STUDIES ON THE FISHERY OF THE PENAEID PRAWN *METAPENAEUS AFFINIS* (MILNE EDWARDS) ALONG THE MANGALORE COAST

S. RAMAMURTHY, N. SURENDRANATHA KURUP* AND G. G. ANNIGERI**
Mangalore Research Centre of C.M.F.R. Institute, Mangalore.

ABSTRACT

The fishery and certain features of the population structures of *M. affinis* caught by the trawlers from 1962 through 1971 are reported. The fishery was chiefly bimodal and was dominated by large size groups early in the season and smaller size groups later. The maximum number of broods entering the fishery was observed to be four. Age and growth studies indicated that the males attain a length of about 95, 140 and 160 mm and females, 100, 145 and 170 mm at the end of one, two and three years, respectively. The minimum size at first maturity for males was found to be 116 mm. The average annual instantaneous fishing mortality was found to be 3.76 for males and 2.50 for females between one and two year olds.

INTRODUCTION

With the progressive introduction of mechanised fishing during the last decade and a half, the prawn fishery at Mangalore on the southwest coast registered a substantial increase. Prawns, almost exclusively composed of various species of penaeids, form about 35% of the trawl catch. Though the average annual landing of *M. affinis* is about 110 tonnes constituting only one-nineth of the prawn catch, this species is of immense importance since it grows to a large size and is of high export value.

In an earlier account (Ramamurthy 1972) the importance of the trawl fisheries of the Mangalore coast has been highlighted. The results of the investigations on the catch trends and certain population characteristics of *M. affinis* over ten years from 1962 through 1971 have been presented in this paper. The bionomics of *M. affinis* occurring in the inshore waters of Calicut have been reported by Subrahmanyam (1963). Mohamed (1965) and George *et al* (1968) have dealt with some aspects of the biology of this species from the Bombay and Cochin waters respectively.

Present address: *Central Marine Fisheries Research Institute, Cochin-18.
**Karwar Research Centre of C.M.F.R.Institute, Karwar.

Material and Methods

The samples for this study were collected from the trawlers which make daily-fishing trips usually from 05.00 to 14.00 hrs. The fishing season generally commences from October and closes early in June with the onset of monsoon. A coastal belt up to about 22-m depth is fished by the trawlers. The prawns were generally sorted out from fish before landing. Twice a week, 10-20% of the boats were randomly sampled for estimation of catch, specieswise composition by weight, and for length-frequency and maturity studies. The total catch of each species for the observed day (Yd) was estimated as:

$$Yd = \frac{N}{n} \Sigma Yi$$

where N = the total number of units operated,
n = the number of observed units
and Yi = the yeild of the i-th unit.

The catch of various species on the observed days was estimated by summing up the daily totals. The monthly data pertaining to the total number of fishing trips (g) and the prawn catch (all species) were obtained by the courtesy of the Department of Fisheries, Karnataka. The monthwise contribution of *M. affinis* (Y_m) was calculated on the basis of the summed-up daily totals in relation to the other species of prawns. Since the information on the number and duration of hauls was not available, the catch per unit of effort has been expressed in terms of fishing trips and was calculated as $\frac{Y_m}{g}$.

The estimation of prawns in numbers in a particular length group (I_d) in each sampling day was determined as

$$I_d = \frac{I_i}{Si} Y_d$$

where I_i = the number of prawns in a particular length group of the sample
and S_i = the sample weight.

The monthly total (I_m) in various size groups was calculated as

$$I_m = \frac{Y_m}{\Sigma Y_d} \Sigma I_d$$

The catch per unit of effort in numbers was expressed as

$$\frac{I_m}{g}$$

Males and females were separated and length measurements (tip of the rostrum to the tip of the telson) taken.

The mean length ($\bar{l}$) during the season was calculated as

$$\bar{l} = \frac{\Sigma j\ \Sigma i\ Ni_j\ Ij}{\Sigma j\ \Sigma i\ Ni_j}$$

Where Ni_j = the estimated numbers in the i-th month.

and I_j = the mean length of the j-th size group.

The condition of the gonads and the number of impregnated females were noted and the data for each month were pooled and their percentage calculated.

Catch and Effort

The fishery showed wide fluctuations in abundance annually as well as within the year (Table 1). Though trawling commenced in September in some years, this species appeared in the catches only from November. In certain years

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

Month	'62-63	'63-64	'64-65	'65-66	'66-67	67'-68	68'-69	69'-70	'70-71	'71-72	Average
September	No fishing	Nil	———	No Fishing	———		Nil	No fishing	Nil	Nil	Nil
October	-do-	-do-	Nil	Nil	No fishing	Nil	-do-	Nil	-do-	-do-	Nil
November	13.36 (51.6)	0.37 (0.6)	0.03 (0.1)	0.24 (0.3)	2.29 (4.4)	5.63 (3.7)	74.38 (28.5)	1.78 (1.6)	0.15 (0.06)	Nil	9.82 (0.74)
December	51.60 (48.1)	30.19 (28.2)	0.06 (0.1)	44.64 (42.1)	68.97 (39.7)	11.56 (4.1)	8.50 (3.1)	30.37 (20.4)	0.35 (0.1)	8.25 (2.7)	25.45 13.72
January	10.90 (9.3)	15.98 (17.2)	0.79 (0.8)	12.50 (7.3)	48.35 (24.7)	7.52 (3.0)	33.60 (8.3)	1.43 (0.8)	Nil	Nil	13.11 (6.35)
February	4.31 (3.9)	12.31 (16.1)	0.36 (0.4)	13.11 (7.2)	44.48 (22.9)	7.44 (2.8)	20.28 6.2)	1.28 (0.5)	0.50 (0.3)	Nil	10.41 (5.42)
March	20.37 (17.8)	20.17 (23.9)	6.11 (4.7)	7.06 (3.4)	18.31 (6.3)	24.28 (9.1)	32.14 (6.6)	24.85 (7.2)	4.97 (1.3)	4.83 (1.5)	16.31 6.18
April	35.43 (69.8)	26.24 (39.6)	11.38 (9.8)	6.84 (3.3)	18.03 (7.6)	26.85 (11.1)	22.27 (6.0)	33.72 (7.7)	13.74 (2.1)	5.64 (1.1)	20.02 6.58
May	8.94 (26.2)	2.74 (5.4)	0.97 (1.0)	15.40 (11.6)	13.02 (7.6)	41.92 (14.9)	45.55 (19.3)	20.30 (10.4)	5.05 (1.4)	3.16 (0.7)	15.70 7.90
June	———	No fishing	———	0.26	4.0	———	No fishing			0.09	0.43
TOTAL	144.94 (25.8)	108.00 (19.8)	19.70 (2.8)	99.79 (9.2)	213.71 (16.2)	129.20 (7.2)	236.72 (9.7)	113.73 (6.6)	24.76 (0.9)	21.97 (0.8)	111.25 7.10
% in the prawn catch	18.7	23.4	3.4	9.3	27.5	13.6	14.5	17.3	2.5	1.3	11.8

trawling was continued even in June but these efforts yielded poor return. Indigenous gear viz., shoreseine and cast-net operated during July-August also brought negligible quantities. George *et al* (1968) attributed the poor fishery during June-September in the inshore areas of Kerala coast to the moving away of prawns into the deeper zones as a result of upwelling. The fishery at Mangalore had two peaks — a primary one during November-December and a secondary during April-May. However, during 1964-65 the fishery was poor in November-December. During 1966-67 the fishery showed a gradual decline after the peak landings in December. The 1968-69 season was far better as compared to the other seasons and was characterised by four intermittent peaks.

To study the trend of the fishery over the years the catch and catch per effort are plotted against effort in Fig. 1. The smoothed lines are drawn visually through the points (Gulland 1972). The catch and catch per effort showed an overall decline with the increasing fishing effort. The data gathered during 1972-73 also indicated that the fishery continued to be poor (the estimated catch and catch per unit of effort being 29.6 tonnes and 1.0 kg respectively). It is seen from the figure that the maximum sustainable yield is about 150 tonnes and the fishing effort required to harvest this is 12,000 boat days (fishing trips) approximately per season, i.e., about 60 boats calculated on the basis of an average 200 fishing days. These values have however their own limitations.

Length Frequency

Figures 2 & 3 present the length-frequency distribution of males and females separately,. The percentages are based on CPUE in numbers. The year

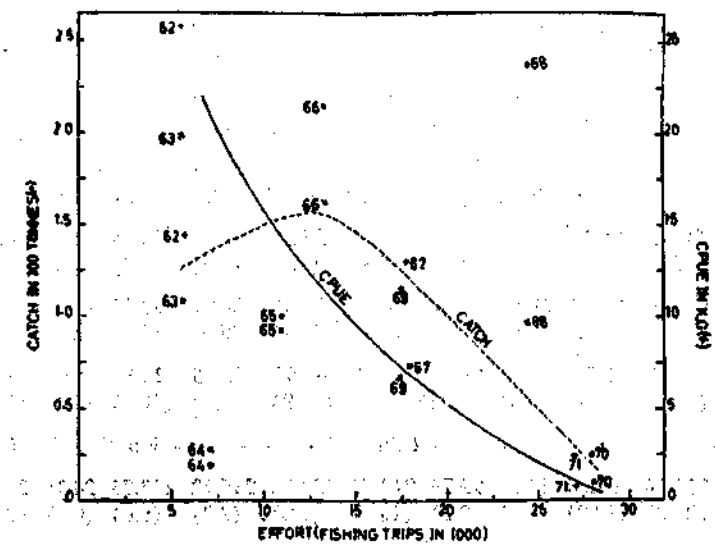

Fig. 1. Relation between total effort and total catch and catch per effort.

classes of 1961-71 are designated according to the alphabetical order. The fishery during November-February was generally composed of size groups above 120 mm. From March|April smaller size groups (70 mm onwards) were seen to enter the fishery. These observations support George *et al* (1968) who stated that big prawns move shoreward during October-January and small prawns during February.

According to Rao (1968) *M. affinis* has a protracted spawning period with the possibility of more than one spawning peak. During the present study the entry of several broods into the fishery (Figs 2 & 3) lends further evidence to this view. The maximum number of broods that could be noticed in a season was four. The pattern of growth is not identical during the different years as could be expected because of the various ecological factors. Taking into account

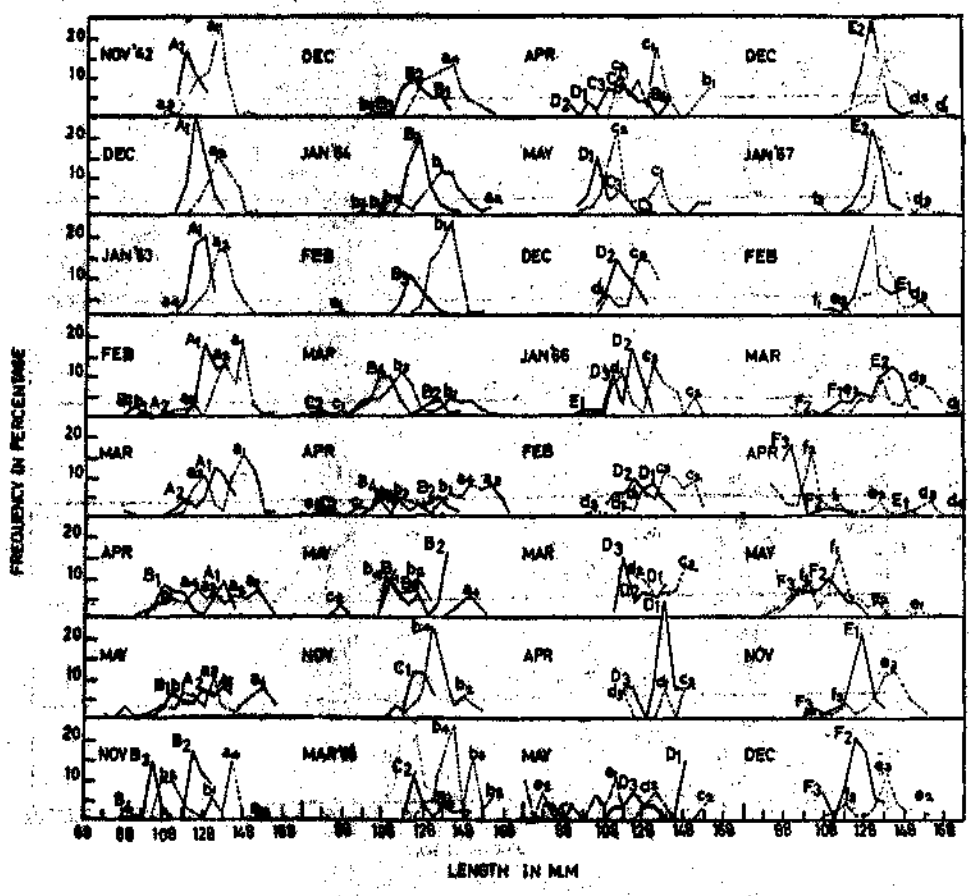

FIG. 2. Length frequency of *M. affinis* during 1962-67.

of the spawning season and various broods, it is reasonable to consider that the 93-mm size group of February 1963, which is the product of the previous year's spawning, grows to 138 mm in December 1963, i.e., during the second year of life. The 78-mm size group of March 1964 attains a length of 148 mm in May 1966, i.e., during the third year of life. Similarly in the case of females it will be seen that the 98-mm size group of February 1963, a product of 1962 spawning, reach a length of 143 mm in April 1964 during the second year of life and 168 mm in May 1965 during the next year. The progression of other broods also follows similar pattern. From these, it would appear that the males and females of *M. affinis* attain a length of 95, 140 and 150 mm and 100, 145 and 170 mm during the first, second and third year of their life, respectively.

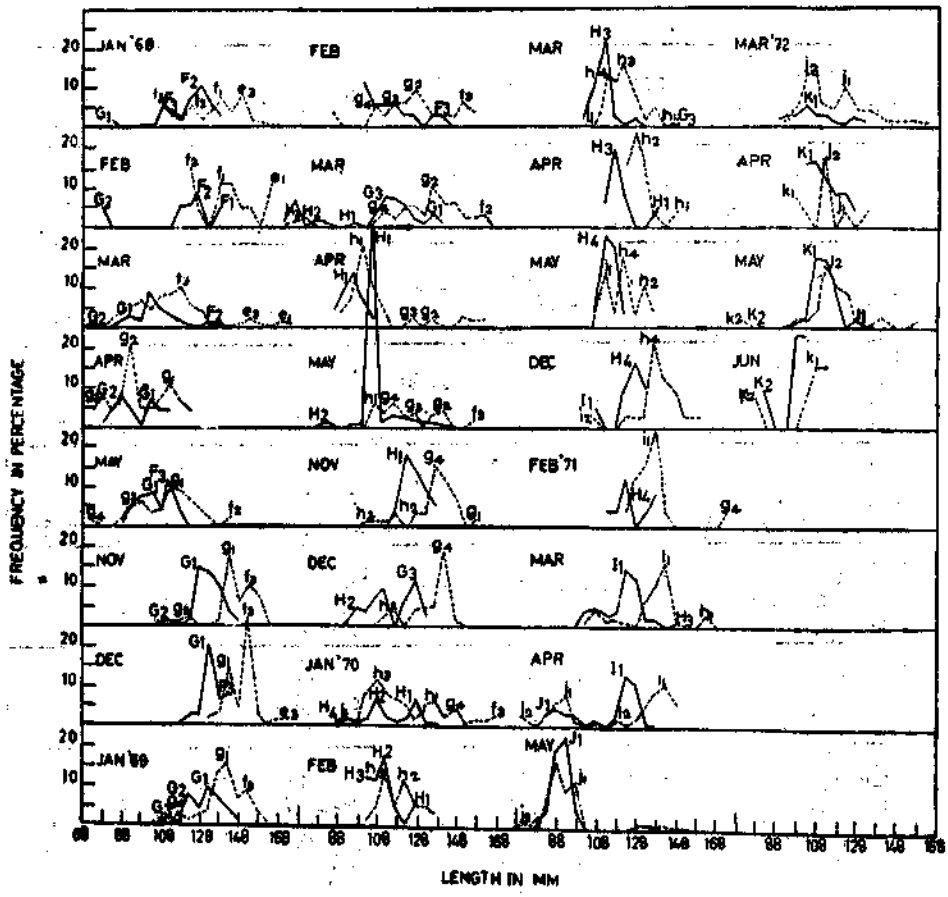

FIG. 3. Length frequency of *M. affinis* during 1968-72.

Von Brtalanffy's equation was applied and L, K and t were estimated and their values are given below:

		Males	Females
L_∞	=	174.3	188.0
K	=	0.07	0.06
t_o	=	1.7	0.17

Based on these values the sizes attained at age one, two and three have been calculated and are given in Table 2. The average size attained at the respective ages is also shown. These values were more or less similar. It can therefore be concluded that the males and females of *M. affinis* reach a length of about 95, 140 and 160 mm and 100, 145 and 170 mm at the end of 1, 2 and 3 years respectively. The maximum size recorded in the catch for males and females was 152 and 172 mm respectively during the present study. The differential growth in sexes is also evident. Based on the size-frequency distribution, Subrahmanyam (1963) estimated that the males grow to 105, 135 and 155 mm and females to 115, 155 and 175 mm respectively during the first, second and third year of their life. Mohamed (1965) considered that the 71-90-mm group which is 9-10 months old attains a length of 120 mm at the end of one year. However, the rate of growth is usually known to slow down with the advancing age and hence the 120-mm group might well represent individuals which are more than 15 months old.

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

Age in months	Males		Females	
	Estimated size	Average size (from Table 5)	Estimated size	Average size (from Table 6)
12	89.5	93.0	95.6	101.6
24	137.7	135.5	143.0	144.6
36	158.5	—	166.1	164.7

AGE COMPOSITION

Table 3 represents the age distribution of the catch, sexwise, based on CPUE in numbers, from which it is apparent that the fishery was constituted primarily by one-year olds. The two-year olds also contributed to a certain extent. The 0-year class was represented well in the catches only in some years (1966-67 and 1967-68).

MEAN LENGTH

The values of mean size for the various years for males and females are given in Table 4. When the fishery failed during 1964-65, 1970-71 and 1971-72

the mean length of males and females ranged from 105.3 to 124.4 mm and 110.2 to 141.9 mm respectively. During 1966-67 and 1968-69 when the fishery was at its peak the corresponding values were 114.5-117.3 mm and 123.3-129.1 mm. Thus the variations in the mean length do not appear to bear any relation to the fluctuations in the fishery. Therefore, the changes in the average size may represent only the natural fluctuations.

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

	Males				Females			
	O-year	1 year	2 year	Mortality	O year	1 year	2 year	Mortality
	(n_0)	(n_1)	(n_2)	$\log_e \frac{n_1}{n_2}$	(n_0)	(n_1)	(n_2)	$\log_e \frac{n_1}{n_2}$
Year	(up to 95 mm)	(96-140 mm)	(141-160 mm)		(up to 100 mm)	(101-145 mm)	(146-170 mm)	
1962-63	3	650	17	—	9	644	129	—
1963-64	5	511	82	2.07	38	608	236	3.30
1964-65	3	44	6	4.44	—	74	26	3.14
1965-66	13	260	23	0.64	32	282	34	0.77
1966-67	87	601	7	3.68	94	491	72	1.36
1967-68	58	256	1	6.39	125	340	28	2.86
1968-69	28	399	11	3.14	21	298	84	1.38
1969-70	—	216	1	5.98	—	229	31	2.25
1970-71	20	20	—	—	23	18	3	4.33
1971-72	3	37	—	—	4	39	1	3.13
Average	—	—	—	3.76	—	—	—	2.50

TABLE 4. *Mean length (in mm) of* M. affinis *during different seasons.*

	'62-63	'63-64	'64-65	'65-66	'66-67	'67-68	'68-69	'69-70	'70-71	'71-72
Males	118.4	124.3	124.4	124.8	117.3	107.7	114.5	117.5	105.3	110.2
Females	132.4	133.2	141.9	129.2	123.3	113.7	129.1	128.3	113.1	116.8

SEX COMPOSITION AND MATURITY

The proportions of sex based on CPUE in numbers are shown in Table 5. Females were in excess of males except during 1966-67 and 1968-69. It is interesting to note in this context that these two fishing seasons were exceptionally good. Subrahmanyam (1963) and George *et al* (1963) also observed predominance of females in the catches. However, George and Rao (1965)

concluded that the variations of the sex ratio were not significant, thereby suggesting absence of any segregated movements. As seen from the estimates of total instantaneous mortality, it is apparent that the males have a higher rate of mortality.

TABLE 5. *Sex ratio of* M. affinis.

	1962-63	'63-64	'64-65	'65-66	'66-67	'67-68	'68-69	'69-70	'70-71	'71-72
Males	46.0	40.4	33.9	46.00	51.0	39.0	52.2	45.4	47.6	47.6
Females	54.0	59.0	66.1	54.00	49.0	61.0	47.8	54.6	52.4	52.4

Table 6 shows the monthly distribution of maturity and impregnation in percentages among females in the different years. The frequency of mature females and impregnated ones in the different length groups is shown in Table 7. The data presented are based on the examination of 3800 specimens from random samples. Mature as well as impregnated females occurred almost throughout the season, their percentage being high in the earlier part i.e., during November-January. Spent females were met with in rare numbers during January-March. These observations suggest a protracted breeding period extending from November-March in conformity with those of Rao (1968). Mohamed (1965) observed year-round breeding with intense activity during December-February and June-August in the Bombay waters.

The smallest mature male and female measured 93 mm and 98 mm respectively during the present study. Mature females and their impregnation were rare in specimens less than 100 mm long (Table 7). The data on maturity (maturing and mature) in relation to the length groups for all the seasons are pooled and presented in Fig. 4. It seems that the length at first maturity is 116

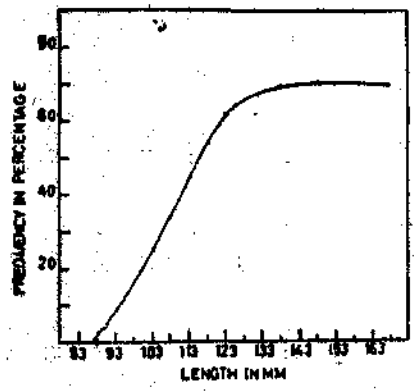

FIG. 4. Size at first maturity of *M. affinis*.

mm. It is of interest to note that while Subrahmanyam (1963) recorded 122 mm as the smallest mature female, Rao (1968) estimated the minimum size at first maturity as 88.6 mm.

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

Year	November		December		January		February		March		April		May	
	Mature	Impregnated	Mature	Impregnated	Mature	Impregnated	Mature	Impregnated	Mature	Impregnated	Mature	Impregnated	Mature	Impregnated
1962-63	60.7	36.0	50.8	52.3	55.8	31.5	14.6	17.0	66.3	48.6	39.1	41.4	35.1	29.5
1963-64	42.1	50.0	42.5	60.0	63.3	43.7	33.3	30.9	25.2	34.0	7.0	38.3	9.2	53.7
1964-65	21.3	47.0	—	—	17.0	16.0	28.0	71.0	22.0	67.0	21.9	43.7	12.0	34.0
1965-66	—	—	18.2	72.7	12.5	35.0	2.8	44.4	7.4	41.1	—	—	—	—
1966-67	57.0	57.0	11.8	40.7	21.6	32.7	20.3	25.0	26.7	52.1	—	11.1	3.8	9.0
1967-68	—	30.0	6.7	45.7	10.9	17.1	25.0	33.3	7.5	21.5	—	3.5	5.4	40.0
1968-69	41.5	33.7	33.3	40.0	15.4	26.1	11.1	16.7	5.3	52.2	15.8	4.0	—	8.0
1969-70	37.2	32.5	27.7	25.0	13.8	15.5	9.7	28.6	12.3	41.5	31.2	50.0	18.9	7.5
1970-71	—	—	10.0	35.0	—	—	23.5	53.0	2.8	8.6	12.0	6.9	—	—
1971-72	—	—	—	—	—	—	—	—	9.1	7.5	22.0	—	1.7	5.0

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

Year	Length groups in mm.																	
	Below 90		91-100		101-110		111-120		121-130		131-140		141-150		151-160		160-170	
	Mature	Impregnated	Mature	Impregnated	Mature	Impregnated	Mature	Impregnated	Mature	Impregnated	Matu e	Impregnated	Mature	Impregnated	Mature	Impregnated	Mature	Impregnated
1962-63	—	—	—	—	40.0	12.5	42.0	21.2	37.0	32.0	44.4	42.6	58.5	41.3	57.8	58.8	38.4	35.7
1963-64	—	—	21.4	14.3	14.5	31.2	24.7	33.3	25.0	46.0	33.0	42.3	40.0	42.5	41.4	60.0	26.5	47.0
1964-65	—	—	—	—	16.7	16.7	6.0	37.0	16.2	32.5	23.6	45.6	14.6	66.7	23.0	61.5	35.7	71.4
1965-66	—	—	—	—	—	—	11.1	44.4	15.4	42.3	13.0	47.8	2.8	50.0	6.3	43.7	—	—
1966-67	—	—	—	—	2.2	3.3	11.1	30.0	15.1	34.1	23.6	35.6	19.4	42.0	20.0	41.7	50.0	40.0
1967-68	—	—	—	12.5	—	10.4	6.6	25.8	2.8	44.0	9.1	37.7	14.0	34.0	20.0	24.0	27.3	18.2
1968-69	—	—	—	—	3.1	6.0	10.0	22.5	13.5	16.2	51.3	39.5	33.7	41.5	25.0	42.8	42.9	28.5
1969-70	—	—	—	—	—	19.0	13.1	24.3	22.5	28.7	14.0	38.6	37.4	22.4	33.3	33.3	40.0	40.0
1970-71	—	—	—	—	—	14.3	33.0	16.7	18.2	9.1	15.9	25.0	8.0	18.4	—	25.0	—	16.7
1971-72	—	—	—	—	—	13.6	8.8	—	5.0	—	12.5	—	—	—	20.0	—	—	—

Mortality Rate

Since the 0-year class was not fully represented in the fishery, the instantaneous rate of fishing mortality was calculated between one- and two-year olds. The estimated values varied considerably from year to year (Table 3). However, the values for males were higher. The average annual instantaneous mortality rate was estimated to be 3.76 for males and 2.50 for females between the first and second year.

Acknowledgements

The authors are thankful to Shri K. H. Mohamed for his critical comments on the paper. They are greatly indebted to Shri M. H. Dhulkhed for his help in the statistical analysis and for his suggestions in the preparation of the manuscript.

References

George, M. J., K. Raman and P. Karunakaran Nair. 1963. Observations on the offshore prawn fishery of Cochin. *Indian J. Fish.*, **10**: 460-499.

George, M. J. and P. Vedavyasa Rao. 1965. Distribution of sex ratios of penaeid prawns in the trawl fishery off Cochin. *Proc. Symp. Crustacea, Mar. biol. Ass. India*, Pt. 2: 698-700.

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.*, **2** (57): 265-284.

Gulland, J. A. 1972. *Some introductory guidelines to management of shrimp fisheries. FAO UNDP|IOFC Dev.*|72|24: 1-12.

Mohamed, K. H. 1965. Penaeid prawns in the commercial shrimp fisheries of Bombay with notes on species and size fluctuations. *Proc. Symp. Crustacea. Mar. biol. Ass. India*, Pt. 4: 1408-1418.

Ramamurthy, S. 1972a. Trawl fisheries of the South Kanara coast during 1967-70. *Indian J. Fish.*, **19**: 54-59.

Ramamurthy, S. 1972b. Observations on the mechanised fishery of the Mangalore coast. *Proc. Seminar Mariculture and Mechanised Fishing, Dept. of Fisheries, Tamilnadu*, Nov. 1972; 124-129.

Subrahmanyam, C. B. 1963. Notes on the bionomics of the penaeid prawn Metapenaeus affinis (Milne Edwards) of the Malabar Coast. *Indian J. Fish.*, **10**: 11-22.

Vedavyasa Rao, P. 1968. Maturation and spawning of penaeid prawns of the southwest coast of India. *FAO Fish Rep.*, **2** (57): 285-302.