

**SOME ASPECT OF POPULATION DYNAMICS OF THREE PENAEID SHRIMPS (*PENAEUS MONODON*, *PENAEUS SEMISULCATUS* AND *METAPENAEUS MONOCEROS*) FROM THE BAY OF BENGAL, BANGLADESH**

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**ABSTRACT**

In the Bay of Bengal of Bangladesh area the values of asymptotic length ( $L_{\infty}$ ) for tiger shrimp (*Penaeus monodon*), green tiger shrimp (*Penaeus semisulcatus*) and brown shrimp (*Metapenaeus monoceros*) were found to be 30.0 cm, 23.5 cm and 16.5 cm for male and 32.1 cm, 27.0 cm, and 19.4 cm for female respectively while the growth co-efficient (K) were 0.94, 0.80 and 1.5 year<sup>-1</sup> for male and 0.97, 0.90 and 1.52 year<sup>-1</sup> for female respectively. The length growth performance index ( $\phi'$ ) of the Pauly and Munro's function were in the range of 2.61- 3.00. Natural mortality, fishing mortality and total mortality for tiger, green and brown shrimps were in the range of 1.72-2.75, 2.13-3.94 and 3.85-6.59 respectively. Length frequency data analysis through FiSAT programme reveals that the studied three species were under fishing pressure. Spawning months appeared to be from April to July for main cohort. The recruitment pattern of the penaeid stocks suggested one main pulse of annual recruitment and current exploitation rate were in the range of 0.553-0.667.

বাংলাদেশের বঙ্গোপসাগর এলাকার বাগদা চিংড়ি (Tiger shrimp, *P. monodon*), সবুজ বাগদা চিংড়ি (Green tiger shrimp, *P. semisulcatus*) এবং বাদামী চিংড়ি (Brown shrimp, *M. monoceros*) এর পুরুষ প্রজাতির asymptotic length ( $\infty$ ) এর মান ব্যাপ্তি ছিল যথাক্রমে ৩০.০ সে.মি., ২৩.৫ সে.মি. এবং ১৬.৫ সে.মি. এবং স্ত্রী প্রজাতির মান ব্যাপ্তি ছিল যথাক্রমে ৩২.১ সে.মি., ২৭.০ সে.মি. এবং ১৯.৪ সে.মি.। বাগদা চিংড়ি (Tiger shrimp), সবুজ বাগদা চিংড়ি (Green tiger shrimp) এবং বাদামী চিংড়ি (Brown shrimp) এর পুরুষ প্রজাতির বৃদ্ধি সহগ (Growth co-efficient-K) এর মান ব্যাপ্তি ছিল যথাক্রমে ০.৯৪, ০.৮০ এবং ১.৫/বছর এবং স্ত্রী প্রজাতির মান ব্যাপ্তি ছিল যথাক্রমে ০.৯৭, ০.৯০ এবং ১.৫২/বছর। Pauly এবং Munro এর দৈর্ঘ্য বৃদ্ধির মাসের সূচক ( $\phi'$ ) এর ব্যাপ্তি ছিল ২.৬১-৩.০০। বাগদা, সবুজ বাগদা এবং বাদামী চিংড়ির প্রাকৃতিক মৃত্যু হার, আহরণজনিত মৃত্যু হার এবং মোট মৃত্যু হার ছিল যথাক্রমে ১.৭২-২.৭৫, ২.১৩-৩.৯৪ এবং ৩.৮৫-৬.৫৯। FiSAT programme দ্বারা দৈর্ঘ্য ফ্রিকোয়েন্সী ভাটা বিশ্লেষণে দেখা গিয়েছে তিনটি প্রজাতিই ফিশিং প্রেসার এ আছে। প্রধান কোহোর্টের প্রজনন মাস এপ্রিল থেকে জুলাই দেখা গিয়েছে। Penaeid ষ্টকের প্রবেশন এর ধরণ থেকে বুঝা যায় স্বৎসরে এদের প্রধানত একবার প্রবেশন ঘটে এবং বর্তমান আহরণের হার এর ব্যাপ্তি ০.৫৫৩-০.৬৬৭।

**INTRODUCTION**

Several authors have indicated the existence of a rich population of penaeid shrimps in the Bay of Bengal and a series of surveys carried out by both national and international agencies [1]. From these surveys [2-14] various standing stock and potential yield estimates have been made.

For conservation and sustainable exploitation of the shrimps, scientific management based on population dynamics study is the most important issue. Proper management and utilisation of shrimp resources in developing countries are suffering for the lack of appropriate information on natural and fishing mortality. Among the shrimp species studied tiger shrimp, green tiger shrimp and brown shrimp contributed about 75% of the trawl catch [15].

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In the present investigation three commercially important shrimps (*Penaeus monodon*, *Penaeus semisulcatus* and *Metapenaeus monoceros*) from the trawl catch fishery of the Bay of Bengal of Bangladesh area were considered for the study of the following parameters:

Asymptotic length ( $L_{\infty}$ ), growth co-efficient (K), natural mortality (M), fishing mortality (F), total mortality (Z), recruitment pattern, length at first capture ( $L_c$ ), relative yield-per-recruit, stock prediction (Thompson and Bell method), length weight relationship and biological sustainable management.

#### MATERIALS AND METHODS

The study was conducted from April 1995 to March 1997. Length-frequency and length-weight data were collected for present study from commercial shrimp trawlers immediately after return from trips and also research vessel R. V. Anusandhani, fished within the continental shelf of Bangladesh. Gears used were a pair shrimp trawl of the same size and were operated from out riggers. The mesh size of cod end was 45mm. Trawling depth varying from 20m to 90m. Total length (from the tip of the rostrum to the tip of the telson) of the 1907 *Penaeus monodon* male, 2286 *P. monodon* female, 764 *P. semisulcatus* male, 637 *P. semisulcatus* female, 17781 *Metapenaeus monoceros* male and 21066 *M. monoceros* female shrimps were measured at one centimeter intervals with the help of a centimeter scale by placing the shrimp dorso-ventrally on the measuring board immediately after the catch as well as in the landing center at Chittagong port. Male and female sexes were measured separately. Sampling was done fortnightly and all length-frequency data for each month were pooled and pooled data were entered in computer and analysed through FiSAT programme [16].

#### RESULTS AND DISCUSSION

Population growth parameters ( $L_{\infty}$ , K and Z/K), mortality, selectivity, recruitment and length-weight relationship) of three shrimps (*P. monodon*, *P. semisulcatus* and *M. monoceros*) estimated by different methods [16-19] are given in Table-1. The set of estimates obtained by different methods were found to be comparatively close. Back calculation of growth curve revealed that approximate spawning month appeared for studied shrimps was during April to July for main cohort and September to January for secondary cohort. Variation in the growth coefficient was observed between male and female, and female species showed higher growth coefficient than male. On the basis of constant juvenile and adult growth rate it was found that the tiger shrimp reached 17.0 to 18.5 cm within one year and 25.0 to 27.0 cm in the following year, the green tiger shrimp reached 13.0 to 16.0 cm within one year and 18.5 to 22.5 cm in the following year and the brown shrimp reached 12.0 to 14.5 cm within one year and 16.0 to 19.0 cm in the following year. Faster growth was observed in 1<sup>st</sup> year. Maximum yield could be attained by selecting capture (length) within a year. *P. monodon* and *P. semisulcatus* showed very slower growth coefficient in the third year. The growth performances ( $\phi'$ ) of the male and female *P. monodon*, *P. semisulcatus* and *M. monoceros* were found to be 2.927 and 3.00, 2.645 and 2.817, and 2.611 and 2.757 respectively.

The natural mortality of the male species of *P. monodon*, *P. semisulcatus* and *M. monoceros* were found to be 1.72, 1.73, 2.75, while for female of the same species were 1.72, 1.72 and 2.65 respectively. Simultaneously the fishing mortality of the male species of *P. monodon*, *P. semisulcatus* and *M. monoceros* were found to be 3.33, 3.47 and 3.58, while for the females of the same species were 2.13,

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2.98 and 3.94 respectively (Table 1). The selection pattern ( $L_{50}$ ) of the male species of *P. monodon*, *P. semisulcatus* and *M. monoceros* were found to be 19.79, 15.88 and 9.29 while for the female of the same species were 22.79, 19.86 and 10.72 respectively. Wide variations were observed for different values of  $L_{\infty}$  for different selected species. The exponent value (b) of length-weight relationship of the male species of *P. monodon*, *P. semisulcatus* and *M. monoceros* were found to be 2.82, 2.895 and 2.522, while for the females of the same species were 2.88, 2.921 and 2.661 respectively. Major peaks of recruitment for the tiger shrimp, green tiger shrimp and Brown shrimp were during August to September, June to August and September to October respectively. The recruitment patterns of the three studied shrimp stocks in the Bay of Bengal of Bangladesh waters suggested only one main pulse of annual recruitment and this was supported by the results of catch rate analysis [20]. It is therefore concluded from the recruitment pattern that peak recruitment for the three studied shrimps were appeared during May to September and highly concentrated during July to September.

TABLE 1 : GROWTH PARAMETERS AND GROWTH INDEX SUMMARY RESULTS OF MALE AND FEMALE *P. MONODON*, *P. SEMISULCATUS* AND *M. MONOCEROS*.

Name of species	BLEFAN I		Powell-Wetherall plot		Mortality			Lc	Recruitment		Length-weight relationship	
	$L_{\infty}$	K	$L_{\infty}$	Z/K	M	F	Z		$L_{50}$	Lean	Peak	Intercept
<i>P. monodon</i> male	30.0	0.94	31.34	6.26	1.72	3.33	5.05	19.79	Apr-May	Aug-Sep	0.001	2.82
<i>P. monodon</i> female	32.1	0.97	32.21	4.02	1.72	2.13	3.85	22.79	Apr-May	Aug-Sep	0.002	2.88
<i>P. semisulcatus</i> male	23.5	0.80	23.22	4.68	1.73	3.47	5.20	15.88	-	Jun-Aug	0.0116	2.895
<i>P. semisulcatus</i> female	27.0	0.90	27.21	5.37	1.72	2.98	4.70	19.86	-	Jun-Aug	0.01102	2.921
<i>M. monoceros</i> male	16.5	1.50	16.16	3.87	2.75	3.58	6.43	9.29	May-Jun	Sep-Oct	0.0258	2.522
<i>M. monoceros</i> female	19.4	1.52	19.33	3.62	2.65	3.94	6.59	10.92	May-Jun	Sep-Oct	0.02071	2.661

**Exploitation and yield per recruit**

It was found that tiger shrimp (*P. monodon*), green tiger shrimp (*P. semisulcatus*) and brown shrimp (*M. monoceros*) were over exploited [21] in the Bay of Bengal ( $E = 0.628 \pm 0.0438$ ,  $E > 0.5$ ).

The yield per recruit analysis with different selectivity revealed that a change in selection was likely to produce a higher yield for shrimps. Change in selection to  $L_{25}$  level for *P. monodon* and *P. semisulcatus* could provide a better yield of shrimps.

***P. monodon***

*P. monodon* attained its maximum size of biomass (standing stock) at maximum relative yield per recruit ( $E=0.60$  for male,  $E=0.65$  for female) when for the potential yield per recruit the length of first capture ( $L_c$ ) were 19.79 cm for male and 22.79 for female.

***M. monoceros***

The maximum values of relative yield per recruit were obtained at  $E=0.626$  for male and  $E=0.615$  for female and for this potential yield per-recruit the lengths of first capture ( $L_c$ ) were 9.298 cm for male and 10.92 cm for female when the biomass (standing stock) attained its maximum size.

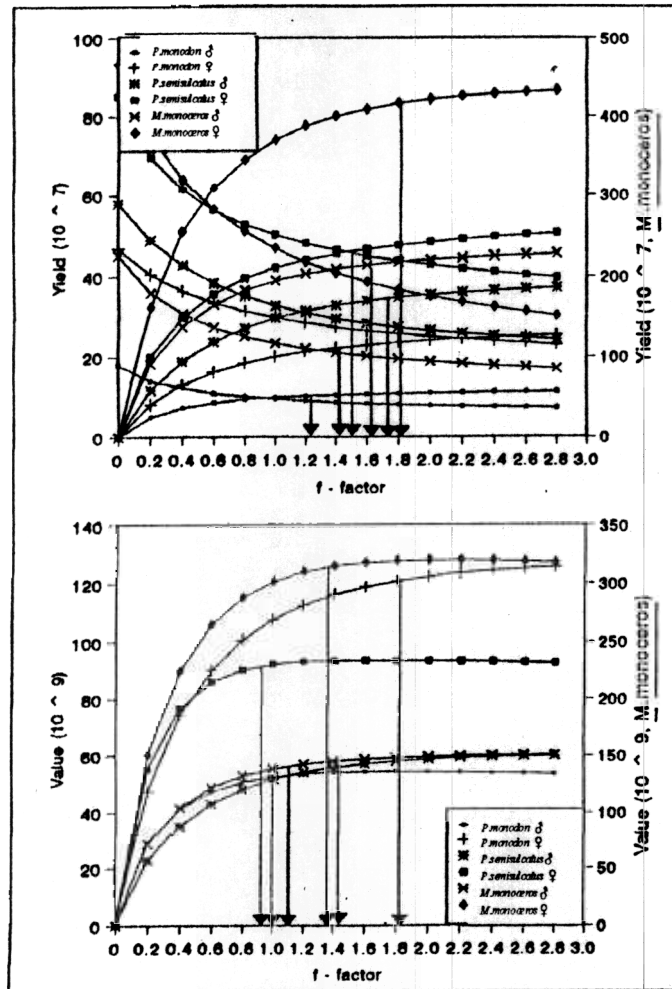


Fig.1. Estimation of yield, biomass and value of *P. monodon* male, *P. monodon* female, *P. semisulcatus* male, *P. semisulcatus* female, *M. monoceros* male, and *M. monoceros* female based on Thompson and Bell methods.

***P. semisulcatus***

The maximum values of relative yield per recruit were  $E=0.572$  for male and  $E=0.597$  for female when the lengths of first capture were  $L_c=15.88$  cm for male and  $L_c=19.86$  cm for female at which the biomass (standing stock) attained its maximum size.

It appears that yield per recruit for shrimps have generally swinging between Maximum Sustainable Yield (MSY) and over exploitation. These result indicate that the exploitation rate of studied species have been above the optimum exploitation level.

### Yield, biomass and value prediction

Using the results of Jones' length cohort analysis in the (length converted) Thompson and Bell [22] model current size of stock biomass, potential yield and values were analysed. Figure 1 presents the values of yield, biomass and values at different levels of fishing efforts for *P. monodon*, *P. semisulcatus* and *M. monoceros*. The present level of fishing mortality was 3.33 for *P. monodon* male, 2.13 for *P. monodon* female, 3.47 for *P. semisulcatus* male, 2.98 for *P. semisulcatus* female, 3.58 for *M. monoceros* male and 3.94 for *M. monoceros* female. The exploitation rates were 0.659 and 0.553 for *P. monodon* male and female, 0.667 and 0.634 for *P. semisulcatus* male and female, 0.572 and 0.597 for *M. monoceros* male and female respectively. The maximum sustainable yield of *P. monodon*, *P. semisulcatus* and *M. monoceros* could be attained for an F-factor 1.6, 1.5 and 2.0 respectively and average fishing mortality have to be reduced by 46.85%.

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