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Some Aspects of Population Dynamics of *Exopalaemon styliferus* from Bangladesh Coast

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Elefan I and Elefan II were used to estimate population parameters in *Exopalaemon styliferus* from length-frequency data collected from Kutubdia channel of Bangladesh Coast. The L_∞ and K were 11.21 cm and 2.20 per year respectively. The annual rate of natural mortality, fishing and total mortality were 3.94, 4.57 and 8.57, respectively. The rate of exploitation (E) was 0.54. The mean length at first capture (Lc) was estimated as 6.276 cm. The shrimp was recruited in the fishery during March-May and July-October. Peak recruitment took place during April and September. Emax was found 0.859. This study shows some over fishing of *Exopalaemon styliferus* (E> 0.50) in the Kutubdia Channel of Bangladesh coastal water. The length-weight relationship ($W=0.00359TL^{3.184}$) was studied. The asymptotic weight was calculated as 7.889g.

Key words. Population dynamics, *Exopalaemon styliferus*, Kutubdia Channel, Bangladesh coast.

Introduction

A number of species of prawns are available in Bangladesh and to date eleven species of the family Palaemonidae have been recorded (Ahmed 1957; Khandker and Patra 1971, Shafi *et al* 1975), all belonging to the genus Macrobrachium with only one exception i.e. *Exopalaemon styliferus* (H.Milne Edwards).

Among palaemonids, *Exopalaemon styliferus* is the commercially important and most commonly appearing shrimp in the coastal areas of Bangladesh. The fishing grounds of the shrimp were unexplored and shrimp fishery was not at commercial level in Bangladesh till 1976 (Shahidullah 1986). It is distributed from Pakistan to Malay Archipelago through Indian waters. In Bangladesh, it is available in the coastal waters of Chittagong and Cox's Bazar region (Mahmood *et al* 1978).

It is an inshore shallow water and estuarine shrimp in the Bay of Bengal (Shafi and Quddus 1982). The important fishing centres are located around the Kutubdia, Moheshkhali, Cox's Bazar. Sonadia and coastal areas of Chittagong and Khulna. Large part of the catch particularly during the peak fishing season (November-March) is sun dried and small amount is sold fresh in the local markets.

Considering its commercial importance in the fishery, the investigation was undertaken on the different aspects of population parameters such as asymptotic length (L_∞); growth coefficient (K), natural mortality (M), fishing mortality (F), total mortality (Z), length at first capture (Lc) and exploitation rate (E) for scientific management of the stock.

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Materials and Methods

Fortnightly samples of *Exopalaemon styliferus* were collected from August 1995 to July 1996 from the Kutubdia channel (Fig 1) of Bangladesh coastal water. Shrimps were collected from the Set Bag Net (Behundi net, mesh: mouth 10 cm, middle 5 cm and cod end 1.5 cm). Total length (TL) of 2120 specimens was measured in the size range 5-11 cm at 0.5 cm interval (Table 1). Length-frequency data were pooled monthwise.

Length-frequency based computer programs, Elefan I and Elefan II, were used to estimate population parameters. As explained in detail by Pauly and David (1981) and Saeger and Gayanilo (1980) the growth parameters L_∞ and K of the Von Bertalanffy equation for growth in length are estimated by Elefan I. An additional estimate of L_∞ and Z/K value was obtained by plotting $\bar{L}-L'$ on $\bar{L}$ (Wetherall 1986) as modified by Pauly (1986) i.e.

$$\bar{L}-L' = a+bL'$$
$$L_\infty = -a/b$$
$$Z/K = -(1+b)/b$$

where L' is defined as the mean length computed from L'

upward, in a given length-frequency sample while L′ is the limit of the first length class used in computing a value of L′.

The growth performance index (ϕ) of *Exopalaemon styliferus* population in terms of length was calculated using the formula of Pauly and Munro (1984) i.e.

$$\phi' = \text{Log}_{10} K + 2 \text{Log}_{10} L_\infty$$

where L_∞ is the asymptotic length in cm and K is a growth constant per year.

The Elefan II estimated total mortality (Z) from catch curve based on the equation:

$$Z = \frac{K(L_\infty - \bar{L})}{\bar{L} - L'} \quad \text{---------- (i)}$$

where, $\bar{L}$ is the mean length in the sample computed from L′ upward and L′ is the lower limit of the smallest length class used in the computation of $\bar{L}$ (Beverton and Holt 1956).

The parameter natural mortality (M) was estimated using the empirical relationship derived by Pauly (1983).

$$\text{Log}_{10} M = -0.0066 - 0.279 \text{Log}_{10} L_\infty + 0.6543 \text{Log}_{10} K + 0.4634 \text{Log}_{10} T$$

where L_∞ is expressed in cm (total length) and T (°C) is the mean annual environmental temperature (here it was taken as 28°C).

The estimate of fishing mortality (F) was taken by subtracting M from Z. The exploitation rate (E) was then computed from the Gulland's expression (Gulland 1971) i.e. E=F/Z=F/F+M).

"Gear Selection Pattern" was determined using the routine Elefan II i.e. plots of probability of capture by length (Pauly 1984) by extrapolating the catch curve and calculating the number of fish that would have been caught.

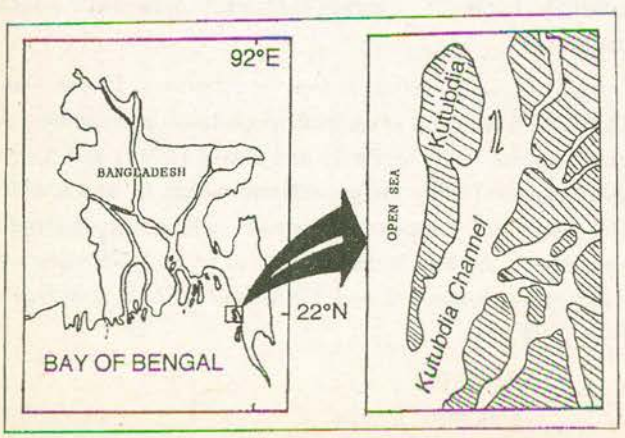

Fig 1. Investigated area of Kutubdia channel in the coastal water of Bangladesh.

Recruitment pattern is obtained by backward projection on the length axis of a set of length frequency data (seasonal growth curve) according to the routine Elefan II.

Relativ yield-per recruit (Y/R) and biomass-per-recruit (B/R) was obtained from the estimated growth parameter and probabilities of capture by length (Pauly and Soriano 1986). Here, yield (Y)- per-recruit (R) was calculated as relative yield-per-recruit (Y/R). The calculations were carried out using the "Complete Elefan" software package developed at ICLARM (Ingles and Pauly 1984).

Results and Discussion

Growth parameters. Growth parameters of Von Bertalanffy growth formula *Exopalaemon styliferus* were estimated as L_∞ =11.21 cm and K=2.20 per year. For these estimates through Elefan I, the response surface (Rn) was 0.192 for the main line (solid line) and 0.175 for the secondary line (dotted line). The computed growth curve produced with those parameters are shown over its restructured length distribution in Fig 2. The t_0 value was taken as zero.

The Powell-Wetherall plot are shown in Fig 3. The corresponding estimates of L_∞ and Z/K for *E.styliferus* are 10.663 cm and 2.934 respectively. This additional estimate of L_∞ is slightly lower than the L_∞ estimated through Elefan I. The correlation co-efficient was 0.943 (a=2.71 and b=-0.254).

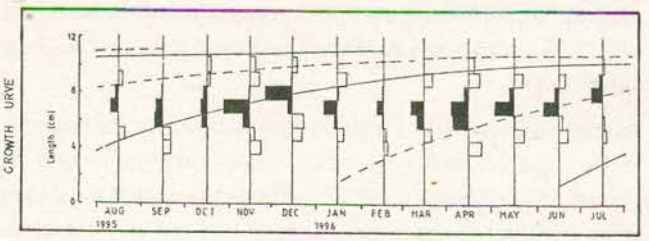

Fig 2. Growth parameters of *Exopalaemon styliferus* estimated by ELEFAN (L_∞ = 11.21 cm and K = 2.20 year^{-1}).

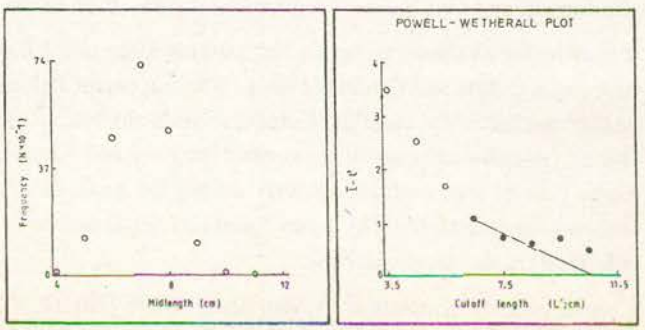

Fig 3. Estimation of Lc and Z/K using the methods of Powell-Wetherall plot for *Exopalaemon styliferus;* the estimated L_∞ = 10.663 cm and Z/K = 2.934.

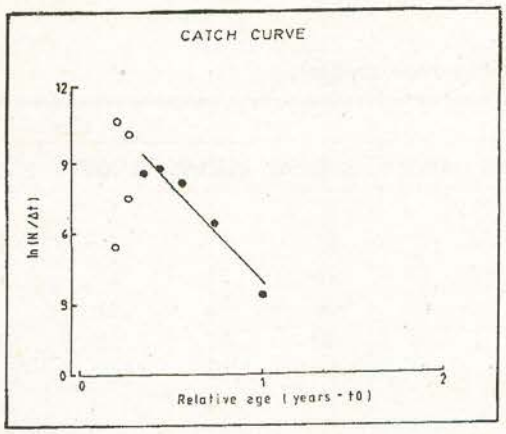

Fig 4. Length-converted catch curve of *Exopalaemon styliferus.*

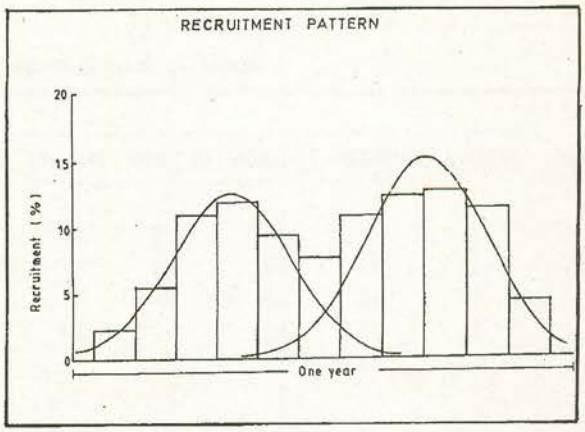

Fig 6. Recruitment pattern of *Exopalaemon styliferus.*

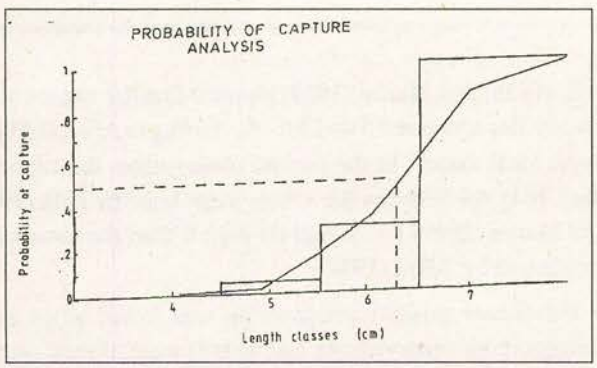

Fig 5. Selection pattern of *Exopalaemon styliferus.*

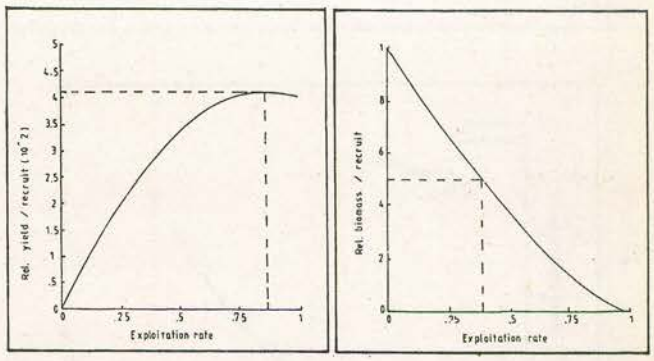

Fig 7. Relative yield per recruit and biomass per recruit of *Exopalaemon styliferus;* (Lc/L_∞ = 0.56, M/K = 1.79).

Calculated growth performance index (ϕ') was found to be 2.441.

It is assumed in the Elefan I analysis that the value of the third parameter of the Von Bertalanffy growth function, t_0 is zero (Pauly and David 1981). Therefore the sizes attained by the *E. styliferus* are 7.478 cm, 9.967 cm, 10.796 cm and 10.971 cm at the end of 6,12,18 and 21 months of age, respectively. The growth rate of *E.styliferus* was 0.628 cm^{-1} per month from six to seven months age.

Mortality. The computed mortality rates M, F and Z are 3.94, 4.57 and 8.51, respectively. Fig 4 represents the catch curve utilized in the estimation of Z. The darkened circles represent the points in calculating Z through least square linear regression. The blank circles represent points either not fully recruited or nearing to L_∞ and hence discarded from the calculation. Good fit the descending fight hand limits of the catch curve was cosidered. The correlation co-efficient for the regression was .968 (a=12.34 and b=-8.51). The natural mortality rate was estimated from the empirical equation. Pauly (1980) suggested that his method gave a reasonable value of M. This method of estimating M is widely used throughout the tropics where time series of reliable catch and effort data and several years of Z values are not available. The fishing mortality rate (F) was taken by subtraction of M from Z and was found to be 4.57.

Exploitation rate. The exploitation rate (E) was 0.54. From these values, it seems that the stock of *Exopalaemon styliferus* in the Kutubdia Channel was under some fishing pressure. The assumption is based on Gulland's (1971) who stated that suitable yield is optimised when F=M and when E is more than 0.5, the stock is generally subjected to over fishing. It appears that this state of little overfishing in the stock of *Exopalaemon styliferus* could be due to its distribution in shallow water and could be an impact of set bag net fishery.

Selection pattern. It appears (Fig 5) that the resultant curve derived from the probabilities of capture curve provided an estimate of Lc=6.276.

Recruitment pattern. The recruitment pattern (Fig 6) was determined through the Elefan II analysis (Pauly *et al* 1981) with the separation of the normal distributions of the peaks by means of the Normsep program. It shows that annual recruitment consists of two unequal seasonal pulses in March-May and July-October. Peaks appear in the months of April

Table 1
Monthly length-frequency data *Exopalaemon styliferus*

Mid	Date											
length	15/08/95	15/09/95	15/10/95	15/11/95	15/12/95	15/01/96	15/02/96	15/03/96	15/04/96	15/05/96	15/06/96	15/07/96
4		5		2			5		2			
5	4	12	28	15	2	14	20	4	25	3	3	6
6	20	55	69	39	5	53	61	57	73	33	14	14
7	35	60	63	78	38	72	101	60	79	96	45	25
8	31	45	50	27	84	31	71	30	40	61	35	46
9	12	23	20	5	31	5		2	5	10	6	31
10			5	1	4				1			10
11			3									
Sum	102	200	238	167	164	175	258	153	225	203	103	132
Total =	2120											

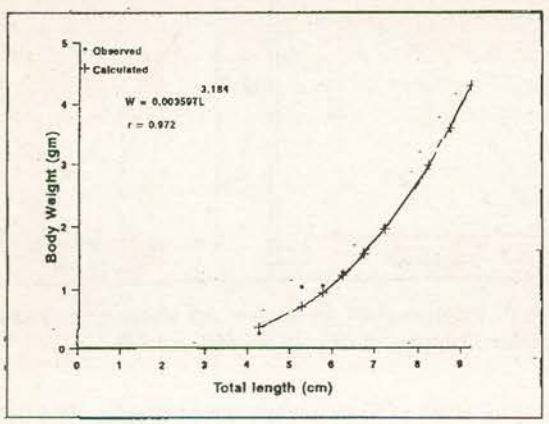

Fig 8. Relationship between total length and body weight in *Exopalaemon styliferus;(Arithmetic).*

and September. It is evident from the growth curves that one spawning takes place in December and another in May.

Yield per-recruit and biomass-per-recruit. The relative yield-per-recruit and biomass-per-recruit were determined as a function of Lc/L_{∞} and M/K and are 0.56 and 1.79, respectively. Fig 7 shows that the present exploitation rate (E=0.54) does not exceed the maximum exploitation rate (E_{max}=0.859).

Length-weight relationship. For the length-weight relationship a total of 339 specimens of *Exopalaemon styliferus* were measured and wighed. The total length varied between 4.25 cm and 9.25 cm and the body weight varied between 0.25 g and 3.8667 g during one-year samples. The calculated value of log a and regression co-efficient 'b' were -2.44454 and 3.18466, respectively. Thus the logarithmic equation for the total length-body weight relationship was found as log W=-2.44454+3.18466 log TL. In exponential form, this equation is $W=0.00359TL^{3.18466}$ (r=0972;t cal=11.70).

Hile (1936) and Martin (1949) showed that the exponent 'b' usually lies between 2.5 and 4.0. According to Allen (1938), 3 is the ideal value. In the present observation, the exponent (b=3.184) lies between the values mentioned by Hile (1936) and Martin (1949) but is slightly higher than the ideal value mentioned by Allen (1938).

A curvilinear positive relationship was found when body weights (both observed and calculated) were plotted against total length (Fig 8) which became linear after logarithmic transformation. The co-efficient of correlation (r) between log total length and that of body weight was positive and highly significant at 0.1% (t cal=11.70) level.

References

Ahmed N 1957 *Prawn and prawn fishery of East Pakistan.* Director of Fisheries, Dacca, East Pakistan, 31 p.

Allen KR 1938 Some observations on the biology of the trout *Salmo trutta* in Windermere. *J Amer Ecology* **7** 333-349.

Beverton R J H Holt S O 1956 A review of methods for estimating mortality rate in fish populations with special references to sources of bias in catch sampling. Rapp P-V.
Rea Cons Inst Explor Mer **140** (124) 67-83.

Gulland J A 1971 *The fish resources of the ocean west by Fleet Survey.* Fishing News (books) Ltd for FAO, p 255.

Hile R 1936 Age and growth of the Cisco, *Leucichthys artedi* (Le Seur) in the lakes of the north eastern highlands, Wisconsin. *Bull U S Bur Fish* **48** 211-317.

Ingles J, Pauly D 1984 An atlas of the growth, mortality and recruitment of Philippine fishes. *ICLARM Tech Rep* **13** (2) 127.

Khandker N A, Patra R W R 1971 Commercial caridean prawns of East Pakistan. *Pakistan J Sc* **23** 195-201.

Mahmood N, Khan Y S A, Hussain M 1978 Shrimp fishery: Record of three sergestid shrimps in Bangladesh. *Proceed Zoo Soc Bangladesh* 204-214.

Martin W R 1949 The mechanics of the environmental control of body form in fishes. *Univ Toronto Stud Biol* **58**; *Ontario Fisheries Res Lab* **70** 1-91.

Pauly D 1980 On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. *J Cons Explor Mer* **39** (3) 175-192.

Pauly D 1983 Some *simple method for the assessmentof tropical fish stocks.* FAO Fish Tech Pap,234-52.

Pauly D 1984 *Fish populaltion dynamics in tropical waters: a manual for use with programmable calculators.* ICLARM Contribution No.143, Inter Centre Living Aqua Resourc Manag, Manila, Philippines.

Pauly D 1986 On improving operator and use of the ELEFAN programme. Part II. Improving the estimation of L_∞. *Fishbyte* **4**(1) 18-20.

Pauly D, David N 1981. Elefan I, a Basic Programme for the objective extraction of recruitment pattern from length-frequency data. *Meeresforsch* **27** 201-210.

Pauly D, Munro J L 1984 Once more on the composition of growth in fish and invertebrates. *Fishbyte* **2**(1) 21.

Pauly D, David N, Ingles J 1981 *Elefan II: User's instructions and program listing pag var,* (mimeo) (1).

Pauly D, Soriano M L 1986 Some practical extensions to Beverton and Holt's relative yield-per-recruit model. In: *1st Asian Fisheries Forum,* eds Maclean J L, Dizon L B & Hosillos L V, Asian Fisheries Society, Manila, Philippines, pp149-195.

Saeger J, Gayanilo Jr F C 1986 *A revised and graphics oriented version of Elefan I and II basic programs for use on HP/86/87 microcomputers.* Tech Rep Dept Marine Fish 8.

Shafi M, Quddus M M A 1982 *Bangladesher Matsya Shampad* (in Bengali). Bangla Academy, Dhaka.

Shafi M, Quddus M M A, Islam M M 1975 *Bangladesher Matsya Shampad* (in Bengali). Bangla Academy Biggan Patrika, Dhaka **4** 11-23pp.

Shahidullah M 1986 *Marine Fisheries Resources Management in Bangladesh and current status of exploitation.* Mar Fish Bull Rep 3, April 1986, Chittagong, Bangladesh.

Wetherall J A 1986 A new method for estimating growth and mortality parameters from length-frequency data. *Fishbyte* **4**(2) 12-14.