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Age and Growth of Spotted Snakehead Channa Punctata (Bloch, 1793) of Kajla Beel in North East Bangladesh

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***Abstract* – Present study described age and growth of spotted snakehead, *Channa punctata* (Bloch, 1793) locally known as taki belongs to the family Channidae. A total of 1200 fish were collected from kajla beel at Mohongonj. Therefore, age and growth pattern of *C. punctata* was established by direct fit of length frequency data both to standard and modified von Bertalanffy growth models with ELEFAN I procedure. Powell-Wetherall procedure gave an initial asymptotic standard length (SL_∞) for male and female were 208.43 mm and 173.52 mm and Z/K value were 2.39 and 1.52 respectively. Based on direct fitting of growth equation by ELEFAN I method, the asymptotic standard length (SL_∞) of male was 217.88 mm and growth coefficient (K) was 1.10 per year. The asymptotic standard length (SL_∞) of female was 186.60 mm and growth coefficient (K) was 1.35 per year. The relationships of the pooled data of standard length and body weight for male was $BW = 0.00003\ SL^{2.94}$ and for female $BW = 0.00003\ SL^{2.97}$. The von Bertalanffy growth curves were fitted to weight- at-age data and the equation for male was $BW_t = 220.65\ [1- \exp\{-1.10\ (t + 0.01)\}]^3$ and for female was $BW_t = 164.25\ [1- \exp\{-1.35\ (t + 0.004)\}]^3$. Male grew faster than female in all stages of life cycle. The value of coefficient of determination (R^2) for male and female were 0.997 and 0.971 respectively which indicated high degree fit to the model in both cases.**

***Keywords* – Population, Spotted Snakehead, Growth, Standard Length and Body Weight.**

I. Introduction

Bangladesh is a subtropical country in the south-east part of Asia and it is located between 20° to 26° North and 88° to 92° East. It is bordered on the west, north and east by India, on the southeast by Myanmar and on the south by the Bay of Bengal and the Himalayas to the north. Its widespread water resources within her boundaries and the territorial and economic zones in the Bay of Bengal and 200 nautical miles Exclusive Economic Zone (EEZ) which is bigger (1,64,000 sq. km) than that of area of the main landmass (1,44,000 sq. km) of the country (Khan *et al.,* 1997). Bangladesh is fortunate enough having an extensive and huge water resources scattered all over the country in the form of small ponds, beels (natural depressions), lakes, canals, small and large rivers and estuaries covering an area of about 4.34 million ha. Bangladesh is one of the world's largest deltas through which flow two of the world's largest rivers-the Ganges and the Brahmaputra. The country is literally crisscrossed by some 250 large and small rivers. The floodplains of these rivers and the natural depressions (haor-seasonal wetland, baor-oxbow lake, and beel-perennial water body) go under water during the monsoon and create a huge open water fish habitat. The fisheries sector of Bangladesh playing an increasingly important role in the economy uplift efforts which augments growth and alleviates poverty. The inland water is inhabited by 260 species of indigenous fin fishes, 14 species of exotic fishes and 25 species of shrimp, while the marine water is inhabited by 475 species of fishes, 36 species of shrimp, 21 species of sharks, rays and skates, 6 species of lobsters, 16 species of crabs, 3 species of turtle, 7 species of squid and cattle fish, species of crocodiles, 350 species of mussels and snails and 165 species of sea weeds (Khan *et al*., 2005).

Age and growth are particularly important for describing the status of a fish population and for predicting the potentials yield of the fishery. Knowledge of fish age characteristics is necessary for stock assessments, and to develop management or conservation plans. Size is generally associated with age; however, there are variations in size at any particular age for most fish species making it difficult to estimate one from the other with precision. Growth is perhaps the most studied of all parameters used to describe the life history of exploited fish. Growth is usually expressed as a mathematical equation describing the mean growth of a population and relating size to age (Katsanevakis and Maravelias, 2008).

This fish prefers to live in waters of muddy streams and they have also adapted to live in stagnant waters (Moyle and Cech, 1998). *C. punctata* is carnivore in habit, prolific breeder and development is rapid, matures in first year and attains maximum length of 30 cm (Talwar and Jhingran, 1991). It is also voracious and predatory to small fish and fries (Bhuiyan, 1964; Rahman, 1989 and 2005). An understanding of growth is fundamental for population modeling, stock assessments, and managing exploited species. The methods used to estimate growth in fish vary significantly with the type of data being used. The most commonly used data for estimating fish growth is length-at-age data, although length-frequency data and mark recapture data are also used.

The aim of the assessment of population parameters, mainly age and growth, is to establish the status of a resource and to determine the levels at which it may be sustain ably exploited. Information about fish age, development and growth is fundamental for fishery research. A basic knowledge of how quickly fish grow and the relative numbers of juvenile and mature fish in a population is required to help answer questions about how fishing effects the population. It is helpful to know at what size and age a particular species reaches sexual maturity. Fishing can be restricted so that sufficient numbers of fish can reproduce before being exposed to sustained fishing pressure. It often necessary to hold fish in a hatchery until they reach an age capable of reproducing knowing the size and variation at different ages over several years is also important for basic comparison studies. Changes in these normal or may deflect a change in the suitability of the environment.

II. Materials and Methods

Multiple Samples Length- Frequency Analysis

In multiple samples, the modes of a single cohort with the same spawning date are traced as they progress over ages along the length axis when length-frequency distributions from samples at different times were arranged sequentially. Length-frequency distribution of each fish sample was segregated into its component modes using Bhattacharya method (1967).

Bhattacharya Plot

A method of sorting out a length-frequency distribution into its component normal distributions was developed by Buchanan-Wallaston and Hodgson (1929) and subsequently developed by Bhattacharya (1967). It was a graphical method of separating a length-frequency distribution into a series of normal distributions or pseudo-cohorts. The method is based on approximating the assumed normal curve of a length-frequency distribution as a parabola, which is then converted to a straight line. The Bhattacharya plot, the straight line has the form: dt (ln N) = a + b (L) where dt (ln N) was the difference between the natural logarithms of the number of one length class and the number in the preceding length class: L was the upper limit of the preceding length class.

Direct Fitting of Length-Frequency Data

Electronic Frequency Analysis I (ELEFAN I)

ELEFAN I was a routine that can be used to identify the (seasonally oscillating) growth curve that "best" fits a set of length-frequency data, using the value of Rn as a criterion. FISAT II provides three options to the user to identify that "best" growth curve: (1) curve fitting by eye (plotting of the histogram or restructured data may also be accessed from the Support Menu): (2) scan of K-values, and (3) response surface analysis. It was noted that in ELEFAN I, the parameter t_0 was replaced by the coordinates of a point (any point actually) through which the curve must pass, and whose coordinates consist of SS as starting sample and of SL as starting length. A file of time series of length-frequency data with constant class size was required. In ELEFAN I, data were reconstructed to generate "peaks" and "troughs". The program can be used more objectively to estimate growth coefficient (K).

Powell-Wetherall Plot

This method allows estimation of L_∞ and Z/K from a sample representing a steady–state population, as can be approximated by pooling a time series of length–frequency data (Wetherall, 1986). The value of SL_∞ and Z/K were estimated independently by the use of Powell-Wetherall plot, by pooling a series of length-frequency data composed at small time intervals. For that purpose, a file of length-frequency data with constant class size was mandatory. Input parameter graphical identification of smallest length fully recruited by the gear (L', or cut-off length) has a function of the form: (L-L') = a + b * L', where L was the mean length of all fish equal to, or longer than, length L', which becomes a series of lower limits for the length intervals of fully vulnerable fish. The regression line in the Wetherall plot was fitted through all data representing the fully exploited part of the sample, often from one length-interval to the right of the highest mode in the length-frequency data. From the regression line, the value of Z/K was estimated from the slope, b, as: Z/K = -(1+b) / b. A useful result of the analysis was that L may be estimated from the intercept, a, with the X-axis as: L = -a /b.

ELEFAN I method was used in the estimation of growth parameters of C. *punctata* in this study (Pauly and Garcia, 1994). Stepladders 1-5 were run with the corrected length distribution data in order to estimate correct growth and seasonal parameters. To get smooth curves, length class having small frequencies were excluded from ELEFAN I analysis. Bhattacharya method, Powell-Wetherall plots, and ELEFAN I methods were performed using FISAT software (Gayanilo and Pauly, 1997). Growth patterns of both male and female BW of *C. punctata* were established by fitting the von Bertalanffy growth equations to the mean body weights at ages: $BW_t = BW_\infty [1- \exp\{-K (t-t_0)\}]^3$ where BW_t is body weight (g) at age t (year), BW_∞ is asymptotic body weight, K is growth coefficient, t is age and t_0 is the theoretical age at zero weight. Body weights and ages were calculated from a few corresponding standard lengths of both by means of respective length-weight relationships and calculated from von Bertalanffy growth equations in terms of standard length. Length-weight relationships were approximated by the allometric equation of Huxley (1932). The growth parameters in terms of BW for both male and female were obtained by non-linear methods based on a direct search for the parameters that best fitted to body weight at age data using a routine that performs a Gaussian elimination by Delta Graph 4.5 software (Delta Point Inc., Monterey, CA, USA).

III. Results

Standard Length and Body Weight

A total of 1,200 specimens from 12 samples were composed. The range of standard length and body weight of both sexes were 35 to 205 mm and 2.21 to 191.15 g, respectively. Among the total number of fish 887 were male and 313 were female. The standard length of male ranged from 35 to 205 mm and the body weight ranged from 2.21 to 191.15 g. The standard length of female varied from 72 to 176 mm and the body weight ranged from 7.64 to 132.94 g (Table 1).

Age and Growth Model

To evaluate age and growth of spotted snakehead length frequency analysis was applied. This method was with arranging histograms sequentially of both sexes and analyzed by Bhattacharya plots for pseudo cohorts, it could not mark out the progression of any cohort over the sampling period. In conclusion, the study on age and growth of *C. punctata* got progressed by direct fitting of length-frequency data both to standard and to modified von Bertalanffy growth models with ELEFAN I procedure.

ELEFAN I procedure was used to fitting the seasonalized von Bertalanffy growth (VBG) function (Gayanilo and Pauly, 1997) to 12 time-series standard length-frequency data sets:

$SL_t = SL_\infty (1 - \exp(-K(t - t_0) + St_s + St_0)$,
$St_s = (CK/2\pi) \sin(2\pi(t - t_s))$,
$St_0 = (CK/2\pi) \sin(2\pi(t_0 - ts))$

Where SL_t is the standard length at age t (mm), SL_∞ the asymptotic standard length (mm), K the growth coefficient (per year), C the amplitude of oscillations, t the age (year), t_0 the theoretical age at zero length (year), and t_s is the starting time of the sinusoid growth oscillation. Here, t_s was replaced with WP (winter point, which is the period when growth is slowest) as $WP = t_s + 0.5$.

IV. Discussions

This study adopted von Bertalanffy growth equation for male and female as the appropriate equation for *C. punctata* in the Kajla beel of Bangladesh. Von Bertalanffy growth curves were fitted to length-at-age data of male and female separately and ELEFAN I method provided the values of the growth parameters by direct fitting of standard length-frequency data. By using these parameters the relationship between age and standard length were established.

The growth equation in terms of length for male was $SL_t = 217.88 [1- \exp\{- 1.10 (t - 0)\}]$ and the growth equation in terms of length for female was $SL_t = 186.60 [1- \exp\{- 1.35 (t - 0)\}]$.

The relationships between the pooled data of standard length (SL) and body weight (BW) for both sexes were as $BW = 0.00003\ SL^{2.94}$ for male and $BW = 0.0003\ SL^{2.97}$ for female. The von Bertalanffy growth equation in terms of body weight (BW) for male and female were $BW_t = 220.65 [1- \exp\{- 1.11 (t+ 0.01)\}]^3$ and $BW_t = 164.25 [1- \exp\{- 1.35 (t + 0.004)\}]^3$, respectively.

Using of length-frequency analysis Qasim and Bhatt (1966) found asymptotic length $L_\infty = 21.3$ TL cm, growth coefficient, K = 0.45 per year for female taki. Talwar *et al.* (1992) found maximum (L_{max}) length at 31 cm and asymptotic length (L_∞) 32.5 cm. A study on age and growth of *C. punctata* of various part of Tangail river in Bangladesh was reported by Graaf (2003) who determined the age using of length frequency analysis and ELEFAN I method, asymptotic length (L_∞) was 27 cm, 28 cm, 28.5 cm and 29 cm in terms of total length; K = 1.10, 0.90, 0.85 and 1.20 per year respectively. On the other hand, Mustafa and Graaf (2008) determined the age of *C. punctata* of various beels namely Medi, Shapla, Mara, Ashura, and Dikshi beel in Bangladesh, they were found to be asymptotic length (L_∞) was similar in each beel of 24 cm and K = 0.90, 1.20, 0.90, 1.10 and 1.20 per year respectively by using these method. Growth parameters analysis of *C. punctata* were done by Chandrashekhariah *et al.* (2000) in India, reported maximum weight 310 g and maximum length 31 cm. Beside this, using of length-frequency method and scale study, Archarya and Iftekhar (2000) was found that maximum weight 1,500 g in terms of total length in India. In the study of length-weight relationship of mixed population of *C. punctata* of Mathabhanga River in Bangladesh and 6.0 - 18.9 cm TL = 13.72 g was reported by Hossain *et al.* (2006).

But in this study, the von Bertalanffy growth parameters SL_∞ and K for both sexes of *C. punctata* 217.88 mm and 1.10 per year, 186.60 mm and 1.35 per year and BWα of 220.65 g and 164.25 g respectively. For the reason that of the lack of well defined characteristics formed in hard parts that indicate age, the age and growth of natural taki populations were estimated by identifying successive age groups from the modes of length-frequency distributions. For the spotted snakehead *C. punctata*, however, study on age and growth by any standard methods were not present in Bangladesh particularly.

In the present study, we assembled a large number of specimens of *C. punctata* from kajla beel. This in turn, allowed us to get frequency distributions of both sexes that used to estimate age and growth of taki. Nevertheless, reference to its age particularly and the method by which these estimates were made in general was not present. In fish, fecundity generally increases with the fish size. Larger size in females may be considered as a life history strategy for supporting increasing egg production (Roff, 1983; Beckman *et al.*, 1989). For females, relatively little foraging, which may result in decreasing the risk of predation, may slow the growth (Roff, 1983).

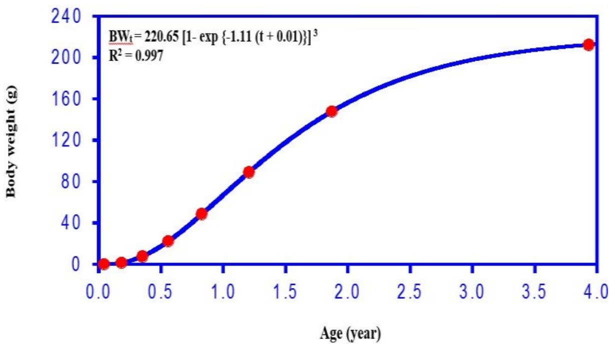
V. Conclusions

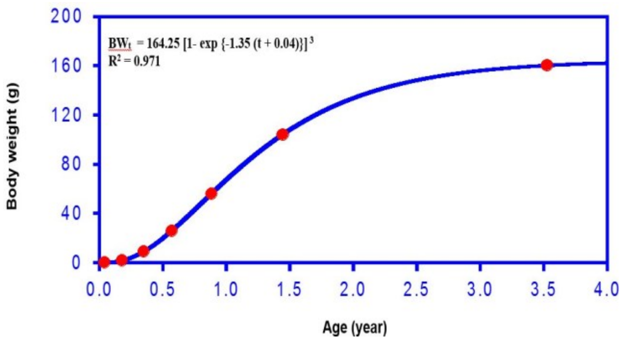
The present study on age and growth got progressed and established the relationship between age and standard length of *C. punctata.* On the other hand the higher values of coefficient of determination (R^2) for both male and female were observed in the Pauly and Gaschutz model. The size of male individual was larger than the female individual, whereas the maximum size was 205 mm for male and 176 mm for male. So estimation of the demographic parameters of fish populations, particularly age and the rates of growth are essential to the assessment of the population dynamics, potential yields and management of fisheries resources and by using the values of these parameters, we can establish the status of the *C. punctata* stock and the levels at which the stock could be sustain ably exploited from the Kajla beel.

Table 1. Age-weight keys for both male and female *C. punctata* to fit growth models. Body weights were estimated from respective length-weight relationship

Male		Female	
Mean BW(g)	**Age (years)**	**Mean BW(g)**	**Age (years)**
0.026	**0.04**	**0.03**	**0.04**
1.52	**0.18**	**1.70**	**0.18**
7.87	**0.35**	**8.96**	**0.35**
22.42	**0.55**	**25.81**	**0.57**
48.46	**0.82**	**56.21**	**0.88**
89.16	**1.21**	**104.09**	**1.44**
147.69	**1.87**	**160.14**	**3.53**
212.34	**3.93**		

BW = Body Weight





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