Population dynamics of Acetes erythraeus (Nobili, 1905) in the Kutubdia Channel of Bangladesh

MOHAMMAD ZAFAR AND S. M. NURUL AMIN
Institute of Marine Sciences, University of Chittagong, Chittagong 4331, Bangladesh

ABSTRACT

ELEFAN I, ELEFAN II were used to estimate population parameters in Acetes erythraeus based on length-frequency data collected from Kutubdia Channel of Bangladesh coastal water. The asymptotic length \( L_\infty \) and growth constant \( K \) for the species were 37.00 mm and 1.20/year respectively. The annual rate of natural mortality \( (M) \), fishing mortality \( (F) \) and total mortality \( (Z) \) were found to be 3.61, 1.11 and 4.72 respectively. The rate of exploitation \( (E) \) was estimated as 0.24. The mean length at first capture \( (L_c) \) was estimated as 18.206 mm. This shrimp was recruited continuously with peak during April to June. Emax was found to be 0.87. From the analysis, Acetes erythraeus was found to be below optimum fishing pressure (i.e. \( E < 0.50 \)) in the investigated area.

Introduction

Acetes erythraeus is known as gura chingri or sada ichha in the coastal districts of Bangladesh (Mahmood et al., 1978). It is commonly found in the coastal shallow water of Bay of Bengal and its adjacent estuaries (Azad, 1994). It was also reported from the east coast of Africa, French Somaliland, Kenya, Madagascar, Mozambique and South Africa. It is also found in Manila Bay and Indian coastal waters.

A limited quantity of A. erythraeus is harvested in Madagascar (Crosnier and Fourmanoir, 1962; Le Reste, 1970), Mozambique (De Freitas, 1966; MacNae, 1974) and Tanzania, (Mwaiseje, 1982); Mistakidis (1973) reported on the presence of Acetes fisheries in Hong Kong. Acetes is fished by push-nets attached to the front of a small boat (Omori, 1975). There are several accounts of Acetes fishery from West Malaysia or Malay Peninsula (Tham, 1950; Johnson, 1965, 1976; Pathansali, 1966; Mistakidis, 1973; Omori, 1975; Holthuis, 1980). A. erythraeus is the most important species in Malaysia (Johnson, 1976).

Although A. erythraeus is a common shrimp in the coastal waters of Bangladesh, no work has been done on it. This paper reports on the population dynamics of A. erythraeus of the Kutubdia Channel, Bay of Bengal.

Materials and methods

Fortnightly samples of Acetes erythraeus were collected during August 1995 to July 1996 from the Kutubdia
Channel (Fig. 1) of Bangladesh coastal water. Acetes shrimps were collected from the Set Bag Net (S.B.N.) locally called behundi jal (Mesh size: at mouth, 7.5 cm, at middle, 2 cm and at cod end, 0.3 cm). Samples were immediately preserved in 5% formalin in the field and measured after 1-2 days of preservation. Total length (TL) was measured at 1 mm interval for 2200 specimens. Length-frequency data were pooled month wise.

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

$$T \cdot L' = a + bL'$$

where $L_\alpha = -a/b$

and $Z/K = (1/b)/-b$

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 $T$.

The growth performance index ($\theta'$) of A. erythraeus population in terms of growth in length was calculated using the formula of Pauly and and Munro (1984):

$$\theta' = \log_{10} K + 2 \log_{10} L \cdot$$

where $L_\alpha$ is the asymptotic length in mm and $K$ is the growth constant per year.

The instantaneous total mortality coefficient ($Z$) was estimated using the length converted catch curve method which has been incorporated into the Compleat ELEFAN computer program (Gaynilo et al. 1989).

Natural mortality ($M$) was estimated by using Pauly’s (1980) empirical formula, i.e.,

$$\log_{10} M = -0.0066 - 0.279 \log_{10} L + 0.6543 \log_{10} K + 0.463 \log_{10} T$$

Here $L_\alpha$ is expressed in mm for this study due to small size of shrimp and $T$ is the mean water temperature in °C (taken as 28°C).

The estimate of fishing mortality ($F$) was done by subtracting natural mortality ($M$) from total mortality ($Z$), the exploitation rate ($E$) was then computed from Gulland’s (1971) expression:

$$E = F/Z = L \cdot F/(F+M)$$

“Gear Selection Pattern” was deter-
mined 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.

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.

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

**Results and discussion**

**Growth parameters**

Growth parameters of von Bertalanffy growth formula for *Acetes erythraeus* were estimated as $L_0 = 37.00$ mm and $K = 1.20$ per year. For these estimates through ELEFAN I, the response surface was 0.283 for the main curve (solid line) and 0.112 for the secondary line (dotted line). The computed growth curve produced with those parameters are shown over its restructured length distribution (Fig. 2). The $t_v$ value was taken as zero.

The Powell-Wetherall plot are shown in Fig. 3. The corresponding estimates of $L_0$ and $Z/K$ for *A. erythraeus* are 36.795 mm and 2.80 respectively. This additional estimate of $L_0$ is slightly lower than the $L_0$ estimated through ELEFAN I. The correlation coefficient for the regression was 0.990 ($a = 9.68$ and $b = 0.263$). Calculated growth performance index ($\theta^*$) was found to be 3.215. Lei (1988) reported the $K = 0.51$ per month, $L_0 = 21.38$ mm

![Growth curve](image)

**Fig. 2. Growth parameters of *Acetes erythraeus* estimated by ELEFAN ($L_0 = 37.00$ mm and $K = 1.20$ year$^{-1}$).**
values for Acetes japonicus from the eastern coasts of Guangdong province, China.

**Mortality**

The mortality rates $M_R$, $F$ and $Z$ computed are 3.68, 1.11 and 4.72 respectively. Fig. 4 represents the catch curve utilized in the estimation of $Z$. The dark circle represents the points used in calculating $Z$ through linear regression. The blank circles represent points either not fully recruited or nearing to $L_a$ and hence discarded from the calculation. Good fit to the descending right hand limits of the catch curve was considered. The correlation co-efficient for the regression was 0.985 ($a=12.00$ and $b=-4.72$). The natural

Fig. 4. Length - converted catch curve of Acetes erythraeus.

Fig. 5. Selection pattern of Acetes erythraeus.

Fig. 6. Recruitment pattern of Acetes erythraeus.
nal mortality rate was estimated from the empirical equation. Pauly (1980) suggested that this method gives a reasonable value of \( M \). The method of estimating \( M \) is widely used throughout the tropics where time series of reliable catch and effort data and several years of \( Z \) value are not available. The fishing mortality rate (\( F \)) was taken by subtraction of \( M \) from \( Z \) and was found to be 1.11.

**Exploitation rate**

The rate of exploitation (\( E \)) is 0.24.

It appears that the stock of *Acetes erythraeus* in the Kutubdia Channel of Cox's Bazar coastal water is not under fishing pressure.

**Selection pattern**

It appears from Fig. 5 that the length at first capture (\( L_c \)) for "Selection Patterns" was 18.206 mm on the basis of the present net used and the estimated sizes of *Acetes erythraeus* at 25%, 50% and 75% probabilities of capture were 16.315, 18.206 and 20.093 mm respectively.

**Recruitment pattern**

The recruitment pattern (Fig. 6) was determined through ELEFAN II analysis (Pauly et al., 1981) and it shows that this species was recruited continuously with major peak during April to June.

**Yield-per-recruit and biomass-per-recruit**

The relative yield-per-recruit and biomass-per-recruit were determined as a function of \( L_c/L \) and \( M/K \) being 0.49 and 3.008 respectively. Fig. 7 shows that the present exploitation rate (\( E = 0.24 \)) does not exceed the optimum exploitation rate (\( E_{\text{max}} = 0.87 \)). \( E_{\text{max}} \) was found from the yield-per-recruit and biomass per recruit model.

**References**


Gayalino, F.C Jr., M. Soriono and D. Pauly 1989. A draft guide to complete ELEFAN. International Centre for Living Aquatic
Resources Management, Manila.


Pauly, D. 1986. On improving operation and used the ELEFAN I, a Basic programme for the objective extraction of recruitment pattern from length-frequency data. Meeresforesch. 27 (2): 201-210.


