GROWTH AND POPULATION DYNAMICS OF THREE PENAEID PRAWNS IN THE TRAWLING GROUNDS OFF KAKINADA

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ABSTRACT

The von Bertalanffy growth parameters L „ , K and t_n in *P. monodon* are estimated to be 357 mm, 1.206 and 0.041, respectively, in females and 296.9 mm, 2.316 and 0.138, respectively, in males. The Instantaneous rates of mortality Z, M and F are 5.13, 2.02 and 3.If in females and 10.58, 2.89 and 7.69 in males. There is thus scope to increase the yield of the species by increasing effort. In *M. monoceros* the values were L_B 216.2 mm, K = 0.996 and t_c = —0.044 in females and L^ = 208.4 mm, K = 0.972 and t_0 = —0.063 in males. The Instantaneous rates of mortality values are Z = 5.49, M = 1.84 and F = 3.65 in females and Z = 7.98, M = 1.81 and F = 6.17 in males, showing that this species also is capable of increasing the yield.

In *M. dobsoni* the values of the growth parameters are: D^ = 140.0 mm, K = 1.69 and $t<_n$ = 0.110 in females and L „ = 117.0 mm, K = 1.89 and t. = 0.115 in males. The mortality rates are: Z = 12.72, M = **3.44 and** F = **9.28** in females and Z = 12.51, M = 2.54 and F = 9.97 in males. The yield per recruit analysis shows that yield increases with increased effort without reaching a maximum.

INTRODUCTION

Breeding of *P. monodon* was studied by Panikkar and Aiyar (1939) from Madras and aspects of biology by Subrahmanyam and Ganapati (1975) from the Godavari estuarine system. Information on some aspects of biology of *M. monoceros* from Cochin (George 1959, 1962; George et al 1969; George and George 1964; Nalini 1976) and from the Godavari estuary (Subrahmanyam 1973) is available. Of *M. dobsoni*, studies on various aspects of biology (Menon 1955, George 1962, Rao 1968, Kurup and Rao 1975, Ramamurthy et al 1978) and mortality rates (Banerji and George 1967, Kurup and Rao 1975, Ramamurthy et al 1978) were made from the west coast of India. But, there is no information on the growth and population dynamics of *P. monodon* and *M. monoceros* from anywhere along the Indian coast and of *M. dobsoni* from the east coast. The following study, on the growth and population dynamics of these three species, is on the basis of the data collected during 1979-1983 from the landings of commercial trawlers at Kakinada.

MATERIAL AND METHODS

Data on effort and catch of prawns were collected for 15-20 days in a month. Boats of three sizes operated in the area. So an effort standardisation was made taking the trawling time of the boat *Pomfret* since the number of boats of this category was the most dominant in the fleet. Data on species composition and biology were collected at weekly intervals. Total length (from tip of rostrum to tip of telson) and individual weight were taken to the nearest mm and mg, respectively. Males and females were treated separately. The data on species composition and length composition collected on each observation day were weighted to the day's and thence to the month's estimates. Growth was studied by the progression of modes in the monthly length-frequency distribution. For different species the modes were connected, keeping in view the growth rates obtained in the culture experiments conducted by the author (unpublished) and those reported by Subrahmanyam (1973 a and b), Subrahmanyam and Ganapati (1975) Banerji and George (1967) and Rao and Raghavulu (1982). It was assumed that the growth in length follows von Bertalanffy growth formula, which is of the form:

Lt = Leo i t-exp f -K ($t-t_c$) 1 I

The values of *L<*>* and K were estimated using the Ford-Walford plot (Ford 1933; Walford 1946) on the basis of the lengths attained at intervals of **two** months. The value of t«$_0$ was estimated by a plot of Log; (La, - Lt) against t. The values of K and t_0 thus obtained were converted into those of per year and year respectively.

The length-weight relationship was calculated using the equation (Le cren 1951):

$$\log W = \log a + b \log L.$$

where 'W is weight in g and 'L' is total length in mm.

Instantaneous rate of total mortality (Z) was estimated for each year following the catch-curve method of Pauly (1983) and the averages of all years were considered. The natural mortality rate (M) was estimated using the relation Z M 4- qf; it was also estimated taking the life-span (Tmax) in the species in the fishery and assuming that 99% by numbers would die by the time they attain Tmax in an unexploited state as was done by Sekharan (1975). The yield in weight per recruit (Yw / R) was calculated using the Beverton and Holt's (1966) equation:

Yw - Y' W„ (1 -Lc)

where Y' - E (l-c)MK/ 3

V Lln(1,,c)n

nK

n - ° '•+ HvT~ (i-E)

wheie E = F/Z; c = Lc/L_w

The value of W« was estimated taking the value of La, and the constants of length-weight relationship. The value of length corresponding to the first point in the descending straight portion of the catch curves was taken as length at first capture (L;)

The total annual stock of a species in the fishing grounds was estimated as Y/U where 'Y' is the average catch during 1979-83 and

U = *JL* (i_e-Z}

ESTIMATION OF GROWTH PARAMETERS

P. monodon

Females: Data collected during 1980-1983 are presented in Fig. 1 and 2. The length range of catch was 52-335 mm.

Mode 'A' at 125 mm in June 1980 is traceable to 155 mm in July and to 205 mm in September. Mode 'B' at 205 mm in July 1980 can be connected to the mode at 235 mm in September. Mode 'C at 145 mm in January 1981 can be taken to have grown to 195 mm in March. Mode 'D' at 265 mm in February 1981 is traceable to 285 mm in April. Mode 'E' at 225 mm in May 1981 can be taken to have grown to 255 **mm in July. Mode** 'F' at **205** mm January 1982 is traceable to 235 mm in March. Mode 'G' at 235 mm in February 1982 can be connected to the mode at 265 mm in April and is further traceable to 275 mm in May. Mode 'H' at 95 mm in March 1982 can be taken to have grown to 155 mm in May and to 205 mm in July. Mode T at 265 mm in July 1982 can be connected to the mode at 285 mm in September 1982. Mode 'J' at 205 mm in September 1982 is traceable to 235 mm in November. Mode 'K' at 205 mm in October 1982 can be taken to have grown to 235 mm in December and to 265 mm in February 1983. Mode 'L' at 225 mm in February 1983 is traceable to 255 mm in April. Mode 'M' at 275 mm in October 1983 can be taken to have grown to 285 mm in November.

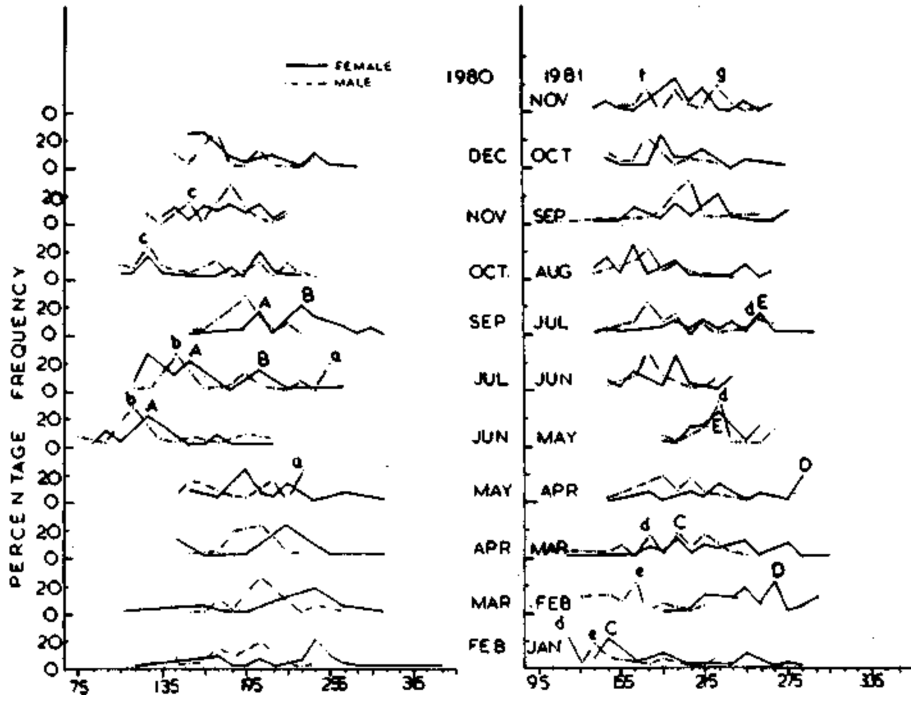

FIG. 1. Monthly length-frequency distribution of *P. monodon* during 1980-81.

The above observations indicate that the monthly growth rates are 30 mm between 95 and 155 mm, 25 mm between 155 mm and 205 mm, 15 mm between 205 mm and 265 mm and 10 mm between 265 mm and 285 mm.

In the backwaters of Kakinada, the length-frequency data (length range 35-95 mm) collected by the author (unpublished) show a monthly growth rate of 30-32 mm. On the basis of this, individuals of the modal length 95 mm (the smallest modal length from which growth could be traced) (Fig. 1 and 2) were taken as 3 months old. Taking this and the constants of Ford-Walford plot (Fig. 3 a) into account, the lengths attained at successive bimonthly intervals were estimated for calculating the value of l_0. The estimated values are shown in Table 1.

Males: (Fig. 1, 2 and. 3 b) Mode 'a' at 235 mm in May 1980 is traceable to 255 mm in July 1980. Mode 'b' at 115 mm in June 1980 can be connected to the mode at 145 mm in July. Mode *'C* at 125 mm in October 1980 can be taken to have grown to 155 mm in November. Mode 'd' at 115 mm in January 1981 is traceable to 175 mm in March, and to 225 mm in May, this is further traceable to 255 mm in July. Mode 'e' at 135 mm in January 1981

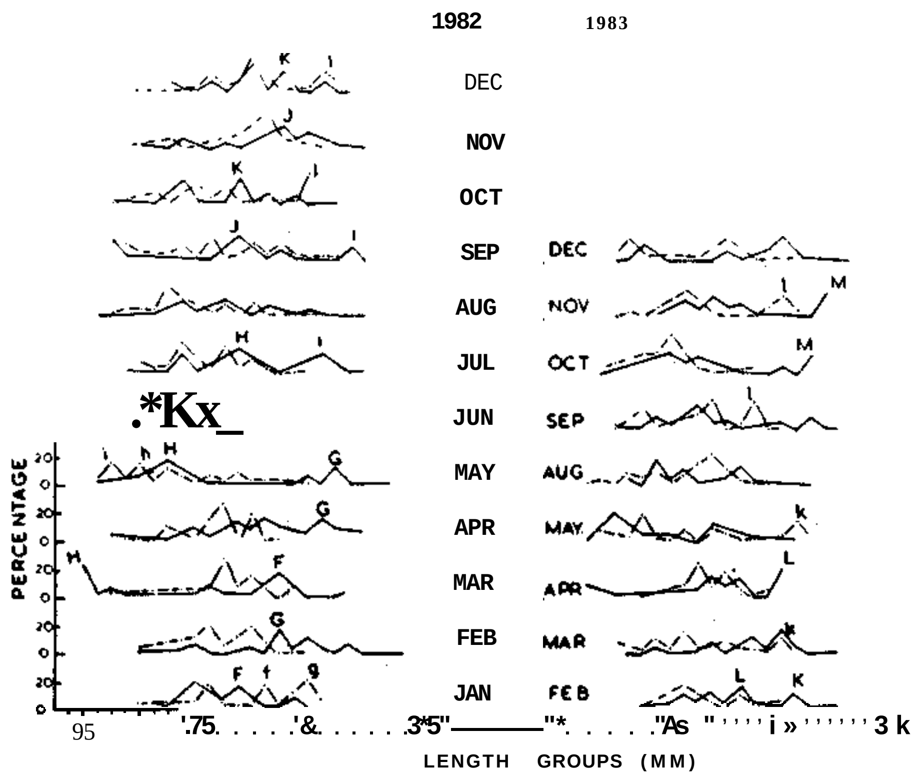

FIG. 2. Monthly length-frequency distribution of *P. monodon* during 1982-83.

can be take* to have grown to 165 mm in February. Mode 'f at 175 mm in November 1981 can be connected to the mode at 225 mm in January 1982. Mode 'g' at 225 mm in November 1981 can be taken to have grown to 255 mm in January 1982. Mode 'h' at 135 mm in May 1982 is traceable to **165** mm in June. Mode 'i' at 115 mm in May 1982 can be connected to a mode at 145 mm in June. Mode 'j' at 255 mm in October 1982 can be taken to have grown to 265 mm in December. Mode 'k' at 255 mm in March 1983 can be connected to a mode at 265 mm in May. Mode 1' at 235 mm in September 1983 is traceable to 255 mm in November.

From the above observations, the growth rates are 30 mm between 115 and 175 mm, 25 mm between 175 and 225 mm, 10-15 mm between 225 and 255 mm, and 5 mm between 255 and 265 mm. Since a growth of 32 mm per month (in the length range 45-115 mm) was observed in the backwaters of Kakinada, the prawns forming a mode at 125 mm can be reasonably taken as 4 months old. The values of different parameters are shown in Table 1.

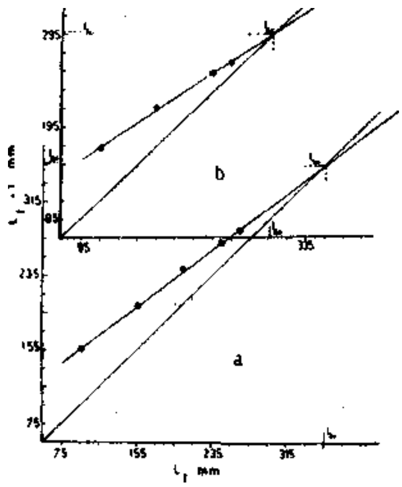

FIG. 3. Ford-Walford plot in *P. monodon.* a. female, b. male.

From the maximum lengths of males and females in the fishery at 287 and 335 mm respectively, the maximum ages (Tmax) were calculated as 1.60 and 2.27 years, respectively.

M. monoceros

The modal progression was traced as in the case of *P. monodon.* Data collected during 1980-1982 are presented in Fig. 4 and 5. The length range of the females and males observed in the fishery was 62-199 mm and 55-192 mm respectively.

Females: Mode 'A' from 102 mm in February 1980 progressed to 137 mm in 3 months; 'B' from 152 mm in February 1980 to 167 mm in 2 months, and

TABLE 1. *von Bertalanffy growth parameters in the three species*

	P. monodon		*M. monoceros*		*M. dobsoni*	
Growth parameters	Female	Male	Female	Male	Female	Male
L_∞ mm	357.0	296.9	216.2	208.4	140.0	117.0
K (per year)	1.206	2.316	0.996	0.972	1.69	1.89
t_0 (year)	0.041	0.138	—0.044	—0.063	0.110	0.150

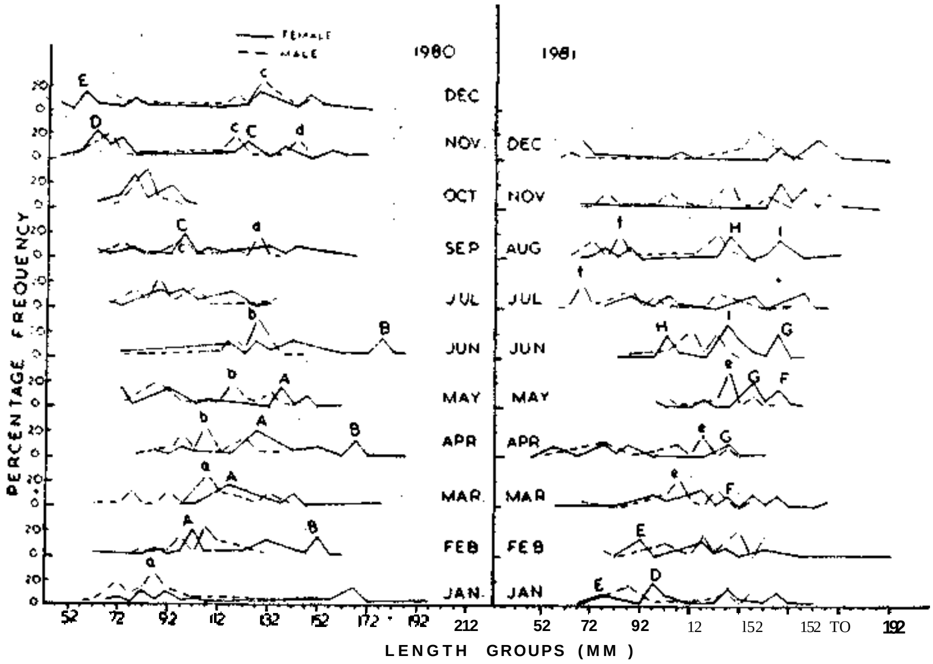

FIG. 4. Monthly length-frequency distribution of *M. monoceros* during 1980-1981.

further to 177 mm in 2 months; 'C from 97 mm in September 1980 to 122 mm in 2 months, 'D' from 62 mm in November 1980 to 97 mm in 2 months; 'E' from 57 mm in December 1980 to 92 mm in 2 months; *F from 127 mm in March 1981 to 147 mm in 2 months; 'G' from 127 mm in April 1981 to 147 mm in 2 months; 'H' from 102 mm in June 1981 to 127 mm in 2 months; T from 127 mm in June 1981 to 147 mm in 2 months; 'J' from 152 mm in January 1982 to 167 mm in 2 months; 'K' from 102 mm in February 1982 to 127 mm in 2 months; 'L' from 127 mm in May 1982 to 147 mm in 2 months; 'M' from 127 mm in July 1982 to 137 mm in one month.

From the above observations, the monthly growth rates are 17.5 mm between 57 mm and 92 mm, 12.5 mm between 102 mm and 127 mm, 10 mm between 127 mm and 147 mm, 7.5 mm between 152 mm and 167 mm and 5 mm between 167 mm and 177 mm.

Males: Mode 'a' was traced from 87 mm in January 1980 to 107 mm in 2 months; 'b' from 107 mm in April 1980 to 127 mm in 2 months; 'c' from 97 mm in September 1980 to 127 mm in 3 months; 'd' from 127 mm in September 1980 to 142 mm in 2 months; 'e' from 107 mm in March 1981 to 127 mm in 2 months, T from 67 mm in July 1981 to 82 mm in a month; 'g' from 107 mm

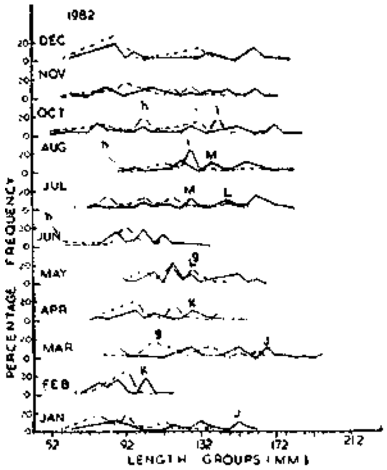

FIG. 5. Monthly length-frequency distribution of *M. monoceros* in 1982.

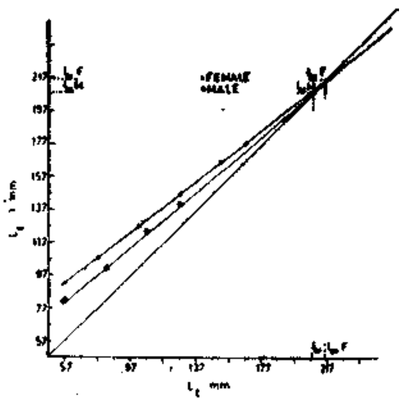

FIG. 6. Ford-Walford plot in *M. monoceros.*

in March 1982 to 127 mm in 2 months; 'h' from 52 mm in June 1982 to 82 mm in 2 months and further to 102 mm in 2 months; 'i' from 127 mm in August 1982 to 142 mm in 2 months.

From the above observations, the monthly growth rates are 15 mm between 52 mm and 82 mm, 10 mm between 82 ram and 127 mm and 7.5 mm between 127 mm and 142 mm. Using the above monthly growth rates and by making the Ford-Walford plot (Fig. 6) the values of L» and K for females and males were estimated as 216.2 mm, 0.0830 per month, and 208.4 mm, 0.810 per month respectively.

In the backwaters of Kakinada, the length-frequency data colltcted by the author (unpublished) show a monthly growth rate of 15 to 18 mm (length range examined 30-50 mm) in females and 16.0-17.5 mm (length range 37-67 mm) in males. On the basis of this, females of the modal length 57 mm was taken as 4 months old and males of 52 mm as 3.3 months old. The lengths at intervals of 2 months were calculated using the constants of Ford-Walford plot (Fig. 6). The estimated parameter values are shown in Table 1.

On the basis of the maximum lengths of males and females in the fishery, the life-spans in the fishing grounds (Tmax) are calculated as 2.50 and 2.54 years respectively.

M. dobsoni

The data collected during 1979-1982 are presented in Fig. 7 and 8. The length of males and females ranged from 51 to 112 mm and from 47 to 122 mm respectively.

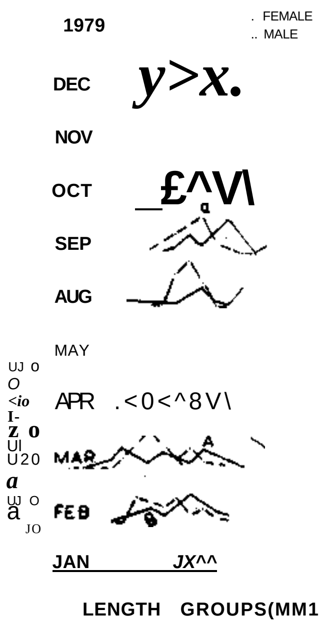

FIG. 7. Monthly length-frequency distribution of *M. dobsoni* in 1979.

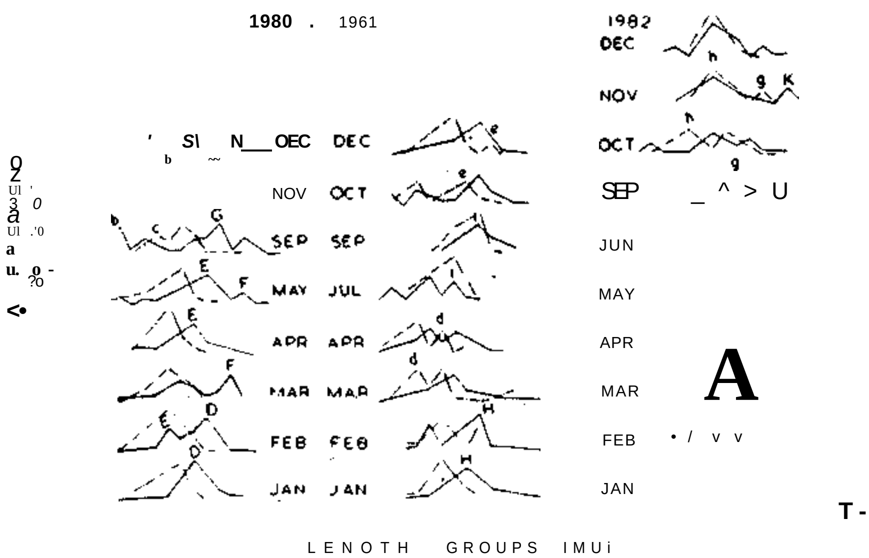

FIG. 8. Monthly length-frequency distribution of *M. dobsoni* during 1980-82.

Females: Mode 'A' from 77 mm in January 1979 progressed to 92 mm in 3 months; 'B' from 67 mm in February 1979 to 77 mm in 2 months; 'C from 77 mm in October 1979 to 87 mm in 2 months; 'D' from 87 mm in January 1980 to 92 mm in 1 month; 'E' from 77 mm in February 1980 to 87 mm in 2 months and to 92 mm in another month; 'F from 102 mm in Marsh 1980 to 107 mm in 2 months; 'G' from 97 mm in September 1980 to 102 mm in 2 months; 'H' from 87 mm in January 1981 to 92 mm in February 1981; T from 8T mm in July 1981 to 92 mm in 2 months; 'J' from 77 mm in January 1982 to 87 mm in 2 months, 'K' from 102 mm in September 1982 to 107 mm in 2 months.

From the foregoing observations, the growth rates are 5 mm per month between 67 mm and 92 mm and 2.5 mm per month between 97 mm and 107 mm.

Males: Mode 'a' progressed from 87 mm in September 1979 to 97 mm in 2 months; 'b' from 57 mm in September 1980 to 77 mm in 2 months; 'c' from 72 mm in September 1980 to 87 mm in 2 months; 'd' from 67 mm in March 1981 to 77 mm in April; 'e' from 87 mm in October 1981 to 97 mm in 2 months; T from 72 mm in January 1982 to 87 mm in 2 months; 'g' from 87 mm in September 1982 to 97 mm in 2 months; 'h' from 67 mm in October 1982 to 77 mm in November 1982.

From the above observations, the monthly growth rates are 10 mm between 57 mm and 77 mm, 7.5 mm between 72 mm and 87 mm, and 5 mm between 87 mm and 97 mm. Usui;; the above monthly growth rates in females and males and by making the Ford Walford plot (Fig. 9 a and b), the values of Li and K for females were estimated as 140.0 mm and 0.1406 per month, and 117.0 mm and 0.1575 per month in males respectively (Table 1). As the growth is faster in the younger stages, the age of 67 mm female prawn can be taken as 5.6 months, and the age of 57 mm male prawn as 5.6 months. The t_0 was estimated as 1.324 months in females and 1.805 months in males.

The maximum lengths (Lmix) of male and female in the fishery were 112 and 122 mm respectively. The age ($T_m$ax) of these prawns is estimated as 1.80 and 1.33 years respectively.

LENGTH-WEIGHT RELATIONSHIP

The values of slopes and elevations of the regressions of males and females of *P. monodon, M. monoeros* and *M. dobsoni* are presented in Table 2.

ESTIMATION OF MORTALITY RATES

Total mortality (Z): /'. *monodon:* (Fig. 10). In each year the total mortality rate of males is greater than that of females. The averages **for females and** males were estimated at 5.13 and 10.58 respectively (Table 3). *M. monoceros* (Fig. 11): the average 'Z' for males

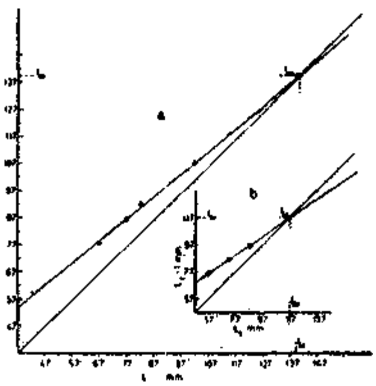

FIG. 9. Ford-Welford plot in *M. dobsoni* a. female, b. male.

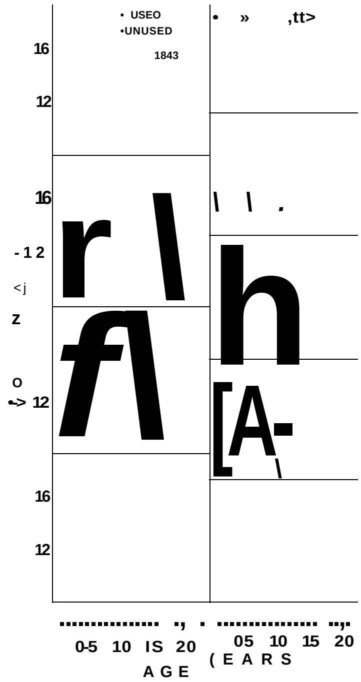

FIG. 10. *P. monodon:* Estimation of 'Z* by catch curve method of Pauly (1983).

TABLE 2. *The values of elevation* (a) *and slope* (b) *of the length-weight relationship in males and females of the three species. {The value of coefficient of determination* (r^2) *in each case is also shown).*

Sex	N	Length range mm	Log a	b	f^2
			P. monodon		
F	95	68-335	—12.0237	3.25	0.99
M	95	68-287	—10.1266 •	3.19	0.99
			M. monoceros		
F	85	62-194	—9.7211	2.56	0.99
M	100	55.I8O	—8.6797	2.30	0.99
			M. dobsoni		
F	105	47.-120	—7.9490	2.19	0.97
M	85	51409	—10.96	2.88	0.98

TABLE 3. *Estimated values of mortality rates in the three species.*

	Total Mortality rates in					
	Females			Males		
Year	1	2	3	1	2	3
1979	—	7.850	10.345	10.597	8.818	13.076
1980	6.000	4.753	10.874	14.419	3.808	13.950
1981	4.700	4.057	17.025	7.511	10.038	15.746
1982	4.800	5.533	13.216	10.646	8.069	12.291
1983	5.000	5.290	12.164	9.752	9.155	7.464
Average	5.12	5.49	12.72	10.58	7.98	12.51
Natural mortality rate (M)	2.02	1.84	3.44	2.89	1.81	2.54
Fishing mortality rate (F)	3.11	3.65	9.28	7.69	6.17	9.97

1. *P. monodon,* 2. *M. monoceros,* 3. *M. dobsoni*

and females were estimated at 7.98 and 5.49 respectively. In this species also, 'Z' was higher in males than in females, except in 1980; however, the average value of 'Z' in males is greater than in females (Table 3). *M. dobsoni* (Fig. 12): the average 'Z' values for females and males were estimated at 12.72 and 12.50 respectively. The 'Z' values of males were observed to be greater than those of females during 1979 and 1980, but the reverse was true during 1981-1983.

Natural mortality rate (M): Plots of Z values of males and females of the three species against effort showed either that there was no good correlation between them or that the estimated values were negative, indicating that the 'M' values thus obtained are unrealistic. Hence, the 'M' values obtained taking the life-span into account were considered (Table 3).

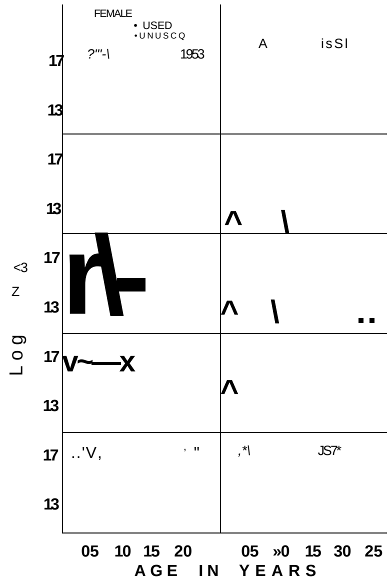

FIG. 11. *M. monoceros:* Estimation of *Z' by catch curve method of Pauly (1983).

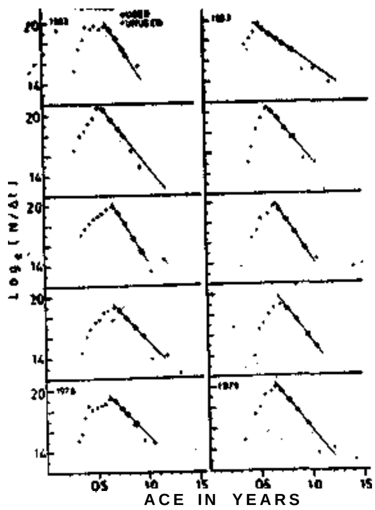

FIG. 12. *M. dobsoni:* Estimation of 'Z' by catch curve method of Pauly (1983).

ESTIMATION OF YIELD PER RECRUIT

P. monodon: Yield in weight per recruit as a function of exploitation ratio (Fig. 13A, a) shows that in both the sexes it increases and reaches a maximum when E is 0.90 and declines slowly with further increase in E. The yield per recruit as a function of c (Fig. 13 B, b) shows that it increases and reaches a maximum in males when c is 0.66 and in females when c is 0.60. Further increase in c results in a decline in the yield. Present E and c respectively are 0.615 and 0.579 in males, 0.726 and 0.527 in females. In both the sexes thus, while there is considerable scope for increasing yield by increasing E, further increase in c (Under the present E) is not likely to result in increased yield.

M. monoceros: The yield per recruit analysis in this species shows (Fig. 13 A, c) that the yield increases with increased E: it reaches a maximum when E is 0.95 in females and 0.85 in males; the present values of E are 0.66 and 0.77 respectively, thus indicating that yield can be increased by increasing the effort. In males, however, the values of E at which Ytmx is obtained is only slightly greater than the present E. The yield per recruit as a function of c (Fig. 13 B, d) taking the present E into account shows that it increases and reaches a maximum when c is 0.58 in females and 0.60 in males. The present values of c are 0.45 and 0.42 in females and males respectively. Thus it is possible to increase the yield of this species without increasing the effort, by increasing the selection length (i.e. by increasing the codend mesh size).

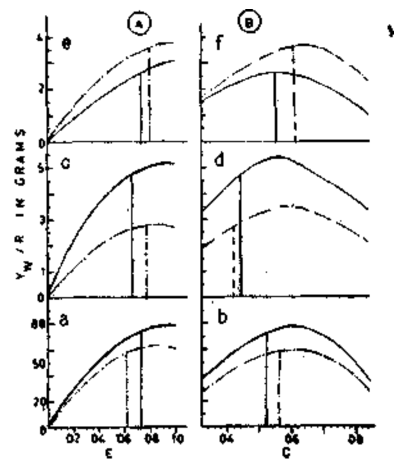

FIG. 13. Yield in weight per recruit as a function of A. exploitation rate (E) in (a) *P. monodon* c. *M. monoceros* e. *M. dobsoni;* B. relative selection size (c) in b) *P. monodon,* d) *M. monoceros* and f) *M. dobsoni,* complete line indicates female, incomplete male; vertical lines show the present E or C.

In M. *dobsoni* (Fig. 13 A, e) the yield per recruit in both the sexes increases with increased E without reaching a maximum. It may be noted (Fig. 13 A, e) that the present values of E in females and males are 0.73 and 0.80 respectively. It is also clear that these values are close to the maximum possible value (i.e. 1.0) since the value of F/Z cannot be more than unity. The yield mesh curves (under the present E) (Fig. 13 B, f) show that the Y_w/R increases and reaches a maximum when c is 0.56 in females and 0.66 in males; further increase in c results in decreased Y_w/R, the curves also show that the present values of c (0.55 in female 0.61 in males) are close to the value of c at which Ymax is obtained.

ESTIMATION OF STOCK SIZE

The estimated values of the relevant parameters (Tables 4 & 5) in all the three species show that the present rate of exploitation has not adversely affected the stocks. It is also clear, particularly from the values of U, that further increase in the effort may result only in a marginal increase in the yield.

DISCUSSION

A survey of literature shows that there is no information pertaining to the growth parameters of penaeid prawns studied from India except of *M. dobsoni*. In *P. monodon* from Indonesia, Badruddin (1977) estimated the growth parameters but apparently assumed the growth rate to be the same in the sexes.

TABLE 4. *Estimated catches (Kg) and percentages of males and females of the three species during* 1979-1983.

	Standard		*P. monodon*		*M. monoceros*			*M. dobsoni*		
	effort	Total	**Percentage** of		Total	**Percentage of**		**Total**	**Percentage of**	
Year	(hours)	catch	Females	Males	catch	Females	Males	catch	Females	Males
1979	401549	88759	52.3	47.7	212644	55.9	44.1	246942	47.2	52.6
1980	323727	156985	54.6	45.6	306947	59.8	40.2	253147	46.4	53.6
1981	377782	192155	55.0	45.0	322110	62.7	37.3	401484	67.9	32.1
1982	378142	202208	50.2	49.8	681564	93.4	6.6	775329	60.2	39.8
1983	324774	164887	53.5	46.5	1029310	61.6	38.4	738630	68.4	31.6
Average	361195	160999			510515			483106		

TABLE 5. *Exploitation rate* (U), *estimated average catch in tonnes* (Y), *annual standing stock* (Y|U) *and average standing crop* (Y|F) *in the three species.*

Sex	Y	U	Y|U	Y|F
		P. monodon		
Males	75.5	0.7262	103.9	9.8
Females	85.5	0.5897	145.0	27.5
Total	161.0	. —	248.9	37.3
		M. monoceros		
Males	155.5	0.7716	201.5	25.2
Females	355.0	0.6481	547.7	97.3
Total	510.5	—	749.2	122.5
		M. dobsoni		
Males	185.8	0.7964	233.3	18.6
Females	297.2	0.7289	407.8	32.0
Total	483.0	—	641.1	50.6

In the case of *M. dobsoni*, Banerji and George (1967) studied the growth from Cochin and estimated the parameters by pooling the data of sexes (Table 6). Kurup and Rao (1975) and Ramamurthy et al (1978) estimated the parameters of growth from Ambalapuzha and Mangalore* respectively (Table 6). The values of K obtained by these authors (Table 6) show that, whereas there is almost no difference between males and females from Ambalapuzha, there is considerable difference along Mangalore coast in the rate at which they attain the asymptote, indicating females grow faster. The present study, however, shows (Table 6) that along Kakinada coast males grow faster. The estimated values of K (Table 1) in *P. monodon* and M. *monoceros* from Kakinada indicate that males attain the asymptotic length faster than females in the former whereas in the latter there is almost no difference in the rate at which males and females attain the asymptotic length. The available information on growth of penaeid prawns of India thus shows that

1) the faster growing sex is not the same in all the species,
2) even within a particular species, the faster growing sex is not the same in different localities,
3) there is difference in growth rate between sexes in a particular species in a particular locality whereas there is no difference in growth rate in the same species from a different locality.

The values of 'Z' estimated by different authors in *M. dobsoni* are given in table 6. Banerji and George (1967) obtained two values by following two methods as 4.04 and 3.56, which according to them were "not very different" (p. 647). As in the case of growth studies, here also these authors have pooled the data of males and females. Kurup and Rao (1975) estimated Z as 3.1 in females and 3.8 in males and Ramamurthy et al (1978) estimated the same as 4.61 and 4.18 respectively. The estimated values of Z in the present study (Table 6) are very much higher than those obtained by the above authors. Banerji and George (1967) have clearly stated that the estimated values of Z could be taken to represent M because "fishing has only just started" (p. 648) in the area. Kurup and Rao (1975) and Ramamurthy et al (1978) did not estimate M. Hence, considering the growth parameters estimated by these authors and following the same method as followed in the present work, the values of 'M' were estimated by the present author (Table 6) (Data on Lnmx are not available from Mangalore, hence 95% of asymptotic length obtained by Ramamurthy et al 1978 was taken as Lmax). The values of M thus obtained for the population in the Ambalapuzha area are more or less close to the Z values esti-

Though Ramamurthy et al (1978) did not mention the units of time considered in estimating growth parameters, the values of K. and *K* appear to be based on monthly growth. Hence the values were converted into those of per year and year (See table 6).

TABLE 6. *Growth parameters and mortality rates of* M. dobsoni *from different localities.*

Locality	Source	Sex	Lmax[1] mm	•max years	L_∞ (mm)	K (per year)	t_0 (years)	Z	M	F
				Parameters of growth				Mortality rates		
Ambalapuzha	Kurup and Rao (1975)	F	121	1.21	144.6	1.536	0.328	3.1	*3.79	
		M	110	1.34	128.9	1.5216	0.0805	3.8	*3.43	0.38
Mangalore	Ramamurthy et al (1978)	F	115	1.73	120.9	2.16	0.335	4.61	*2.66	1.94
		M	103	2.05	109.1	1.44	0.047	4.18	*2.24	1.94
Kakinada	Present study	F	122	1.33	140.0	1.69	0.110	12.7	3.4	9.3
		M	112	1.80	117.0	1.89	0.150	12.5	2.5	10.0
Cochin	**Banerji and George (1967)		130	—	118.31	1.68	—	4.04	3.56	—

Maximum length observed in the fishery by the authors except in the case of Ramamurthy et al, where it refers to 95% of asymptotic length.

Values estimated by the present author.

the authors did not treat the data of sexes separately; the values of Z given were obtained by two methods.

mated by the authors (though the value of M for females is greater than that of Z); in this area also "trawling for prawns in the offshore fishing grounds .... has also been introduced" recently (Kurup and Rao 1975, p. 184). Hence, the Z values obtained by Kurup and Rao (1975) can be reasonably taken to represent M. In the Mangalore area Ramamurthy et al (1978) used the data from trawlers pertaining to the period 1962-1971; the value of F derived (Table 6) is very low. It s clear that at this centre also the data were collected during a period when trawling had just started. The values of M obtained in the present study are comparable to those obtained from Ambalapuzha and Mangalore. Hence, the high values of Z from KaTcinada can only be due to high fishing mortality. This is reasonable because the data pertain to the period 1979-1983 and trawling is carried out almost exclusively to catch prawns (Sudhakara Rao et al 1980).

It is known that estimation of M of a particular species in a multispecies fishery using the regression of Z against effort is difficult (Pauly 1983), because apportioning the effort on a per-species basis is not possible. It is obviously for this reason that the regressions of Z of the three species under consideration against effort showed poor correlation or resulted in negative values of M. Hence the value of M was estimated taking the life-span of the species into account, though information on the life-span of the species when the population was not exploited is not available. The estimated values, however, can still be taken as realistic because the M values of *M. dobsoni* from Kakinada are comparable to those of the same species from the west coast of India (vide supra). It may be mentioned in this connection that according to Cushing (1981, p. 141)" a precise separation of fishing and natural mortality remains inaccessible and yet is one of the central problems of fisheries research".

The yield per recruit analysis in both the sexes of the three species shows that increased yield can be obtained by increasing E in *P. monodon;* in *M. monoceros,* though there is scope to get increased yield by increasing E, the present E in the case of males is only slightly less than the one at which Ymx is obtained; in the case of *M. dobsoni,* though the yield per recruit does not attain a maximum and then show a fall with increased E, there is not much of a scope to increase E further because the present E is close to unity and F/Z value cannot be more than unity.

The yield mesh curves (Fig. 13, B) show that whereas increase in the selection length of *M. monoceros* may result in increased yield, there is not much of a scope to get increased yield by increasing c in the other two species.

It is thus clear that the considerations for the management of the resources of these three species cannot be the same. This need not be taken as a surprise, as a situation like this will normally occur in multispecies fisheries exploiting species having different growth and natural mortality rates. It may be argued that a study such as the present one is an exercise in futility but it may be stressed that attempts such as the present one on several other species also would help in taking meaningful decisions for management of multispecies fisheries.

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