Fishery and biology of penaeid prawn *Parapenaeopsis maxillipedo* Alcock along Chennai (Madras) coast

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ABSTRACT

Parapenaeopsis maxillipedo supported a steadily increasing fishery along the Chennai coast with the average annual catch of 326 t at the catch rate of 1.40 kg/hr contributing 11.8% of prawn landings in 1990-'99. The catches were more abundant in June-September and poor in summer months of April-May. Females were relatively more in number and larger in size. The overall sex-ratio for 1992-'95 was 65.9 : 34.1% in favour of females. The length weight relationship was: Ln W = -3.9469 + 2.7077 Ln L for male and Ln W = -4.3493 + 2.8914 Ln L for female. The growth factors were: L°° = 108.0 mm and K = 2.61/year for males L°° = 117.8 mm and K = 2.21/year for females. The species had a short life span and only small fraction of the population could survive in the second year of life. Higher recruitment was recorded during February-March, June and September-October which was apparently linked to the greatbi spawning spells during June, October and February. The mortality rates were : Z = 7.4713, M = 4.3728 and F = 3.0985 for males and Z = 8.6939, M = 3.8301 and F = 4.8638 for females. These estimates gave an average exploitation rate of 0.49, that, with MSY of 304.7 t against the average catch of 326.4 t, indicated that the species had been in the level of optimum fishing intensity during the study period.

Introduction

Steered by highly profitable export prices, prawns had been subjected to intensive fishing since the introduction of trawling operation in the sixties. The resources were extensively exploited resulting in over-fishing in many areas. Conscious about these developments, continuous studies were made with an objective of ensuring long-term sustainable yield of the resources.

Several species of prawn contributed to the fishery along the west and east coasts, but the studies were concentrated on those species of commercial value. Information on other species remain scanty, despite their greater importance in local fishery status. *Parapenaeopsis maxillipedo* is a marine species with a wide geographical distribution along the coasts of India from Gulf of Kutch to the east coast, Sri Lanka, Malay Peninsula and Indonesia. Along the Chennai coast it forms a fishery of considerable importance, with an annual landing of over 300 t meeting the needs of local consumption. However, information on aspects other than taxonomical record is limited to its seasonal and bathymetric abundance off Cuddalore in the north Tamil Nadu coast (Thangaraj Subramanian, MS). In view of its fishery importance and

limited knowledge about the species, the present study has been made to present some information on the fishery and population characteristics of the species to help in the management of the overall prawn resources of the region.

Material and methods

Data on catch and effort for trawl fishing with reference to prawns were collected weekly during April 1989 to March '99 at Kasimedu, the trawler landing centre at Chennai. During each observation day, around 10% of the trawlers was selected at random to record the weight of prawn catches and therein the proportion of *P. maxillipedo,* along with the effort in trawling hours. The average catch and effort for the observed units were raised to the total number of units to obtain the estimates for the day and similarly the monthly values were calculated from the average of observed days. The CPUE, expressed in kg/hr, was computed for the monthly and annual values and used as the index of relative abundance.

The random samples of *P. maxillipedo* collected on each observation day during 1992-'95 were analysed to record the sex, total length in mm and weight in g of all individuals and the maturity stages of females. The data were further processed and used for different require-ments as described in the text and the procedures of statistical methods were generally referred to from Sparre and Venema (1992).

Results

Fishery

The fishery (Fig. 1) had staged a steady progress over the 10 year period of 1989-'90 - 1998-'99, with higher

catches during 1993 -'94 to 1995 -'96 and 1998-'99. The annual landings, which was 123.3 t at the average catch rate of 0.84 kg/hr in 1989-'90, increased gradually to reach 335.1 t at 1.43 kg/hr in 1993-'94. There was then a sharp increase in the catch to attain the maximum of 670.1 t with a catch rate of 2.45 kg/hr in 1994-'95, but reduced to 514.8 t with 2.19 kg/hr in 1995-'96 and to 302 t with a catch rate of 1.18 kg/hr in 1996-'97. Finally the year 1998-'99 had moderate increase to 465.9 t at a rate of 1.43 kg/hr. The average annual catch for the 10 year period was 326.4 t, the catch rate being 1.40 kg/hr.

The seasonal abundance of the species during 1992-'95 (Table 1) showed that the average monthly landings varied from 18.4 t in November to 54.2 t in August and the catch rate between
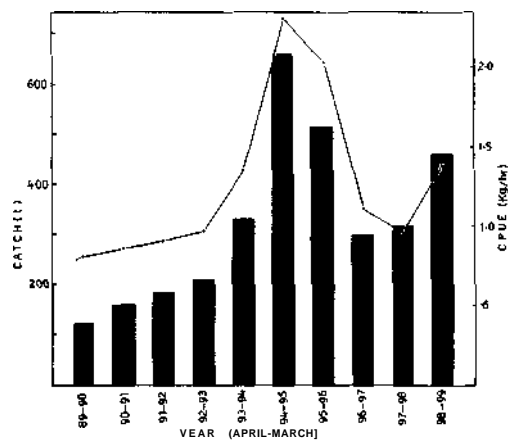

Fig. 1. Fishery trend of *P. maxillipedo* off Chennai during 1989-'99.

1.24 kg/hr (May) and 2.54 kg/hr (Au-gust). The peak fishery season was June-September with slight annual variations and poor abundance noted during the dry and warmer summer months of April-May. The average percentage contribution of this species

in total prawn catch was 11.8 for the period under observation.

Length-weight relationship

Females were heavier than males and the sexual disparity of weight also increased progressively with increasing size. The relationship between length and weight was estimated at

male : $\text{Ln } W = -3.9469 + 2.7077 \text{ Ln } L$

female : $\text{LnW} = -4.3493 + 2.8914 \text{ LnL}$,

where W is the weight in mg and L, total length in mm. The exponent values, 2.7077 and 2.8914, were not significantly different from 3.0 and thus indicated an isometric growth. The W^∞ calculated for L^∞ was 12.14 g for male and 16.15 g for female.

Size-distribution and recruitments

The catch was supported by the population of limited size range in both sexes, females being relatively larger in size. The overall size distribution (Fig. 2) of males was 41-105 mm, with most of them belonging to 61-90 mm size group and the maximum frequency was observed at 71-75 mm. The size range of females was 41-115 mm, with major distribution between 61-95 mm and the highest frequency was recorded at 81-85 mm. Males exceeding 95 mm size and females above 100
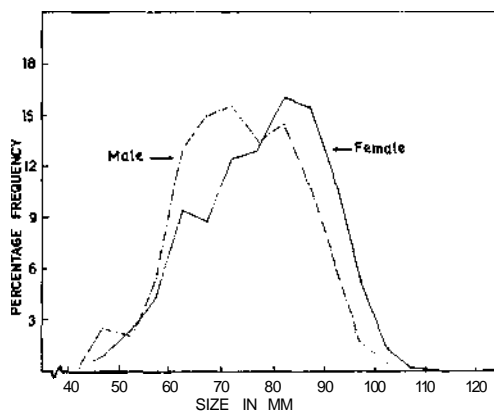
Fig. 2. Overall size distribution *of P. maxillipedo* landed at Chennai during 1992-'95.

mm represented less than 2% of the population landed.

Juveniles measuring less than 55 mm size hardly formed 5% of the catches and most of the fresh recruits into the fishery measured 56 - 60 mm in size. Based on the relative abundance of such young individuals (Fig. 3) three annual waves of fresh recruitment were recorded during February-March, June and September-October.
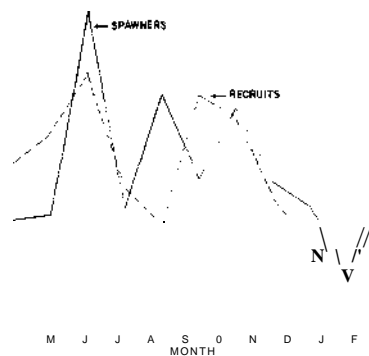

Fig. 3. Seasonal abundance of recruits and spawners into the fishery of *P. maxillipedo* at Chennai during 1992-'95.

Age and growth

Individual broods were discerned as size modes in monthly length-frequency histograms (Fig. 4 a, b and c). Their succession were traced in the following months as mode-chains, of which a few selected ones (Table 2) were used for computation of growth parameters
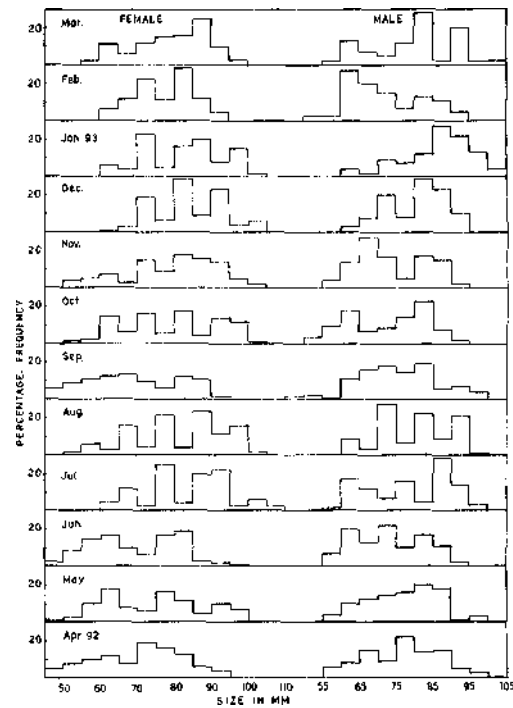

Fig. 4(a). Length-frequency of *P. maxillipedo* landed at Chennai during 1992-'93.

following Gulland and Holt plot for each sex. The females showed faster growth than the males. The estimated value of L°° was 117.7805 mm, with K at 2.2144/ year for females and 108.0116 mm and 2.6132/year for males. Females were estimated to attain 78.9, 104.9 and 116.4 mm size and males, 78.8, 100.1 and 107.4 mm length respectively in 6 months, 1 and 2 years. Accordingly, the
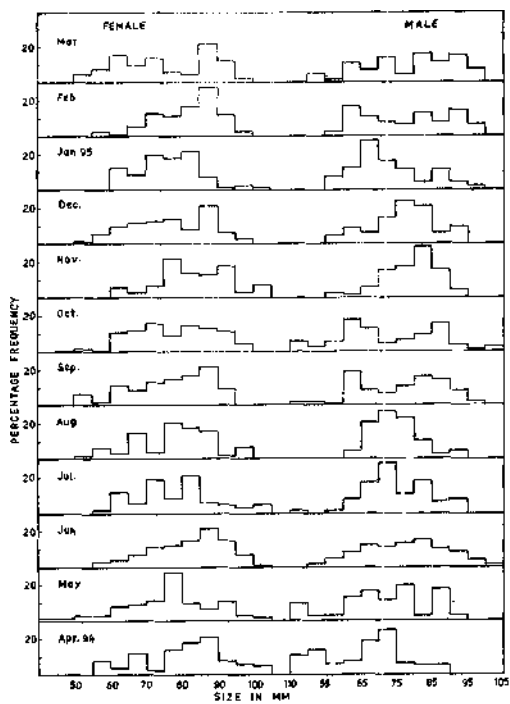
Fig. 4(b). Length-frequency of *P. maxillipedo* landed at Chennai during 1993-'94.
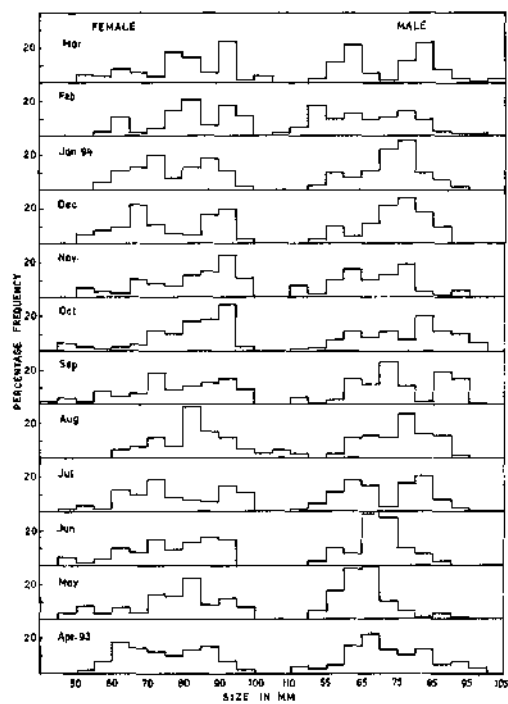
Fig. 4(c). Length-frequency of *P. maxillipedo* landed at Chennai during 1994-'95.

TABLE 2. *Size mode-chains used in calculation of growth parameters by Gulland and Holt plot for* P. maxillipedo *landed at Chennai*

Initial mode		Final mode		Month interval	Size increase (mm)	Mean size (mm)	Monthly growth rate (mm)
Month	Size (mm)	Month	Size (mm)				
Male							
11/93	48	3/94	83	4	35	65.5	8.75
2/94	53	7/94	93	5	40	73.0	8.00
4/92	68	8/92	93	4	25	80.5	6.25
4/94	73	10/94	103	6	30	88.0	5.00
7/93	83	3/94	103	8	20	93.0	2.50
Female							
10/93	48	3/94	93	5	45	70.5	9.00
5/92	63	10/92	98	5	35	80.5	7.00
4/92	73	8/92	98	4	25	85.5	6.25
5/94	78	11/94	103	6	25	90.5	4.17
3/93	88	8/93	108	5	20	98.0	4.00

species would enter the fishery around the age of 4-5 months to support the commercial catches for about 6 months. The age composition of the landed population of *P. maxillipedo* revealed that 48.6% of the females were less than 6 months old and about 99% of them were caught before entering the second year of life. Similarly, about 65% of the males caught belonged to less than the age of 6 months. The growth perfor-mance *(&),* calculated by empirical equation (Pauly and Munro, 1984) for the relationship of L°° and K, were 2.4874 for females and 2.4841 for males.

Sex-ratio

The overall sex-ratio (Table 3) for all the population pooled together for 1992-'95 was 65.9 : 34.1 in favour of females and the preponderance of females was consistent in most of the months. The annual average percentage of females in the catch was 58.03, 56.26 and 57.60 during 1992-'93, '93-'94 and '94-'95, respectively, with the average monthly ratio between 50.9 and 62.0.

Maturation and spawning

Females in advance stage of matu-rity were seen continuously year round with fluctuating intensity (Fig. 3). The minimum size at maturity for females was 58.8 mm and most of them attained maturity around 71-75 mm. The peak spawning months based on the abun-dance of females with ripe ovary were during June, August and October and the spawning intensity was low during the peak monsoon months of November-December.

Mortality rates

The average annual length-fre-quency data of *P. maxillipedo* were analysed to obtain the total mortality rate (Z) by using length converted catch curve method and Beverton and Holt method. The Z values obtained were 8.5458 and 9.1608 by the former and 6.3967 and 7.7770 by the latter for males and females respectively (Fig. 5 a & b). The average values of Z by these two methods were 8.6939 for females

TABLE 3. *Sex ratio (%) of* P. maxillipedo *landed at Chennai during 1992 - '95*

Month	1992-•'93		1993 -'94		1994 -'95		Average	
	Male	Female	Male	Female	Male	Female	Male	Female
Apr.	43.02	56.98	44.88	55.12	26.06	73.94	37.99	62.01
May	46.93	53.07	52.61	47.39	39.65	60.35	46.40	55.60
Jun.	38.35	61.65	46.86	53.14	34.82	65.18	40.01	59.99
July	45.97	54.03	37.98	62.02	48.21	51.79	44.05	55.95
Aug.	39.05	60.95	46.93	53.07	48.35	51.65	44.77	55.33
Sep.	35.61	64.39	44.65	55.35	43.43	56.57	41.23	58.77
Oct.	43.20	56.80	47.55	52.45	40.71	59.29	43.82	56.18
Nov.	20.77	79.23	39.18	60.82	58.75	41.25	39.57	60.43
Dec.	37.09	62.91	28.87	71.13	47.87	52.13	37.94	62.06
Jan.	44.59	55.41	49.24	50.76	38.42	61.58	40.08	59.92
Feb.	56.11	43.89	39.12	60.88	35.42	64.58	43.55	56.45
Mar.	52.75	47.25	47.32	52.68	47.20	52.80	49.09	50.91
Ann. Ave.	41.97	58.03	43.74	56.26	42.40	57.60	42.70	57.30

and 7.4713 for males. The natural mortality rates (M) calculated by Pauly's emipirical equation at a mean temperature of 27°C were 3.8301 (females) and 4.3728 (males). The fishing mortality rates (F) obtained by subtraction for M from Z were 4.8638 and 3.0985 for females and males respectively. The exploitation rates (E), calculated by
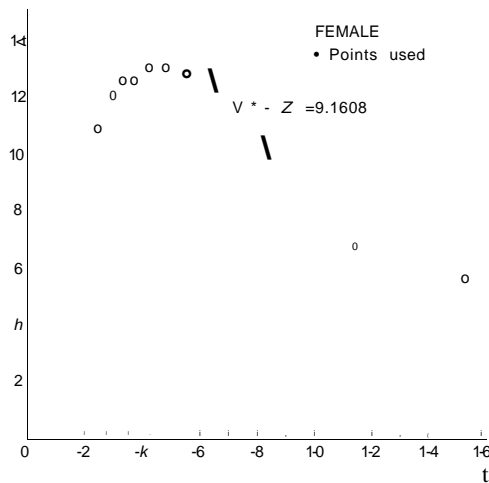
Fig. 6. Fishing mortality rates by Jones' ccohort analysis for *P. maxillipedo* landed at Chennai during 1992-'95.

F/Z, were 0.5594 for females and 0.4147 for males, with the average exploitation rate of 0.49 for the species. An estimation of fishing mortalities for each size-class was made based on Jones' cohort analysis, which showed progressively increasing rates against size upto 91-95 mm for males and 96-100 mm for females and declining sharply further among the last few largest length-groups (Fig. 6). The mortality rates were distinctly higher at 81-95 mm and 86-105 mm for males and females respectively.

Fig. 5(a). Length converted catch curve for total mortality rate of *P. maxillipedo* (male) landed at ('hennai during 1992-95.

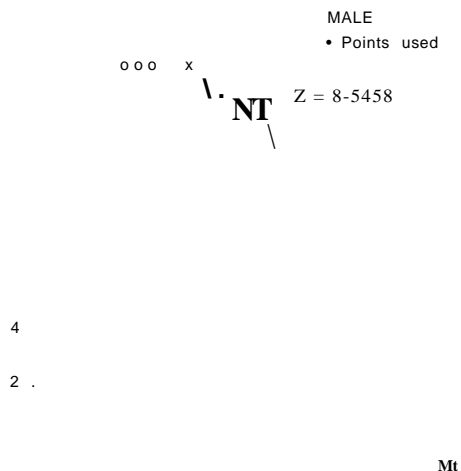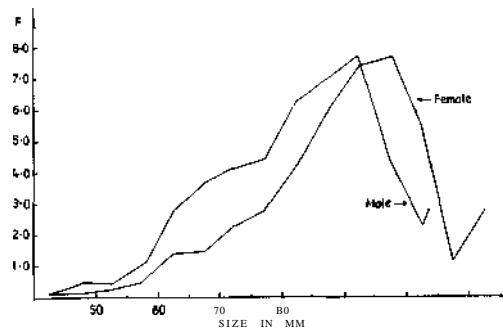### Stock assessment

Time series of catch and effort for 1990-'99 were used in surplus production models for assessment of the stocks to obtain the Maximum Sustainable Yield (MSY) and the optimum fishing effort (fmsy). They were respectively 313.7 t and 252 thousand hours by Schaefer model and 295.6 t and 268 thousand hours by Fox method and the average values of these two models were 304.7 t and 260 t hrs, respectively, while the average annual catch and effort in the present observation were 326.4 t and 233 thousand hrs.

Fig. 5(b). Length converted catch curve for total mortality rate of *P. maxillipedo* (female) landed at Chennai during 1992-'95.

Discussion

P. maxillipedo contributed to a good fishery off Chennai, the magnitude of which has not been reported from any other region, despite its wide distributions. The fishery showed improvement over the years 1990-'99, primarily owing to intensive fishing and extension of fishing locations. Thangaraj (MS) had observed similar increase of this species off Cuddalore to an extent of 30% from deeper grounds by fish-trawls. However, higher catches of the species at Chennai observed during 1994-'96 were largely due to increased CPUE.

P. maxillipedo is a continuous breeder. There were two dominant spawning periods during June-October and February, which agreed with earlier observations on *Penaeus indicus* (Subramanyam, 1965) and *Metapenaeus dobsoni* (Thangaraj, 1985) of the same area.

The Loo calculated for males (108 mm) and females (117.8 mm) were nearer to the length of largest individual sampled. The higher values of K, 2.61 and 2.21 for males and females respectively, could be due to the shorter life span of the species. Although distinct sexual differences existed in growth rates and size, the growth performance, an empirical relationship between L°o and K of growth parameters, remained close around 2.48 as the common characteristic feature of the species. The exponents of L/W relationship calculated at 2.8914 for females and 2.7077 for males were not significantly differing from 3.0 indicating isometric growth. Kirkegaard and Walker (1970) obtained similar values of 2.958 and 2.944 for the respective sexes of the allied species, *P. sculptilis* in Australian waters, while Suseelan and Raj an (1989) gave higher exponents of 4.13 for females and 4.09 for males of JR *stylifera* from Kerala coast.

The catch of *P. maxillipedo* was virtually supported by population of less than one year old. The total mortality rates were higher at 8.6939 for females and 7.4713 for males, with the natural mortality being 3.8301 and 4.3728, respectively. Such a higher natural mortality balanced with or exceeding the fishing mortality was the common feature among species with a short life span, as reported for the brown shrimp, *Crangon crangon* (Boddeke, 1989). Higher mortality would further indicate extensive exploitation spread over wider areas round the year leaving the species to have little chance to replenish the population loss. However, the observed average exploitation rate of 0.49 and the average catch of 326.4 t against the esti-mated MSY of 304.7 t, indicated that the exploitation of *P. maxillipedo* at Chennai was at optimum level.

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