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Some population dynamics aspect of *Catla catla* (Hamilton) in the Sylhet Basin, Bangladesh

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Abstract
Population parameters of *Catla catla* (Hamilton) were estimated using FiSAT software with length-frequency data collected from different areas of Sylhet basin, north-eastern part of Bangladesh. The von Bertalanffy growth parameters L∞ and K for the species were 93.95 cm and 0.53/year respectively. The annual rate of natural (M) and fishing mortality (F) were found to be 0.84 and 0.85, respectively. The mean length at first capture (Lc) was estimated as 11.29 cm. The rate of exploitation (E) was estimated as 0.503. Recruitment of this species into the fishery takes place during May to July. Peak recruitment occurred during the month of May E_{max} was found to be 0.41. Their total length total weight relationship was found to be W = 0.012TL3.04.

Introduction
Catla catla (Hamilton) locally known as katal or katal is the largest member of the Ganjetic major carps. It is widely available in the rivers, their tributaries, estuaries, swamps, lakes and pods of Indo-Pak-Bangla. Myanmar subcontinent. It is a large sized, surface plankton feeding carp (Day, 1989; Rahman, 1989). It has got a comparatively broad head and a wide mouth. Its growth performance in closed water aquaculture is better than the other Ganjetic carp species. Although its an important commercial fish of this region, yet little attempts were made to study the different aspects of its biology. Jhingran (1968) has studied the biology of this species extensively from the river Ganga in India. The fish is now endangered in the natural water of the north-eastern region of Bangladesh.

The present account is concerned with the study of the length-frequency based stock assessment of the samples collected from the natural waters of north-eastern region of Bangladesh. The present study was thus under taken to estimate the key parameters of stock assessment and its population dynamics like asymptotic length (L∞), growth co-efficient (K), total mortality (Z), natural mortality (M), fishing mortality (F), exploitation rate (El, recruitment pattern, relative yield per recruit, relative biomass per recruit, and virtual population analysis (VPA), etc. The result of the present study would be of practical value and could be useful for sustained conservation and management the stocks of this species in the said region.

Materials and Methods
Length-frequency data of *C. catla* were collected fortnightly from the commercial catches at different landing sites around Sylhet district from January 1998 to December 1998. Samples of *C. catla* were mainly caught by purse sine net. Random samples of 823 specimens were collected. Total length was measured in cm by a meter scale (1 ± mm) of sizes ranging from 21.0 to 93.0 cm. The weight was measured in g by a Salter spring balance from 823 random samples ranging in weight from 111.50-4, 200 g with corresponding length. The data were then pooled month-wise from different landing sites and subsequently grouped in to classes of three cm intervals. The data were analysed using the FiSAT (FAO-ICLARM Stock Assessment Tools) as explained in detail by Gayanilo Jr. *et al.* (1995) in the computer software package.

Asymptotic length (L∞) and growth coefficient (K) of the von Bertalanffy equation for growth in length were estimated by means of ELEFAN-I (Pauly and David, 1981; Saeger and Gayanilo, 1986). Additional estimate of L∞ and Z/K value were obtained by plotting $\bar{L}$ minus L' on $\bar{L}$ (Whetherall, 1986 as modified by Pauly 1986), i.e.;

$$\bar{L} - L' = a + bL'$$

where, L∞ = -a/b and Z/K = -(1 + b)/b

where, $\bar{L}$ 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 $\bar{L}$.

The growth performance of *C. catla* population in terms of length growth was compared using the index of Pauly and Munro (1984). i.e.;

$$\phi = \log_{10} K + 2 \log_{10} L_\infty$$

Total mortality (Z) was estimated by length converted catch curve method. Natural mortality rate (M) was estimated using Pauly's empirical relationship (Pauly, 1980) i.e.;

$$\log_{10} M = -0.00066 - 0.279 \log_{10} L_\infty + 0.6543 \log_{10} K + 0.4634 \log_{10} T$$

where, L∞ is expressed in cm and T, the mean annual environmental temperature in °C which is here 27°C.

Fishing mortality (F) was obtained by subtracting M from Z and exploitation rate (E) was obtained from F/Z [E = F/Z = F/(F + M)] (Gulland, 1971). Recruitment patterns was obtained by backward projection on the length axis of a set of length-frequency data as described in the FiSAT routine. Relative yield per recruit (Y/R) and biomass per recruit (R/B) values as a function of E were determined from the estimated growth parameters and probability of capture by length (Pauly and Soriano, 1986). The calculations were carried out using the complete FiSAT software package. An estimated length structured VPA of *C. catla* was carried out. L∞ = 93.95, K = 0.53/Yr, M = 0.84, F = 0.85, a = 0.012 and b = -3.04 were used as input to a VPA. The t_0 value was taken as zero.

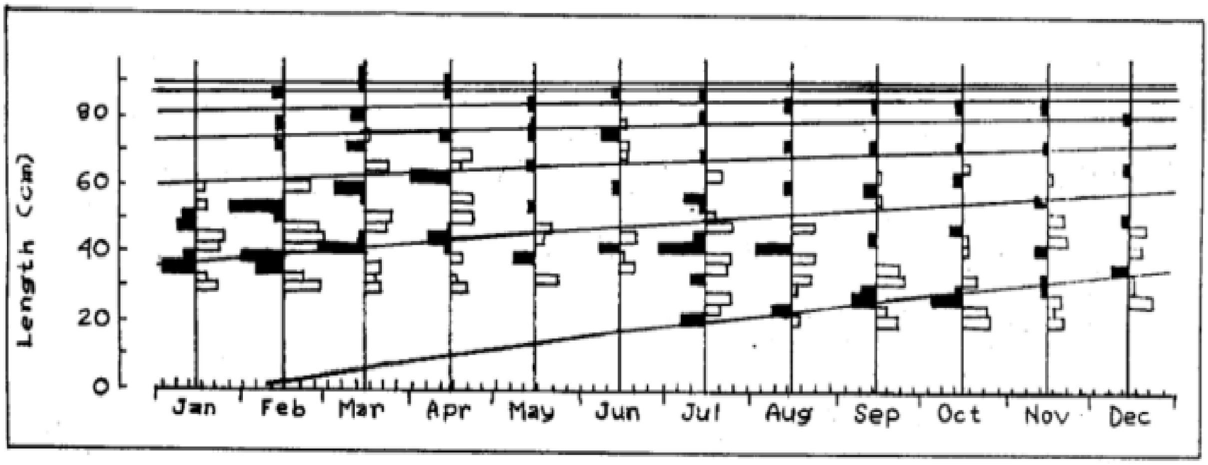

Fig 1: Growth curve of *C. catla* (Hamilton) from Sylhet basin water, Bangladesh by ELEFAN I superimposed on the length frequency diagram (L_∞ =93.95 cm and K =0.53/yr)

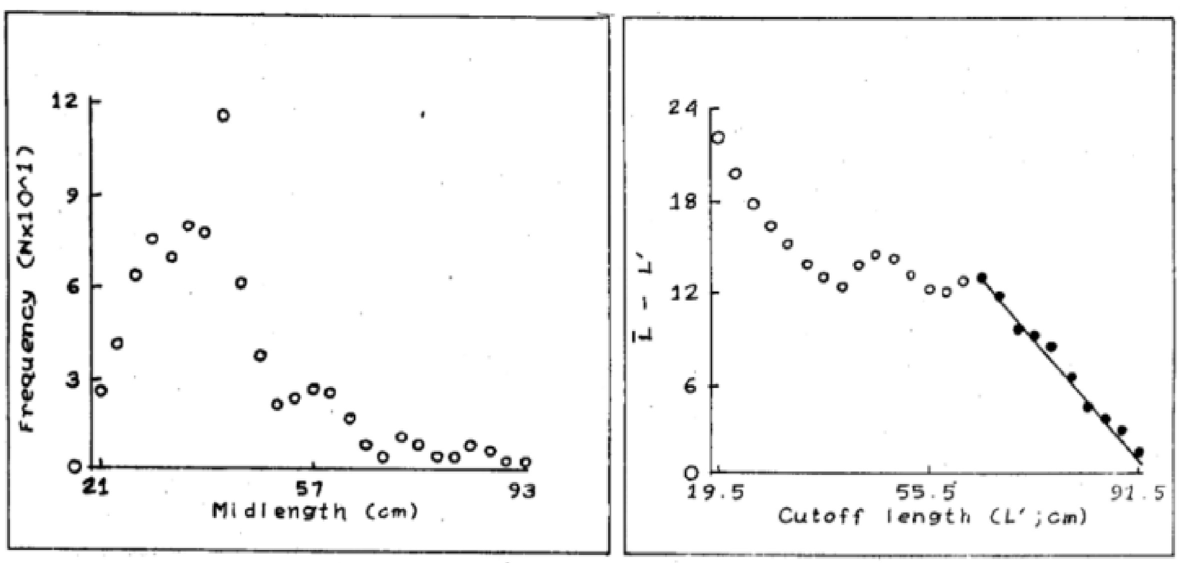

Fig 2: Estimation of L_∞ and Z/K using the methods of Wetherell for *C. catla* (Hamilton) in Sylhet basin waters, Bangladesh (estimated L_∞ = 94.548 cm and Z/K =1.316).

Results

Growth parameters: Growth parameters of von Bertalanffy growth formula for *C. catla* were estimated as L_∞ = 93.95 cm and K = 0.53/year. For these estimates through ELEFAN-I the response surface (R_n) was 0.172 for the curve. The computed growth curve produced with those parameters are shown over its restructured length distribution in Fig. 1.

The Powell-Wetherall plot were shown in Fig. 2. The corresponding estimates of L_∞ and Z/K for *C. catla* are 94.548 cm and 1.316, respectively. This additional estimate of L_∞ is slightly higher than the L_∞ and was estimated through ELEFAN-I. The correlation co-efficient for the regression was 0.967 9a =40.83 and b = -0.432).

Calculated growth performance index (ϕ') was found to be 3.629.

Mortality and exploitation: The mortality rates M, F and Z as computed were 0.84, 0.85 and 1.69, respectively. The

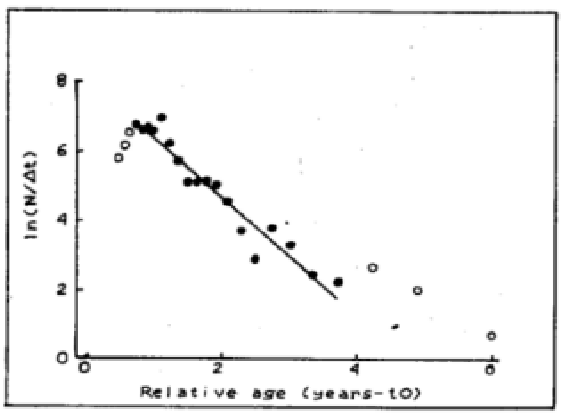

Fig. 3: Length converted catch curve of *C. catla* (Hamilton) in Sylhet basin waters, Bangladesh.

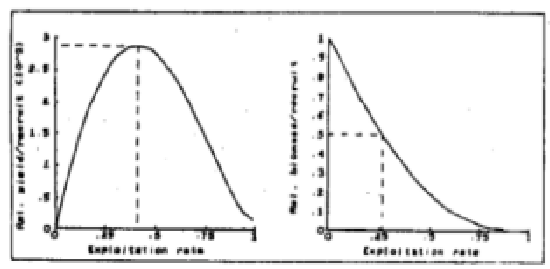

Fig. 5: Relative yield-per-recruit (Fig. 2) and biomass-per-recuit (Fig. b) of *C. catla* (Hamilton) of Sylhet basin waters, Bangladesh ($L_c/L\infty$ =0.12, M/K =1.59)

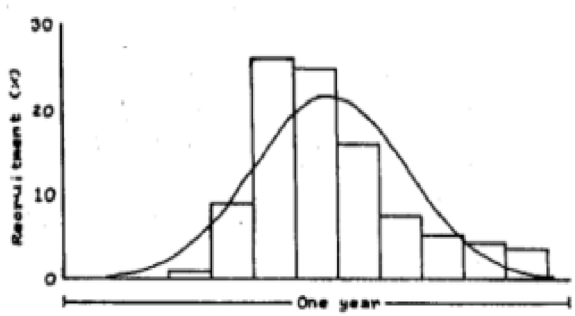

Fig 4: Recruitment pattern of *C. catla* (Hamilton) in Sylhet basin waters, Bangladesh.

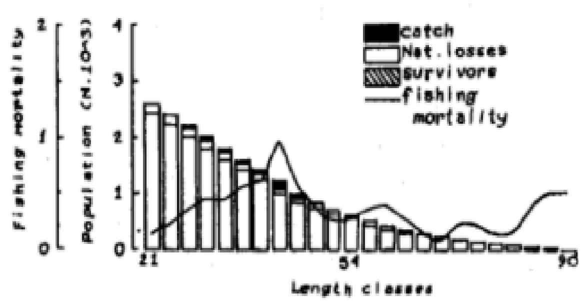

Fig 6: Length-structured virtual population analysis of *C. catla* (Hamilton) of Sylhet basin waters, Bangladesh

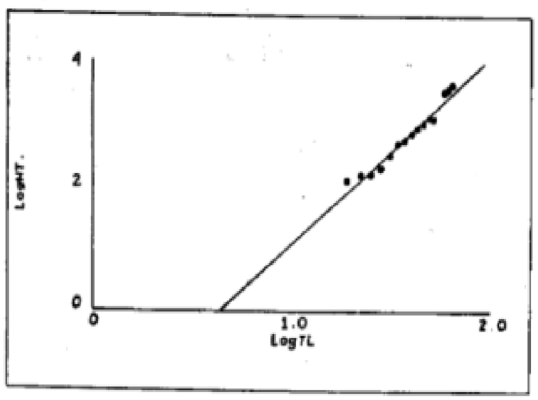

Fig 7: Linearized from of Length-weight relationship of *C. catla* (Hamilton) of Sylhet basin waters, Bangladesh

catch curve utilized in the estimation of Z was represented in Fig. 3. The darkened quadrilateral represents the points used in calculating Z through least squares lines regression. The blank circles represent points either not fully recruited or nearing to L_∞ and hence, discarded from the calculation. Goodness of fit to the descending right hand limits of the catch curve was considered. The correlation co-efficient for the regression was 0.967 (a =8.10 and b = -1.69). The fishing mortality rate (F) was taken by subtracting M from Z and was found to be 0.85. The rate of exploitation (E) was estimated as 0.503 from the study area.

Recruitment pattern: The recruitment pattern (Fig. 4) shows that this species was recruited in the fishery during May and July. Peak recruitment occurred in the month of May. It is clear form Fig. 1 that the growth curve originates in the month of February. From the pattern shown in Fig. 4, it may be inferred that recruitment occurred in the form of a single pulse. Thus, this species would spawn once a year and the stock size is also by the single pulse of recruitment.

Yield-per recruit and biomass per-recruit: The relative yield-per-recruit and biomass-per-recruit were determined as a function of L/L_∞ and M/k were 0.12 and 1.59, respectively. Fig. 5 shows that the present exploitation rate (E_{max} = 0.503) exceeds the maximum exploitation rate of = 0.41.

Virtual Population Analysis: The results of the length-structure VPA of *C. catla* were shown in Fig. 6. Values for the mean fishing mortality (F) and the mean exploitation rate (E) estimated by the analysis were 0.85 and 0.503. respectively. The estimated values for the exploitation rate (E) using the length converted catch curve and VPA were 0.503 and 0.133, respectively.

Length-weight relationship: For the study of the study of the length-weight relationship a total of 823 specimens of *C. catla* ranging in sizes from 2 to 93 cm in total length and weighing 111.50-42,00.0 g were measure. From these samples, length-weight relationship were estimated of the form $W = aL^b$ using the logarithmic transformation LogW = Loge+bLogTL, where, a and b are constants estimated by linear regression of the log transformation varieties. The regression takes the form:

Log W = -1.92+3.04 Log TL (r = 0.99)............(1)
Fig. 7 corresponding to, W - 0.012 $TL^{3.04}$............(2)

which may be used to convert length-frequency data to catch at length data.

Discussion

The natural 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 widely used throughout the tropics where time series reliable catch and effort data and several years of Z values are not available. So the described method is the common way of estimating M and F. It appears that the stock of *C. catla* in the Sylhet basin exceed the maximum fishing pressure (E_{max} =0.41).

Since the estimations made on mean exploitation rates using the VPA are known to be more reliable (Sparre and Venema, 1992), it is reasonable to accept the fact that *C. catla* stocks in the Sylhet basin is in a healthy state.

From the results of the above parameters it could be concluded that the *C. catla* is a moderate sized fish having perfect growth rate. Recruitment pattern of the fish revealed that it recruits in to the fishery almost round the year and peak recruitment occurs in May. Its fishing pressure (F =0.85) is high and need to be reduced for getting more sustained production. Some fishing restriction should be imposed to get higher fish yield from that basin.

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