Bangladesh J. Fish. Res., **2**(1), 1998 : 83-90

Population dynamics of *Harpodon nehereus* (Ham.-Buch.) from the Kutubdia channel of Bangladesh

M.G. Mustafa[1], M. Zafar*, A.K.M. A. Matin and S.M. N. Amin

Institute of Marine Science, Chittagong University, Chittagong, Bangladesh
[1]Present address : Fisheries Research Institute, Marine Station, Cox's Bazar-4700, Bangladesh
**Corresponding author*

Abstract

ELEFAN-ϕ, ELEFAN-I, ELEFAN-II were used to estimate the parameters of population of *Harpodon nehereus* from length- frequency data collected from Kutubdia channel of Bangladesh coastal water. The $L\alpha$ and K were found to be 24.48 cm and 1.50/ year. The annual rate of natural mortality (M) and fishing mortality (F) were found to be 2.46 and 3.27 respectively. The rate of exploitation (E) was estimated as 0.57. The mean length at first capture (Lc) was estimated as 6.747 cm. This species was recruited in the fishery during March to May, August and October. The Peak recruitment appeared between March to April. Emax. was found to be 0.501. The present investigation clearly showed the over fishing (E>0.50) of *H. nehereus* in the investigated area of Bangladesh coastal water.

Key words : Population dynamics, *Harpodon nehereus,* Kutubdia channel

Introduction

Harpodon nehereus (Ham.-Buch 1822) popularly known as Bombay duck is one of the inshore shallow water and estuarine fish of the Bay of Bengal, Indian ocean and the Arabian Sea. It is locally familiar as 'Lotiya much' or 'Loittya' around the coastal areas of Chittagong and Cox's Bazar.

A large number of this fish is caught every year from the coastal areas of Bangladesh located between Latitudes 20^0 N - 22^0 N and Longitudes 84^0 E - 92^0 E (Sarker 1967). The major portion of the fish is caught by the local fishermen and annually about 0.1 million tons are harvested. Kutubdia, Moheskhali, Cox'sBazar, Sonadia, Khulna and the coastal areas of Chittagong are the most important fishing place for *H. nehereus*. In the Bay of Bengal, Bombay duck contributed a major part of the catch of fish population.

The Bombay duck is generally caught by the 'Behundi nets' (set bag net) with mesh size varying from 70 mm at the wider part to 10 mm at the cod end. The peak season of fishing commences from July and continues for a period of about 5-6 months. In other months, they occurred in comparatively small number (Das 1980).

Though *H. nehereus* is one of the highly esteemed table fish at home and abroad, but little work has so far been reported on it in the field of population biology. The present investigation shows the different aspects of population dynamics such as asymptotic length ($L\alpha$), growth co-efficient (K), natural mortality (M), fishing mortality (F), recruitment pattern, length at first capture (L_c), relative yield-per-recruit and biomass-per-recruit and exploitation rate (E) of *H. nehereus* and its management at Maximum Sustainable Yield (MSY) level in the Kutubdia channel of the Bay of Bengal.

Materials and methods

Fortnightly samples of *H. nehereus* were collected during August'95 to July'96 from the Kutubdia channel (Fig.1) of Bangladesh coastal water. Fishes were collected from set bag nets with mesh sizes 10 cm at the mouth, 5 cm at the middle and 1.5 cm at the code end. Total length (TL) at 0.5 cm interval for 2366 specimens were measured and length-frequency data were pooled month wise.

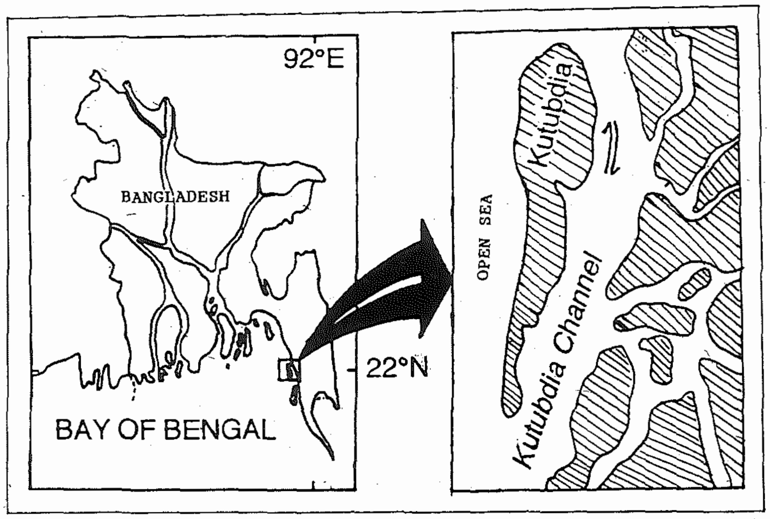

Fig. 1. Investigated area of Kutubdia channel in the coastal water of Bangladesh.

Length-frequency based computer programs ELEFAN I, 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 $L\alpha$ 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.,

$L\alpha - L = a + bL$

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 L.

The growth performance of *H. neherus* population in terms of length growth was compared using the index of Pauly and Munro (1984),

$\phi = Log_{10} K + 2log_{10} L\alpha$

The ELEFAN II estimates Z from catch curve based on the equation,

$$Z = \frac{K(L\alpha - L)}{L\alpha - L} \quad (i)$$

Where, 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 L (Beverton and Holt 1956).

The parameter M was estimated using the empirical relationship derived by Pauly (1983), i.e.,

$Log_{10}M = - 0.0066 - 0.279log_{10}\ L\alpha + 0.6543log_{10}\ K + 0.4634log_{10}\ T$------------(ii)

Where $L\alpha$ is expressed in cm and T the mean annual environmental temperature in ^{0}c which is here $28^{0}c$.

The estimate of F was taken by subtracting M from Z, the exploitation rate (E) was then computed from the expression ,

$E = F/Z = F/ (F+M)$

'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.

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) was 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 yeild -per -recruit (Y/R) . The calculations were carried out using the "Complete ELEFAN" program package developed at ICLARM (Ingles and Pauly 1984).

Results and discussion

Growth parameters

Growth parameters of the Von Bertalanffy growth formula were estimated as $L\alpha = 24.48$ cm and $K = 1.5$ per year. For these estimates through ELEFAN I the response surface (Rn) was 0.157 for the main curve (solid line) and 0.129 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 0.

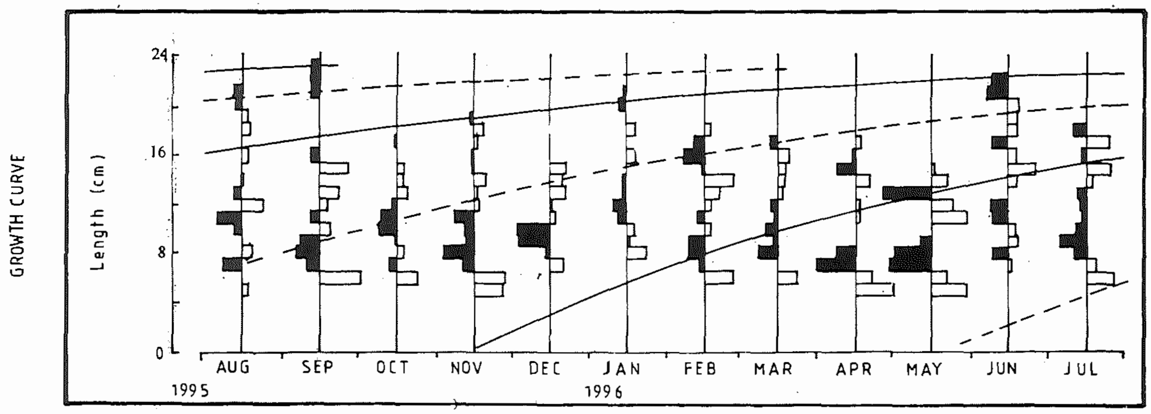

Fig. 2. Growth parameters of *Harpodon nehereus* estimated by ELEFAN (Lα = 24.48 cm and K = 1.50/year).

The Powell-Wetherall plot are shown in Fig. 3. The corresponding estimates of Lα and Z/K for *H. nehereus* are 24.11 cm and 1.838 respectively. This additional estimate of Lα is slightly lower than the Lα estimated through ELEFAN I. The correlation co-efficient for the regression was 0.943 (a = 8.49 and b = -.352). Calculated growth performance index (ϕ) was found to be 2.953. Mustafa *et al*. (1994) reported Lα = 29.0 cm and K value = 0.9 per year for *H. nehereus* from the Kumira estuary and Islam (1995) also reported that Lα = 30.00 cm of the species in the Karnafully estuary of Bangladesh.

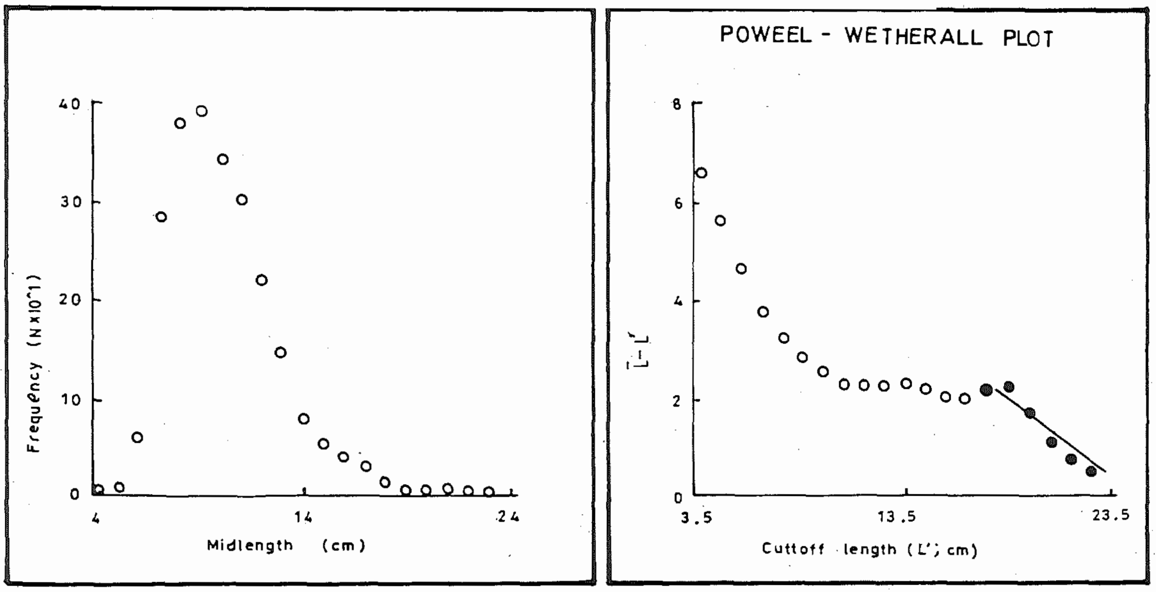

Fig. 3. Estimation of Lα and Z/K using the methods of Powell-Wetherall plot for *Harpodon nehereus*. The estimated Lα = 24.11 cm and Z/K = 1.838.

Mortality

The mortality rates M, F and Z computed are 2.46, 3.27 and 5.73 respectively. Fig. 4 represents the catch curve utilized in the estimation of Z. The darkened quadrilateral represents the points used in calculating Z through least square linear regression. The blank circles represents points either not fully recruited or nearing to Lα 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 0.955 (a = 10.65 and b = - 5.73). The natural mortality rate estimated from the empirical equation. Pauly (1980) suggested that this method gives 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 so as to put into the most usual methods of estimating M and F. The fishing mortality rate (F) was taken by subtraction of M from Z and was found to be 3.27.

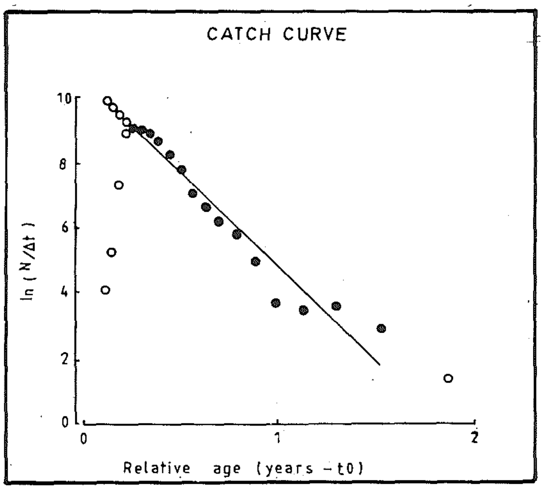

Fig. 4. Length-converted catch curve of *Harpodon nehereus*.

Exploitation rate

The exploitation rate(E) has been estimated from the Gulland's (1971) equation, E = F/F+M. Thus from these range of values of F and Z it can be shown that the rate of exploitation (E) is 0.57. It appears that the stock of *H. nehereus* of Kutubdia channel is under fishing pressure. This assumption is based on Gulland (1971) who stated that suitable yield is optimised when F = M and when E is more than 0.5, the stock is generally supposed to be over fishing. Mustafa *et al.* (1994) and Islam (1995) also reported the over-exploitation of the species in the coastal region of Bangladesh.

Selection pattern

It appears from Fig. 5 that the length at first capture (Lc) from "Selection pattern" was found to be 6.747 cm on the basis of the present net used. But this is likely to differ in case of commercial fish trawlers having different mesh size in the cod end.

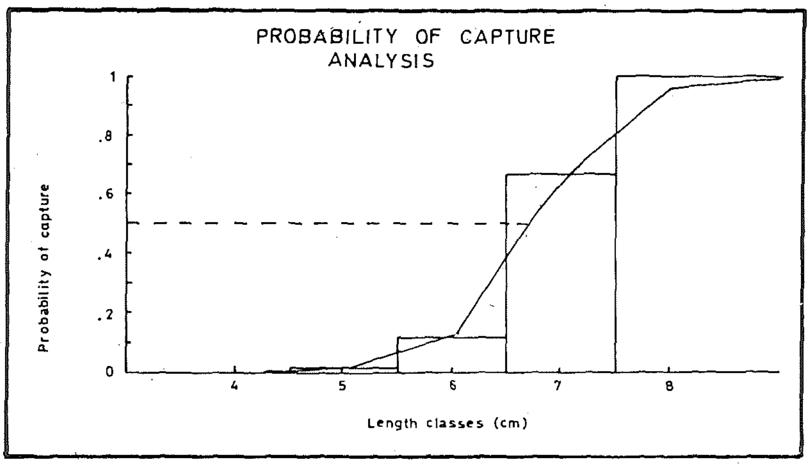

Fig. 5. Selection pattern of *Harpodon nehereus*.

Recruitment pattern

The recruitment pattern Fig. 6 determined through the ELEFAN II analysis (Pauly *et al*. 1981), with the separation of the normal distribution of the peaks by means of the NORMSEP program shows that *H. nehereus* was recruited in the fishery during March-May, August and October. As may be derived from growth curves also, one spawning appears to take place in November and another in May. Peaks appeared during the months of March and April.

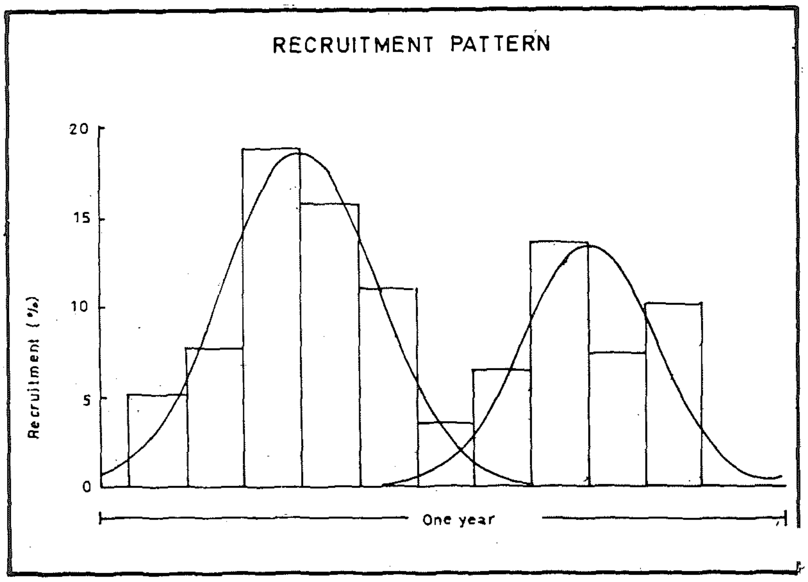

Fig. 6. Recruitment pattern of *Harpodon nehereus*.

Yield-per-recruit and biomass-per-recruit

The relative yield-per-recruit and biomass-per-recruit were determined as a function of Lc/Lα and M/K are 0.28 and 1.64 respectively. Fig. 7 shows that the present exploitation rate (E = 0.57) exceeds the optimum exploitation rate (Emax = 0.501).

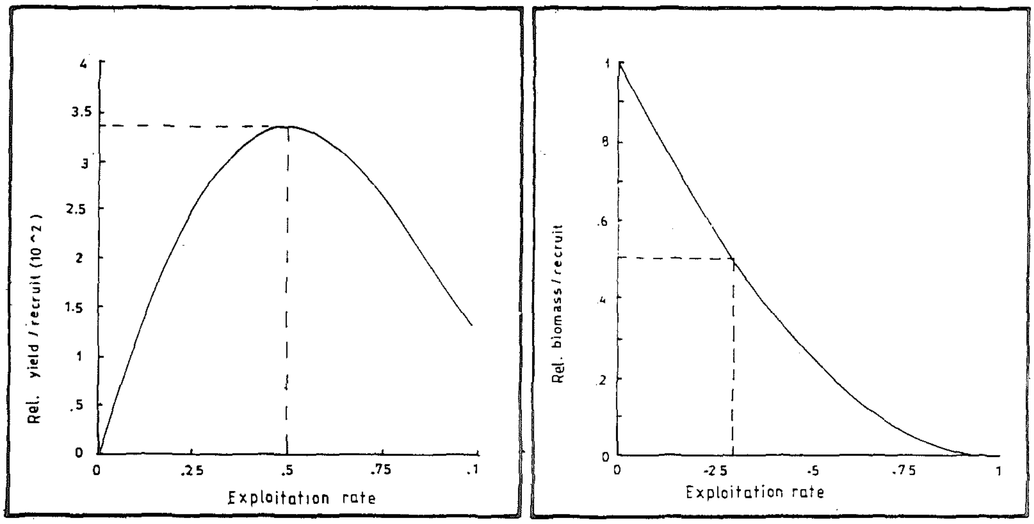

Fig. 7. Relative yield-per-recruit and biomass-per-recruit of *Harpodon nehereus* (Lc/Lα = 0.28. M/K = 1.64).

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(Manuscript received 14 July 1997)