

## Fishery and stock assessment of *Metapenaeus dobsoni* (Miers, 1878) off Chennai

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Fishery, growth, mortality and maximum sustainable yield of *Metapenaeus dobsoni* (Miers) off Chennai during 2004-07 is presented in the article. *Metapenaeus dobsoni* contributed 16.5% to the total penaeid shrimps landed during 2004-2007 at Chennai Fisheries Harbour. Total length range was 36-130 mm for females and 41-120 mm for males, overall sex ratio being 1:1.5 (M:F). Size at 50% maturity (69 mm) was attained in five months. Longevity was estimated to be 1.8 months. Length weight relationship for females and males pooled was  $0.0000062L^{3.02}$ . Growth parameters estimated for sex pooled data are 131 mm ( $L_{\infty}$ ) and 1.68 (K, annual). Linearised catch curve gave total mortality coefficient (Z) of 7.93. Fishing (F) and natural mortality (M) are 5.86 and 1.79 respectively with exploitation ratio (E) of 0.74. Thomson and Bell yield prediction analysis showed that the present fishing has reached the maximum sustainable yield, but the maximum sustainable economic yield is attained at the F-factor 0.6. Hence it is suggested to decrease the present fishing effort by 40% to sustain the fishery and get maximum revenue.

[**Keywords:** *Metapenaeus*, mortality, Maximum Sustainable Yield, Chennai]

### Introduction

*Metapenaeus dobsoni* (Miers) is distributed along the Indian coast, off Sri Lanka, Malaysia, Indonesia to Philippines and New Guinea. In India it is common along the south east coast-Orissa, Kakinada, Visakhapatnam, Tamil Nadu and Union territory of Puducherry and in the South west coast-Kerala, Goa and Karnataka. It ranks first among the penaeid shrimps landed at the Kasimedu (Chennai) Fisheries harbour. Here it is fished at a depth range of 5-60 m by trawl between Ongole in south Andhra Pradesh and Nagapattinam to the south of Chennai.

There are reports on the fishery and dynamics of the species from both the east and west coasts of India where the species contributes to the fishery – Vishakapatnam<sup>1</sup>, Kakinada<sup>2,3</sup> and Mangalore<sup>4</sup>. Alagaraja<sup>5</sup> analysed the yield recruit relationship and Banerjee and George<sup>6</sup> studied the growth of this species from the Kerala coast. Paralkar and Devaraj<sup>7</sup> reported the population dynamics of *M. dobsoni* from the south west coast of India. Sukumaran<sup>8</sup> has discussed the fishery and nature of the stock of this species along the Indian coast. This study was conducted to assess the status of *M. dobsoni* landed by trawl at Chennai fisheries harbour during 2004-2007.

### Materials and Methods

Individual length and weight (nearest g) were measured of *M. dobsoni* samples (1-2 kg) brought to the laboratory on each observation day (once in a week) from Chennai Fisheries harbour. These data were arranged in intervals of '5 mm' group, raised to the observed day's catch and then to the monthly catch. Growth parameters were estimated using appropriate routines in the ELEFAN I<sup>9</sup> module of FiSAT software (Ver.1.2.3).  $L_{\infty}$  was also estimated by the Powell-Wetherall method<sup>10</sup> to get an initial estimate. Total mortality coefficient Z was estimated using length converted catch curve analysis<sup>11</sup> in FiSAT program using the input parameters  $L_{\infty}$  and K. Natural mortality M was obtained from Pauly's empirical equation<sup>12</sup> inputting sea surface temperature as 28°C. The fishing mortality was computed by the subtraction of natural mortality from total mortality ( $F = Z - M$ ). The exploitation ratio (E) - the ratio between the fish caught and total mortality was estimated by  $E = F/Z = F/M + F$ . Longevity was obtained from the equation  $t_{max} = 3/K$ , where  $t_{max}$  is the approximate maximum age the fish of a given population would reach. The probability of capture ( $LC_{50}$ ) was estimated from the gear selection curve generated from the

length converted catch curve<sup>11</sup>. Length at first maturity was established by King's method<sup>13</sup> and length at age by von Bertalanffy growth equation<sup>14</sup>. Length weight relationship<sup>15</sup> was determined for males and females by  $W=a*L^b$  where 'W' is the weight in grams and 'L' is the total length in mm. Difference between the slopes of regression lines of males and females were tested by ANACOVA<sup>16</sup>. Thomson and Bell yield prediction analysis<sup>17</sup> was used for estimating maximum sustainable yield of the species by inputting results obtained from length based cohort analysis.

## Results and Discussion

### Fishery

The average annual landing of *M. dobsoni* was 252 t (2004 -2007), with the highest catch of 329 t recorded in 2006 and the lowest of 180 t in 2007. Highest monthly catch (79.18 kg) was recorded in the month of June, 2004 and lowest (0.45 kg) in March, 2005 (Fig. 1). Percentage contribution of the species to the total penaeid shrimp catch was highest in 2005 (17.2%) and lowest (15.1%) in 2007, the average being 16.5% for the study period.

The total length of females in the fishery ranged from 36-130 mm and males from 41-120 mm. Mean size of the females increased from 85.5 mm in 2005 to 90.8 mm in 2006 and later in 2007 decreased to 86.7 mm. In males the mean size increased from 76.5 mm in 2005 to 89.2 mm in 2007. George *et al*<sup>18</sup> reported the size class in the fishery from Kochi as 125-130 mm and at Kakinada<sup>19</sup>, the length ranged from 40-110 mm. Suseelan *et al*<sup>20</sup> reported a length range of 36-120 mm and 36-100 mm for females and males respectively from Calicut and 66-100 mm for pooled data from Kochi.

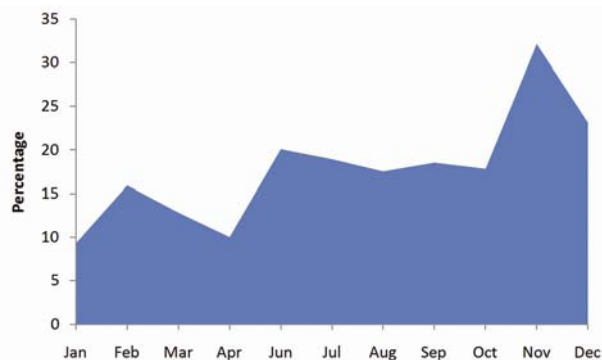


Fig. 1—The monthly catch of *M. dobsoni* off Chennai during 2004-2007

The size at 50% maturity for *M. dobsoni* was 69 mm which was attained during the fifth month (Fig. 2). Rao<sup>21</sup> reported the size at first sexual maturity as 64.1 mm from Kochi. From Karnataka coast, the estimated size at maturity of the species is 71 mm and along the Visakhapatnam coast 88 mm for female and 68 mm for male<sup>22</sup>. Females dominated males in the fishery throughout the period of study, the sex ratio (M:F) being 1:1.5. The preponderance of females in the population has been attributed to reproductive activities and differential growth of the sexes<sup>23, 24</sup>.

The shrimp breeds throughout the year with peak spawning during February to June and December to January, as maximum number of mature females were recorded during this period. Immature females formed 46%, mature females 42% and spent 14% (Table.1). Maximum number of immature females was observed during November and highest number of berried females occurred in the fishery during July-August and October. George *et al*.<sup>25</sup> observed the species from Kochi to breed almost throughout the year with peaks in June through August and in November-December and Banerjee and George<sup>26</sup> reported peak spawning during May to December in Kochi. The timing of the peaks may vary from place to place and year to year. Paralkar and Devaraj<sup>7</sup> found each year class to be composed of two broods, one originating in January and the other in August and a minor brood originating in April-May along the southwest coast.

The length-weight relationship of female (n = 204) is  $0.0000134 L^{2.87}$  and for male (n = 220)  $0.0000048 L^{3.07}$ . Since the relationship was not significant at 1% level, the common equation is  $0.0000062 L^{3.02}$ .

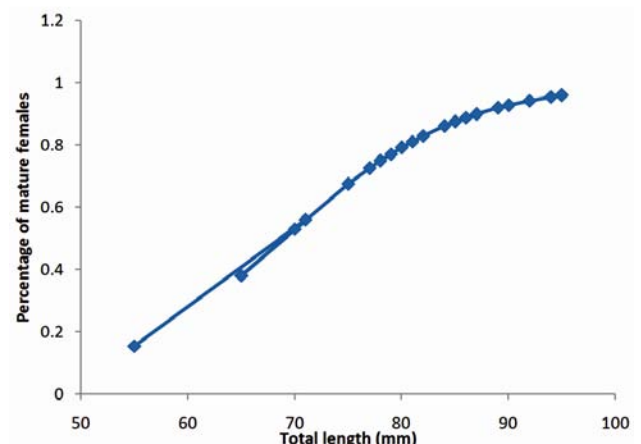


Fig. 2—Size at 50% maturity of *M. dobsoni* female during 2004-07 off Chennai

Growth and mortality

The estimated asymptotic length,  $L^\infty$  was 131 mm ( $Z/K = 3.8$ ,  $r = 0.96$ ) for female and 119.5 mm ( $Z/K = 3.5$ ,  $r = 0.97$ ) for male by Powell and Wetherall method<sup>10</sup>. The  $L^\infty$  and K (yearly) of *M. dobsoni* are 130 mm and 1.55 for females by the ELEFAN I procedure. In males the  $L^\infty$  and K (yearly) are 120 mm and 1.53. Goodness of fit index (Rn) for the obtained  $L^\infty$  and K values of male and female are 0.135 and 0.116 respectively. Table. 2 gives the growth parameters of *M. dobsoni* estimated by earlier workers. The longevity ( $t_{max}$ ) is around two years for both sexes. Total mortality coefficient (Z) for females was 5.45, natural mortality (M) 1.57 and fishing mortality (F) 3.88. The Z was 5.79, M 1.62 and F 4.17 for males. Respective current exploitation ratio (E) of males and females are 0.71 and 0.72 respectively. The Z value derived in the present study is comparatively lower than that reported from Chennai<sup>8</sup> and Kakinada<sup>27</sup> (Table 3). Sukumaran *et al.*<sup>8</sup>. gave very high values of Z and hence F values for males and females from Chennai earlier. Z was 16.4 and 20.4 for

males and females respectively, M was 2.3 for both females and males and F was 18.6 for females and 14.1 for males. The present results are comparable with that reported from Mangalore and Karwar<sup>28</sup>.

Females attained a length of 101 mm in the first year and 123 mm during the second year and males reached 92 mm during the first year and 112 mm in the second year (Fig. 3). The males and females of

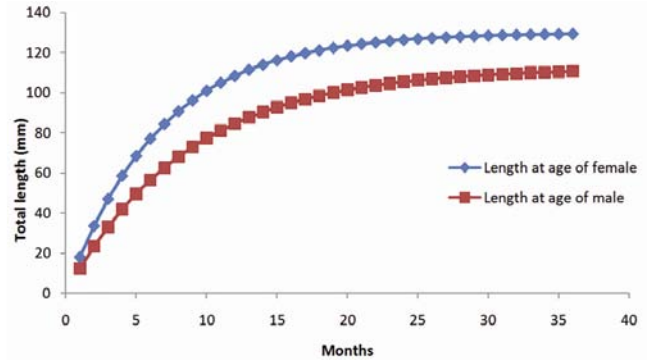


Fig. 3—Length at age of female and male *M. dobsoni* during 2004-07 off Chennai

Table 1—Sex distribution (%) and maturity stages of *M. dobsoni* landed at Chennai fisheries harbour.

Year	M	F	IM	M	S
2004	43.08	56.92	44.5	46.1	9.2
2005	26.7	73.2	51.3	38.7	16.9
2006	45.4	54.5	37.7	41.4	18.9
2007	35.3	64.6	50.7	35.2	14
M=Male	F=Female	IM=Immature	M=Mature	S=Spent	

Table 2—Growth parameters ( $L^\infty$  & K) of *M. dobsoni* reported from different centres

Centre	Sex	$L^\infty$	K	Authors
Mangalore	Male	109.1	0.12 (monthly)	Ramamurthy <i>et al.</i> <sup>24</sup>
	Female	120.9	0.18 (monthly)	
Mangalore	Male		2.4 (Annual)	Sukumaran <i>et al.</i> <sup>8</sup>
	Female		2.76 (Annual)	
Kakinada	Male	140 (F)	1.69 (Annual)	Lalitha Devi <sup>27</sup>
	Female	117 (M)	1.89 (Annual)	

Table 3—Mortality of *M. dobsoni* derived by various workers

Area	Author	Year	Sex	Z	M	F	E
Kakinada	Lalitha Devi <sup>27</sup>	1987	Male	12.72	3.44	9.28	—
			Female	12.50	2.54	9.97	
Karwar	George <i>et al.</i> <sup>28</sup>	1988	Male	9.60	3.06	6.54	0.70
			Female	6.18	1.74	4.44	0.70
Mangalore	George <i>et al.</i> <sup>28</sup>	1988	Male	7.56	2.46	5.10	0.7
			Female	7.26	1.74	5.52	0.75
Mangalore	Sukumaran <i>et al.</i> <sup>8</sup>	1993	Male	25.29	2.30	22.99	0.91
			Female	19.60	2.30	17.30	0.88
Chennai	Sukumaran <i>et al.</i> <sup>8</sup>	1993	Male	16.47	2.30	14.17	0.86
			Female	20.47	2.30	18.67	0.89

*M. dobsoni* from Mangalore attained a total length of about 85 mm and 105 mm in the first year and 95 mm and 120 mm in the second year<sup>24</sup>. Similar observations were made from Kakinada coast<sup>27</sup>. Paralkar and Devaraj<sup>7</sup> found the shrimps to grow to 54.1 mm, 96.4 mm and 120 mm at the end of first, second and third year long the entire west coast. But Sukumaran *et al.*<sup>8</sup> observed the males and females to attain 90 mm and 100 mm at the end of six months and 120 mm and 130 mm at the end of the first year along the Indian coast.

*Stock assessment*

For deriving the fishery resource management measures the growth ( $L_{\infty}$ , K) and mortality parameters (Z, M, F) are estimated for the sex pooled data.  $L_{\infty}$  and K (yearly) are 131 mm and 1.68 by ELEFAN I. The mortality parameters Z, M and F are 6.86, 1.79 and 5.07 respectively (Fig. 4). The exploitation ratio is 0.74 which is high. Length based cohort analysis revealed higher values of F in the length range 80-110 mm. Results of the length based cohort analysis (Table 4) was used as input in Thomson and Bell yield prediction analysis, which showed that the present level of fishing (F=1) has reached maximum sustainable yield (265 t) (Fig. 5). At this level, the

spawning stock biomass (SSB) is 20% of the virgin biomass (Bv). Virgin biomass has declined from 348 t to 94 t (27% decrease from the Bv) at the current level of fishing. The maximum sustainable economic yield (MEY) is at the fishing effort 0.6 after which the revenue generation shows decline and also further increase in effort gives only a marginal increase

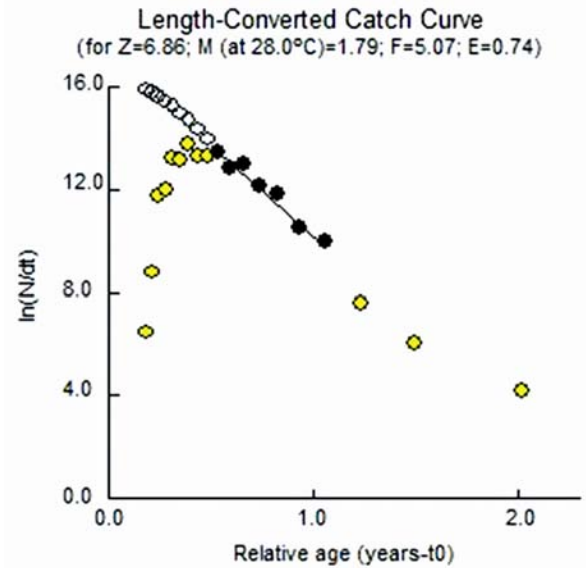


Fig. 4—Mortality of *M. dobsoni* during 2004-07 off Chennai

Table 4—Length cohort analysis of *M. dobsoni*

Lower Limit (length)	Catch in numbers	Numbers in sea	Exploitation rate	Fishing mortality	Total mortality	Average Number in poulation	Average body wt (gms)	Average biomass (kg)	Yield (kg)
36	4.75	153209	0.001	0.00099138	1.790991	4791	0.380613	1823.624	1.80791
41	50.5	144628	0.006	0.01058044	1.80058	4773	0.550338	2626.738	27.79205
46	785.25	136033	0.085	0.16567195	1.955672	4740	0.764419	3623.186	600.2604
51	1500	126764	0.152	0.32066655	2.110667	4678	1.028064	4809.033	1542.096
56	4742	116891	0.369	1.0462033	2.836203	4533	1.346488	6103.063	6385.045
61	4666	104035	0.377	1.08214993	2.87215	4312	1.724918	7437.477	8048.465
66	10889	91651	0.607	2.76953078	4.559531	3932	2.168589	8526.269	23613.76
71	7247	73725	0.539	2.09248814	3.882488	3463	2.682745	9291.262	19441.86
76	7685.25	60278	0.586	2.52866263	4.318663	3039	3.272639	9946.383	25151.05
81	10152.5	47153	0.695	4.08118666	5.871187	2488	3.943527	9810.054	40036.66
86	6092.75	32547	0.637	3.1446936	4.934694	1937	4.700677	9107.42	28640.05
91	7823.25	22987	0.757	5.57644059	7.366441	1403	5.549358	7785.256	43414.02
96	3770.75	12652	0.700	4.1688725	5.958872	905	6.49485	5874.599	24490.45
101	3223.25	7262	0.766	5.86436634	7.654366	550	7.542434	4145.572	24311.15
106	1083.25	3055	0.674	3.69287639	5.482876	293	8.697401	2551.252	9421.46
111	825.75	1447	0.757	5.58556917	7.375569	148	9.965043	1473.195	8228.635
116	107.25	356	0.507	1.84215612	3.632156	58	11.35066	660.8334	1217.358
121	38.75	145	0.378	1.08795179	2.877952	36	12.85955	458.0237	498.3077
126	21.25	43	0.500	1.79	3.58	12	14.49703	172.1017	308.062
Total								96225.34	265378.3

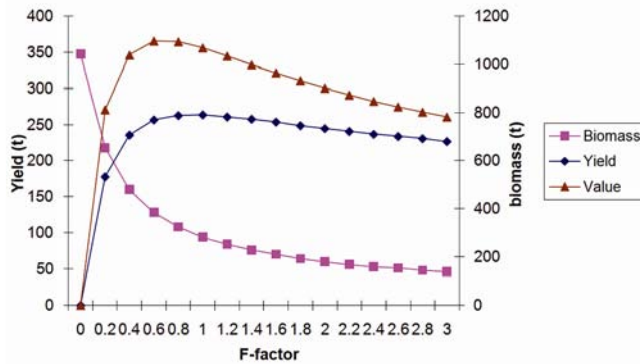


Fig. 5—Thomson and Bell yield prediction of *M. dobsoni* off Chennai

in yield. So in conclusion it can be said that the exploitation of *M. dobsoni*, the dominant penaeid shrimp species in the fishery off Chennai is at MSY level where eventhough the SSB is 20% of  $B_v$ , the fishing effort needs to be reduced by 40% so as to sustain the fishery and generate maximum revenue as MSE is achievable at the F-factor 0.6.

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