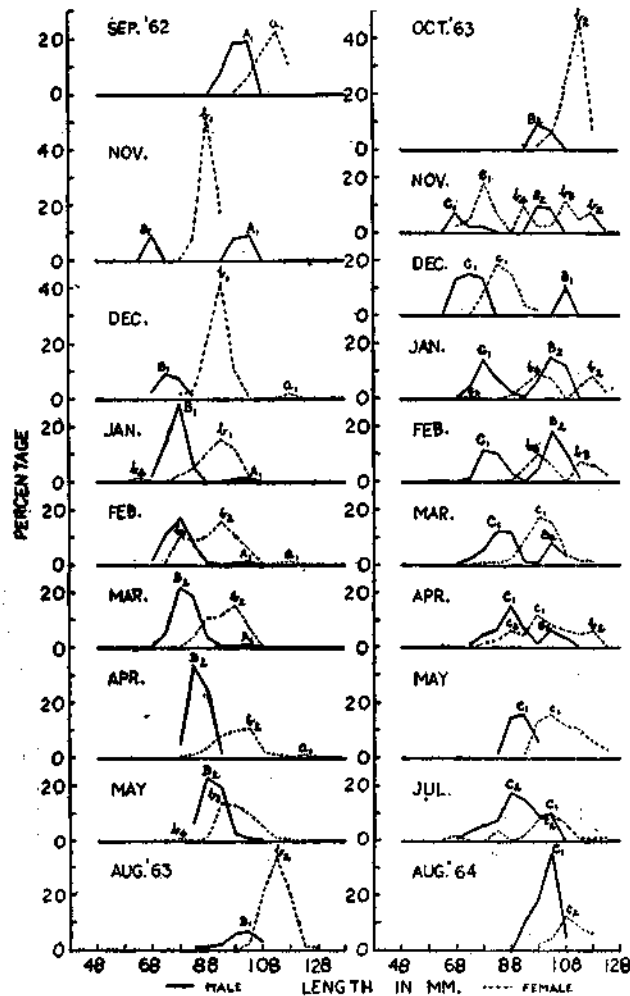


FIG. 2.

Rao (1968) found that *M. dobsoni* breeds throughout the year with peak spawning periods during April, June and November-December. During the present study also several broods were seen to enter into the fishing grounds (Fig. 2-6). The maximum number of broods that could be noticed in a season was five. The pattern of growth was not the same during the different years which could be attributed to the variable ecological conditions. Taking into account the

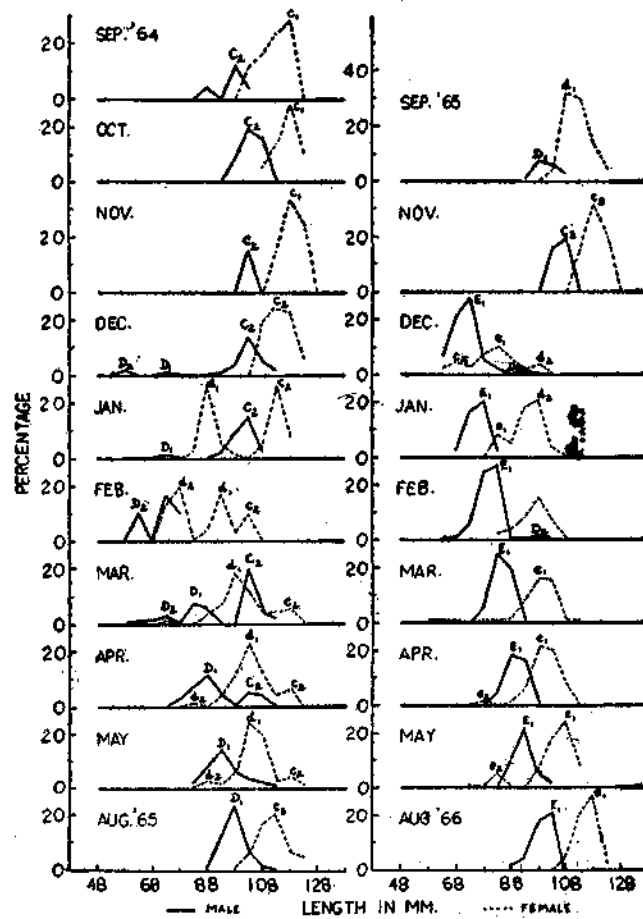


FIG. 3.

spawning season (vide infra) and the various broods, it is reasonable to consider that the size group B2 (78 mm) of March 1963 which is the product of the previous year's spawning grows to 103 mm in April 1964 i.e., during the second year of its life. The brood C2 (88 mm) of July 1964 appears to attain a length of 108 mm in November 1965 i.e., during the third year of life. In the case of females, it will be seen that the brood b2 (93 mm) of February 1963, a product of 1962 spawning, reaches a size of 118 mm in April 1964 i.e., when it is two-years-old. The progression of the broods such as c2, e1, g1 and h1 follows a similar pattern. The groups f1 of December 1966 and j1 of November 1969 at 83 mm attain a size of 123 mm in February of 1968 and 1971 respectively during the third year. It would, therefore, appear that the males and females of *M. dobsoni* grow to a length of 85 and 105 mm and 95 and 120 mm during the

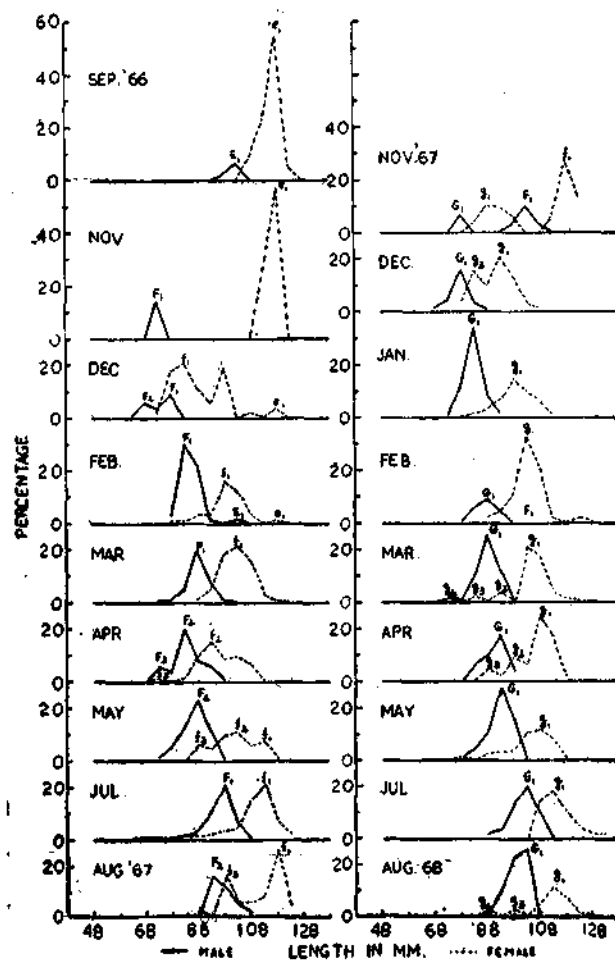


FIG. 4.

first and second year of their life respectively. During the third year very little growth seems to take place since the species attains the maximum size by then.

The same data have been further analysed by arranging the progression of modes following the month of appearance. Von Bertalanffy's equation was applied and the following parameters were calculated.

	Males	Females
$L_{\infty}$	109.1	120.9
$k$	0.12	0.18
$t_0$	0.57	4.02

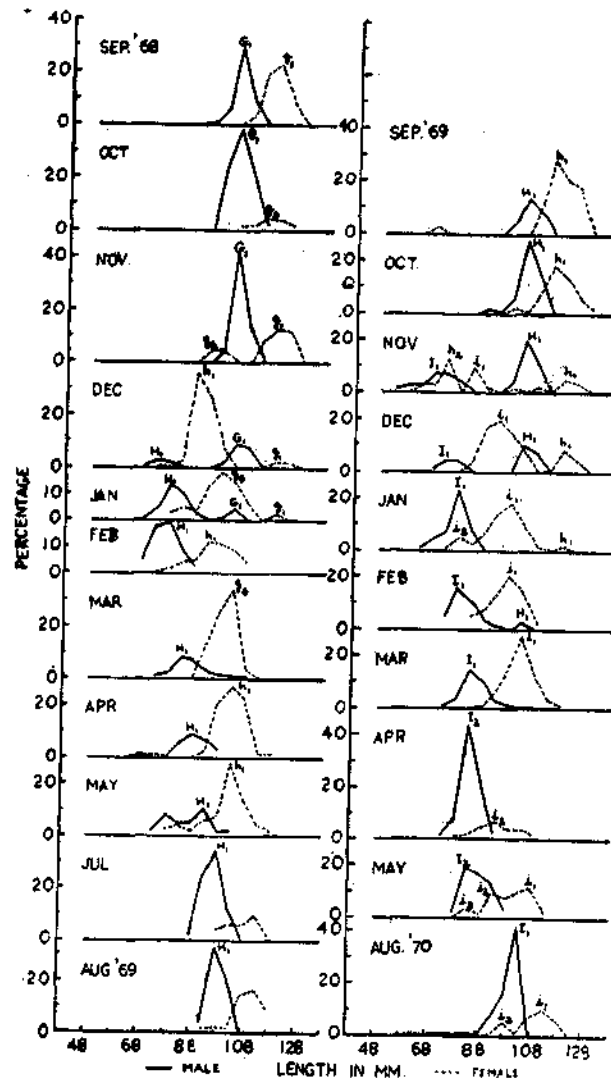


FIG. 5.

Based on these values, the size attained at age one and two has been estimated and is given in Table 2. The average size at the respective ages is also shown. These values are more or less similar. Therefore it can be concluded that the males and females of *M. dobsoni* reach a length of about 85 and 105 mm and 95 and 120 mm when they are one and two-years-old respectively. The differential growth in sexes is also quite evident. Banerji and George (1967) observed that the estimated size of *M. dobsoni* for all sexes is 95, 114 and 118 mm at the end of one, two and three years respectively which is more or less supported



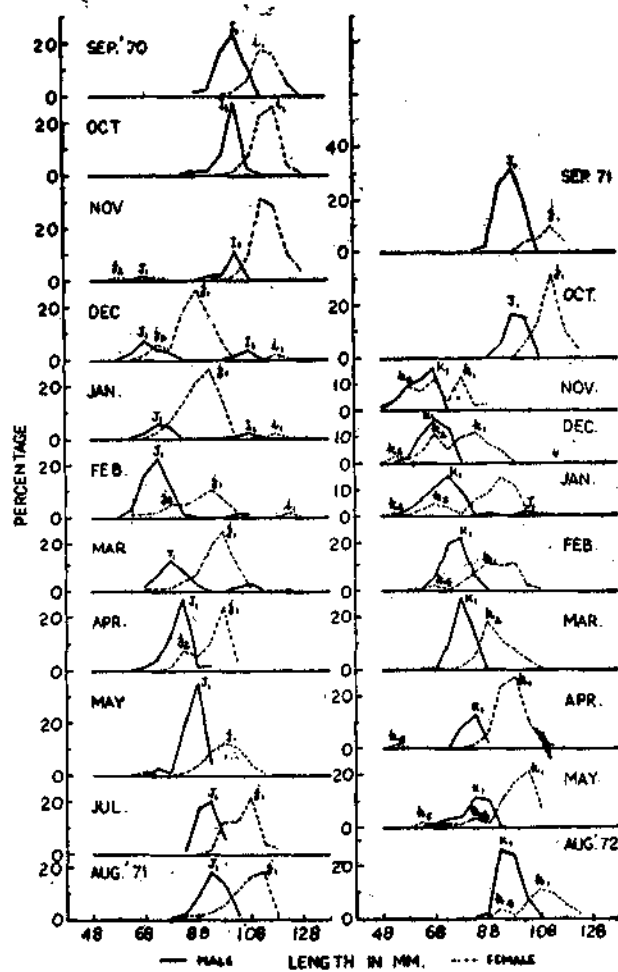


FIG. 6.

by the present findings. However, according to Kurup and Rao (1974) the males and females of this species respectively attain a length of 97 and 115 mm and 122 and 138 mm at the end of the first and second year of life.

#### AGE COMPOSITION

Table 3 represents the age distribution of the catch in numbers per boat day according to the sexes. It is apparent that the fishery was primarily constituted by the late 0-year class (above 60 mm) and one year old prawns.

#### MEAN LENGTH

The values of mean length for the various years for males and females are given in Table 4. When the fishery was a failure during 1963-64, 1966-67

TABLE 2. *Estimated size (in mm) of M. dobsoni at different ages*

Age in month	Male		Female	
	Estimated size	Average size (from Table 5)	Estimated size	Average size (from Table 5)
12	81.3	76.2	91.8	87.1
24	102.5	104.0	117.3	118.7

TABLE 3. *Abundance of age groups and mortality rate*

Year	Males			Mortality	Females			Mortality
	0-Year (upto 85 mm)	1-Year (86-10mm)	2-Year (106-mm & above)		0-Year (upto 95mm)	1-Year (96-120mm)	2-Year (121mm & above)	
1962-63	7185	1760	49	—	3211	6258	3	—
1963-64	607	1132	209	2.13	177	1750	81	4.35
1964-65	574	2154	85	2.59	297	4045	67	3.26
1965-66	3236	1233	1	7.67	725	3512	1	8.30
1966-67	798	1195	1	7.12	253	2409	11	5.76
1967-68	650	1186	1	7.09	183	3454	72	3.51
1968-69	1183	840	55	3.06	230	1368	45	4.33
1969-70	745	548	89	2.23	172	1536	49	4.39
1970-71	439	870	116	1.55	211	1518	81	2.94
1971-72	1522	568	—	—	833	2084	15	4.62
Average				4.18				4.61

TABLE 4. *Mean length (in mm) of M. dobsoni*

	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68	1968-69	1969-70	1970-71	1971-72.
Male	81.5	91.1	93.8	81.5	86.4	87.5	84.9	87.7	93.1	81.8
Female	93.2	103.7	103.4	96.8	100.2	103.2	99.7	101.1	109.4	95.1

and 1969-70, the mean size of males and females ranged from 86.4 to 91.1 mm and 100.2 to 103.7 mm respectively whereas when the fishery was a success during 1965-66, 1968-69 and 1971-72 the corresponding values were 81.5-93.1 mm and 96.8-109.4 mm. Thus the variations in the mean length do not appear to have any relation to the fluctuations in the fishery. Therefore, the changes in the mean length would seem to be only due to natural fluctuations. In the Cochin area a somewhat decreasing trend in the mean size of *M. dobsoni* was noticed by Mohamed (1973) which was attributed to the shoreward shifting of the fishing grounds.

## SEX RATIO AND MATURITY

The proportion of sexes based on the estimated numbers during the different seasons is shown in Table 5. The females predominated in all the years except in 1965-66. The monthly distribution of the sexes indicated the frequent incidence of females exceeding males by more than 1.5 times during April-May and November-December. This generally coincided with the peak periods of breeding, as would be seen later. It is of interest to note that George and Rao (1967) observed significant variations in the sex distribution associated with segregated movements for breeding purpose.

Table 6 shows the monthly distribution of maturity and impregnation in percentage among females during the different seasons. The frequency of mature females and impregnated ones among the different length groups is given in Table 7. Mature females were present in almost all the months of the different years thereby indicating that this species breeds throughout the year. This is in conformity with the observations of Rao (1968). However, slight variations in the timing of the spawning peaks were noticed. Peaks of spawning activity were evident in January, April and October-November. The smallest mature female was 71 mm. Impregnated specimens were encountered in most of the months, the smallest one measuring 68 mm. The percentage of impregnation was found to be generally high in May, August and October.

## MORTALITY RATE

Since the 0-year class was not fully represented in the fishery, the total instantaneous rate of mortality was calculated between one and two-year-old. The estimated values varied considerably from year to year. (Table 3). However, the values for females were higher than those for males except during 1966-67 and 1967-68. The average annual instantaneous mortality rate between the first and second year class was estimated to be 4.18 and 4.61 for males and females respectively. These values were higher than those estimated by Kurup and Rao (1974) for the Cochin region especially in the case of females.

## RELATION OF THE FISHERY TO RAINFALL

The landings of *M. dobsoni* by the trawlers and indigenous gear together with rainfall are given in Table 8. The catch per unit effort for indigenous gear relates to cast net. Bulk of the rainfall was during June-September. It could be seen that the heaviest rainfall occurred during 1970-71 and the lowest during 1964-65 whereas the marine fishery was at its best during 1968-69 and poorest during 1963-64. However, the annual rainfall seems to bear a direct relation to the fishery in most of the years. During 1963-64, 1966-67 and 1969-70 the rainfall and the prawn landings showed a decrease whereas during 1965-66, 1967-68, 1968-69 and 1970-71 the fishery improved with the increase in rainfall. Gunter and Hildebrand (1954) observed that the catch of *Penaeus setiferus*

TABLE 5. Sex ratio of *M. dobsoni* (first column under each month is males, and second females)

Months	September		October		November		December		January		February		March		April		May		July		August		Total	
1962-63	42.2	57.8	—	—	25.0	75.0	20.4	79.6	52.0	48.0	39.4	60.6	50.4	49.6	63.1	36.9	55.0	45.0	—	—	30.0	70.0	48.5	51.5
1963-64	—	—	16.0	84.0	30.2	69.8	52.4	47.6	62.7	37.3	63.1	36.9	47.6	52.4	46.9	53.1	38.6	61.4	67.8	32.2	67.4	32.6	49.5	50.5
1964-65	20.0	80.0	44.7	55.3	16.7	83.3	28.3	71.7	29.0	71.0	35.8	64.2	44.1	55.9	38.1	61.9	36.7	63.3	—	—	42.7	57.3	39.0	61.0
1965-66	17.2	82.8	—	—	34.6	65.4	63.2	36.8	42.4	57.6	61.2	38.8	52.4	47.6	40.5	59.5	39.5	60.5	—	—	45.5	54.5	51.3	48.7
1966-67	9.3	90.7	—	—	14.3	85.7	20.4	79.6	—	—	56.7	43.3	35.4	64.6	49.0	51.0	55.7	44.3	43.8	56.2	33.7	66.3	42.7	57.3
1967-68	—	—	—	—	23.3	76.7	25.8	74.2	55.2	44.8	21.7	78.3	50.4	49.6	37.2	62.8	58.9	41.1	50.0	50.0	70.0	30.0	33.1	66.9
1968-69	46.4	53.6	86.0	14.0	58.3	41.7	23.4	76.6	35.2	64.8	53.7	46.3	23.6	76.4	24.7	75.3	31.5	68.5	72.0	28.0	57.1	42.9	31.7	68.3
1969-70	20.5	79.5	50.0	50.0	58.5	41.5	25.9	74.1	41.6	58.4	38.9	61.1	34.0	66.0	76.1	23.9	55.5	44.5	—	—	65.9	34.1	44.0	56.0
1970-71	56.2	43.8	40.6	59.4	16.3	83.7	20.0	80.0	15.3	84.7	57.4	42.6	32.5	67.5	47.1	52.9	61.7	38.3	46.0	54.0	42.6	57.4	44.1	55.9
1971-72	75.9	24.1	36.7	63.3	44.0	56.0	42.9	57.1	45.7	54.3	55.2	44.8	51.7	48.3	24.8	75.2	32.8	67.2	—	—	60.8	39.2	42.4	57.6

TABLE 6. Monthly percentage of mature and impregnated females during the different years.

	September		October		November		December		January		February		March		April		May		July		August	
	M.	Imp.	M.	Imp.	M.	Imp.	M.	Imp.	M.	Imp.	M.	Imp.	M.	Imp.	M.	Imp.	M.	Imp.	M.	Imp.	M.	Imp.
1962-63	24.3	50.7	—	—	66.2	33.3	34.3	18.5	30.2	33.7	18.0	45.1	28.2	23.0	8.8	42.8	17.4	48.1	—	—	18.8	43.0
1963-64	—	—	51.8	3.4	39.5	14.8	33.3	56.3	25.4	48.3	48.3	41.5	20.7	36.9	2.8	26.8	12.2	16.3	14.5	33.9	43.7	6.2
1964-65	10.0	—	62.8	44.2	—	—	32.1	12.5	—	14.3	13.3	6.6	15.5	22.3	7.3	24.0	20.0	31.4	—	—	16.1	77.5
1965-66	—	23.2	—	—	—	35.3	1.8	10.4	7.0	45.7	6.6	31.1	—	28.6	5.2	23.3	—	35.7	—	—	4.3	73.9
1966-67	72.1	32.5	—	—	—	83.3	4.3	18.2	—	—	25.4	40.5	23.6	47.1	30.0	34.2	5.8	28.0	13.7	41.4	12.2	20.0
1967-68	—	—	33.3	16.7	34.4	18.7	4.3	12.2	4.9	40.3	25.4	27.8	6.0	37.5	8.3	25.5	8.3	32.1	—	—	34.5	16.2
1968-69	28.3	23.5	28.5	85.7	30.0	70.0	23.1	19.7	30.0	35.0	33.3	37.7	21.0	18.8	31.4	28.6	24.3	17.4	—	—	—	—
1969-70	10.0	16.7	56.0	72.0	14.8	43.3	44.4	38.4	21.5	9.3	11.1	20.6	32.0	32.8	8.3	33.3	—	28.5	—	—	20.3	37.8
1970-71	30.0	15.0	45.1	53.3	24.0	47.3	15.6	27.4	24.3	22.8	13.4	25.0	12.5	30.5	15.1	33.3	33.3	35.1	—	—	21.1	27.8
1971-72	23.1	18.0	41.7	62.5	—	—	6.0	10.8	31.2	21.0	17.1	21.6	8.7	19.2	3.6	30.3	10.0	15.0	—	—	16.0	16.0

TABLE 7. Percentage of mature and impregnated females in different length group

	Below 60		61-70		71-80		(Length groups in mm)				101-110		111-120		121-130	
	M.	Imp.	M.	Imp.	M.	Imp.	M.	Imp.	M.	Imp.	M.	Imp.	M.	Imp.	M.	Imp.
1962-63	—	—	—	—	11.1	19.0	27.2	21.8	20.6	36.6	26.7	42.0	26.1	54.6	—	33.3
1963-64	—	—	—	14.3	15.4	11.5	16.0	24.0	28.1	25.5	24.1	33.9	43.0	35.2	46.1	38.4
1964-65	—	—	—	—	—	—	—	22.6	16.7	17.6	15.8	31.7	29.1	47.3	33.3	78.6
1965-66	—	—	—	—	5.5	8.0	1.5	10.5	4.4	31.8	3.5	33.0	1.3	44.7	—	50.0
1966-67	—	—	—	—	—	—	8.1	24.0	19.0	30.0	23.7	46.3	35.1	36.9	13.3	46.6
1967-68	—	—	—	—	16.7	12.5	5.0	15.9	8.5	28.4	10.2	32.0	30.0	33.3	54.5	45.4
1968-69	—	—	—	—	12.5	—	26.8	16.6	29.9	46.7	27.2	29.6	27.1	26.8	25.0	39.1
1969-70	—	—	—	25.0	41.7	19.2	15.1	14.3	20.5	18.6	25.2	32.0	29.3	48.6	40.9	65.4
1970-71	—	—	—	13.3	—	9.8	10.8	25.7	24.4	28.8	21.4	29.2	35.1	37.0	58.3	51.1
1971-72	—	—	—	—	—	4.0	9.6	9.3	17.4	28.0	13.0	25.2	30.0	31.1	66.2	66.2

TABLE 8. Rainfall, estuarine catch and marine fishery

Year	Rainfall in cm.	Marine fishery in tonnes (cpue in kg).		Estuarine fishery	
		Indegenous gear	Trawl Catch in tonnes	cpue in kg.	
1962-63	363.0	41.4 (34.7)	479.56 (85.5)	—	—
1963-64	302.5	2.1 (4.0)	194.86 (35.7)	0.82	0.273
1964-65	271.0	11.3 (13.8)	342.20 (48.9)	1.17	0.583
1965-66	298.0	28.9 (17.1)	499.8 (46.4)	2.22	1.125
1966-67	271.5	11.84 (7.6)	337.76 (25.7)	4.02	1.522
1967-68	334.0	24.78 (27.4)	354.41 (19.8)	0.71	0.304
1968-69	384.5	199.96 (50.4)	967.29 (39.7)	—	0.022
1969-70	316.0	1.36 (1.4)	298.92 (17.2)	—	0.015
1970-71	458.5	11.87 (9.9)	672.18 (24.1)	—	0.065
1971-72	375.0	24.56 (27.5)	832.20 (30.7)	—	0.033

in Texas waters was correlated with the rainfall of the preceding year and the year before that, this time lag being partly related to the salinity fluctuations following the wet and dry spells and to the year-class composition.

#### RELATION OF THE FISHERY TO ESTUARINE CATCH

The low values of the catch per haul in the estuarine environment from 1968-69 onwards (Table 8) was due to the fact that a smaller *kairampani* was operated (vide supra). The steady increase in the estuarine catch during 1963-67 was reflected in the increased marine landings except in 1966-67. During 1967-68, though the estuarine landings declined, the marine fishery showed a rising trend. The relation was again observed to be direct during 1969-70 and 1970-71 and inverse during 1971-72. George (1963) and Rao (1972) have observed that even the abundance of larvae and post-larvae would provide an index to forecast the marine fishery. However, the present study has not established any clear relationship between juvenile abundance and the fishery. This might be due to the fact that the fishing operations in the estuary were

restricted to the receding tide. A better picture of the relationship may emerge if an index of the immigrating and emmigrating population could be obtained.

#### ACKNOWLEDGEMENTS

Dr. K. V. Sekharan, Shri K. H. Mohamed and Shri M. H. Dhulkhed offered suggestion to improve the manuscript. The rainfall data were kindly furnished by the Indian Meteorological Department.

#### REFERENCES

- BANERJI, S. K. AND M. J. GEORGE. 1967. Size distribution and growth of *Metapenaeus dobsoni* (Miers) and their effect on the trawler catches off Kerala. *Proc. Symp. Crustacea mar. biol. Ass. India, Part 2*, 634-648.
- GEORGE, M. J. 1961. Studies on the prawn fishery of Cochin and Alleppey coast. *Indian J. Fish.*, 8: 75-95.
- GEORGE, M. J. 1963. Postlarval abundance as a possible index of fishing success in the prawn, *Metapenaeus dobsoni* (Miers). *Indian J. Fish.*, 10: 135-139.
- GEORGE, M. J., K. RAMAN AND P. KARUNAKARAN NAIR. 1963. Observation on the offshore prawn fishery of Cochin. *Indian J. Fish.*, 10: 460-499.
- GEORGE, M. J., S. K. BANERJI AND K. H. MOHAMED. 1968. Size distribution and movement of the commercial prawns of the southwest coast of India. *FAO Fish. Rep.*, 57 (2): 265-284.
- GEORGE, M. J., AND P. VEDAVYASA RAO. 1967. Distribution of sex ratios of penaeid prawns in the trawl fishery off Cochin. *Proc. Symp. Crustacea mar. biol. Ass. India, Part 2*, 968-700.
- GULLAND, J. A. 1972. Some introductory guidelines to management of shrimp fisheries. *FAO UNDP/IOFC DEV.* 72/24: 1-12.
- GUNTER, G. AND H. H. HILDEBRAND. 1954. The relation of total rainfall of the State and the catch of marine shrimp (*Penaeus setiferus*) in Texas waters. *Bull. mar. Sci. Gulf and Carib.*, 4 (2): 95-103.
- SURENDRANATHA KURUP, N. AND P. VEDAVYASA RAO. 1974. Population characteristics and exploitation of the important marine prawns of Ambalapuzha, Kerala. *Indian J. Fish.*, 21: 183-210.
- MENON, M. K. 1955. Notes on the bionomics and the fishery of the prawn *Metapenaeus dobsoni* Miers on the southwest coast of India. *Indian J. Fish.*, 2: 41-56.
- MOHAMED, K. H. 1973. Penaeid prawn resources of India. *Proc. Symp. Living resources of the seas around India. Spl. Publ. CMFRI., Cochin*: 548-556.
- RAMAMURTHY, S., N. S. KURUP AND G. G. ANNIGERI. 1975. Studies on the fishery of the penaeid prawn *Metapenaeus affinis* (M. Edw) in the Mangalore coast. *Indian J. Fish.* *Indian J. Fish.* 22 (1 & 2): 243-254.
- RAO, P. VEDAVYASA. 1968. Maturation and spawning of the penaeid prawns of the southwest coast of India. *FAO Fish. Rep.*, 57(2): 285-301.
- RAO, P. VEDAVYASA. 1972. Seasonal abundance of larvae and postlarvae of the commercially important penaeid prawns in the inshore waters of Cochin. *Indian J. Fish.*, 19: 86-96.
- SEKHARAN, K. V. AND M. H. DHULKHED. 1963. On the oil sardine fishery of the Mangalore zone during the years 1957-63. *Indian J. Fish.*, 10: 601-626.