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Age and growth of gangatic Mystus: *Mystus cavasius* (Hamilton-Buchanan, 1822) by length-frequency analysis from central Brahmaputra Valley, Assam

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Abstract
The Gangatic catfish *Mystus cavasius* is a native catfish found in Brahmaputra and Barak valley of Assam which is a very popular food fish with has high market price. Our study provides the first data on age and growth of this species in central Brahmaputra valley of Assam. A total number of 285 specimens comprising of 103 males and 182 females have been studied using von Bertalanffy growth model and computer-based FiSAT programme was used for the estimation of growth parameters. In the FiSAT programme, the direct fit of length–frequency data such as Electronic Length Frequency Analysis-I (ELEFAN)-I technique, Shepherd's method and Powell–Wetherall plot were employed in the present study. The Asymptotic length (L_∞) and growth co-efficient (K) (annual) values of *Mystus cavasius* estimated by ELEFAN I, Shepherd's method and Powell and Wetherall method. The value of L_∞ and K by ELEFAN I, Shepherd's method and Powell and Wetherall method are 217.0 mm and 0.8 year^{-1}, 215.25 mm and 0.79 year^{-1} and 220.73 mm and 0.94 year^{-1} respectively. The two values of *Mystus cavasius* estimated about -0.41. The total length attained by this fish is about 135 mm at the end of 1st year, 180 mm at the end of 2nd years, 201 mm at the end of 3rd year and 210 mm at the end of 4th year.

Keywords: Asymptotic length, growth rate, length at age, Mystus cavasius, River Kolong, Nagaon, Assam

Introduction
The mighty river Brahmaputra with 42 important tributaries covering about 640 km in the state. River Kolong-Kopili is an important south bank tributary draining the central Brahmaputra in Assam supporting 126 fish species belonging to 26 families [1]. Kolong, a tributary of river Brahmaputra with a total length of about 250 km, originates from a place near Jakhalabandha (Nagaon district, Assam) in between two hills viz. Hatimura and Barjhap at latitude 26°36'3"N and longitude 93°5'7" E. It flows through the district of Nagaon and Morigaon and meets the Kopili River (a major south bank tributary of the Brahmaputra) near a village called Jagibhakatgaon and finally join into mighty Brahmaputra at Kajalimukh [2].
Bagridae family, the richest and the most important of the Teleostei class comprising of 27 genera (six in Indian region) is widely distributed in Asia and Africa [3]. Even though the catfishes are in great demand in the Indian domestic markets, the catfish aquaculture, including *Mystus* species, has not been developed for its aquaculture potential [4]. The entire demand for this fish in the domestic market is met through capture from rivers and hence the effective management of wild stocks is critical. Information on population structure is used for the development of management strategies that will conserve the biodiversity associated with different species, sub-species, stocks and races [5].
Mystus cavasius (Hamilton-Buchanan, 1822) is considered as one of the most important fish among indigenous catfish under family Bagridae of order Siluriformes. It is commonly known as 'Gangetic Mystus' which has been reported to be distributed in Pakistan, Bangladesh, India, Myanmar, Sri Lanka and Nepal [6]. *Mystus cavasius* is known for its hardy nature since it can survive in tough environment conditions such as wide ranges of

temperature and low oxygen concentrations [7]. Studies on age and growth are of paramount importance in fishery biological investigations, since these are required both in assessing. The changes in abundance of populations in relation to fluctuations in fishing pressure as well as in estimation of rates of mortality [8]. Determination of age and growth of a species further helps in the study of biological characteristics such as, longevity, rate of growth, age at first maturity and age structure of the stock.

The studies on age and growth of tropical fish from Central Brahmaputra Valley are rare and superficial. A little information on length-weight relationship and length-length relationship which were found linear relationship with length and weight and also among total length, standard length and fork length in Central Brahmaputra Valley [9]. Some of the important work on age and growth of Freshwater shark *Wallago Attu* along the Brahmaputra valley are by Goswami and Devaraj [10]. Despite the commercial importance of *Mystus cavasius* in River Kolong at Central Brahmaputra Valley, its age and growth have not been studied in order to access its production potentials. This paper therefore aims at determining the age and growth of *Mystus cavasius* in River Kolong at Central Brahmaputra Valley using length frequency data methods.

Material and Methods

In the present study, a total of 285 specimens of total length ranging from 80 mm to 205 mm collected from the river Kolong near Raha and other places of Morigaon were used for estimation of age and growth. All fishes collected during the period from January 2017 to December 2017 were grouped into length class of 10 mm interval. Fish specimens were caught using gill nets, cast nets and seine nets of varying mesh sizes from 25-40 mm from two different landing centres of ventral Brahmaputra of Assam. The collected fishes were packed in ice filled boxes and brought to the laboratory for further observation. In the laboratory body measurement of fish specimens were taken. Total length (TL) was measured to the nearest 1 mm by scale and body weight (BW) was measured with digital weighing machine with the precision of 0.1 mg using Sartorius BSA224S-CW electronic balance.

The length-frequency distribution are produced by plotting the length of individual sampled from a population against the number of fish (i.e. frequency of each length caught). To measure length frequency analysis, the entire data were analyzed using FAO-ICLARM Stock Assessment Tools (FiSAT) (Gayanilo and Pauly 1996). The von Bertalanffy growth equation (VBGF) (Von-Bertalanffy, 1957) was used to describe the growth. The simplest version of VBGF is;

$$L_t = L_\infty [1 - EXP^{\{-K(t - to)\}}]$$

Where

L_∞ = asymptotic length

K = growth coefficient

T_o = the hypothetical age at which fish had zero length

L_t = Total length of fish at age t

Analysis of the data using Electronic Length Frequency Analysis (ELEFAN I) to estimate 'K' and 'L_∞'. Total mortality (Z) value estimated by Jones and Von Zalinge's (1981) cumulative catch curve method.

Results

Estimation of growth parameters

Monthly Length frequency distribution of *Mystus cavasius* for the period from January 2017 to December 2017 and ELEFAN curve are shown in Figure 1 and 2. The parameters which were obtained by ELEFAN were L_∞ and K of 217.0 mm and 0.8 year^{-1} respectively for *Mystus cavasius*. K values plotted against score function following ELEFAN and Shepherd's methods and the results are depicted in Fig. 3 and 4. The relationship between K value and score function followed a similar trend in ELEFAN and Shepherd's methods. The difference of mean length and cut of length (mean L- L') against the cut of length (length at which fish recruit to gear fully) is shown in Figure 5. Cut of length identified by using Powel-Wetherall Plot available in the software.

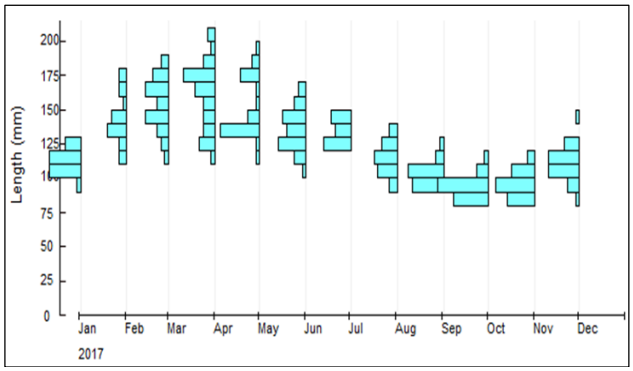

Fig 1: Monthly length frequency distribution of *Mystus cavasius*

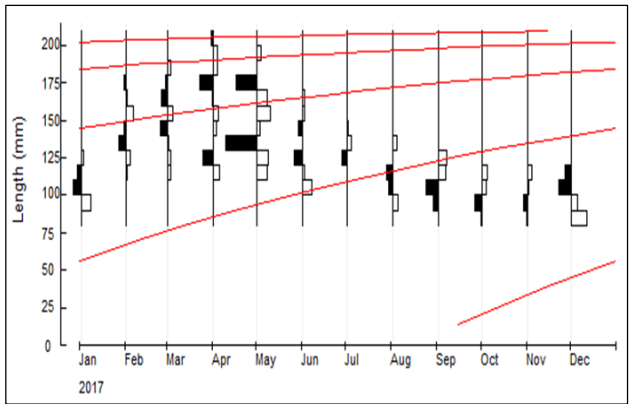

Fig 2: ELEFAN I curve of *Mystus cavasius*

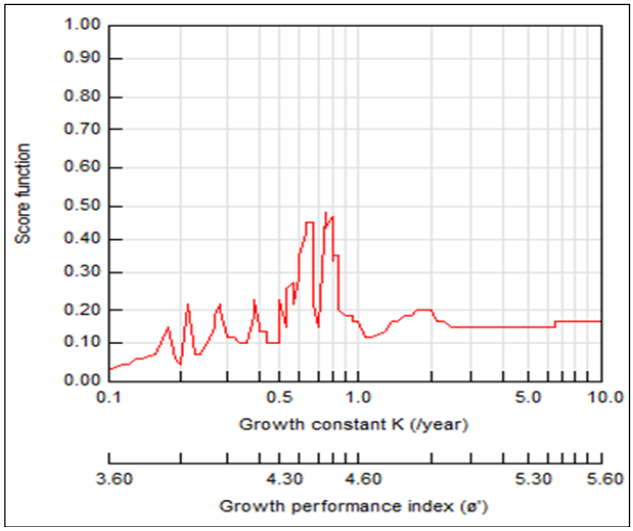

Fig 3: Non-parametric scoring of VBGF fit using ELEFAN I

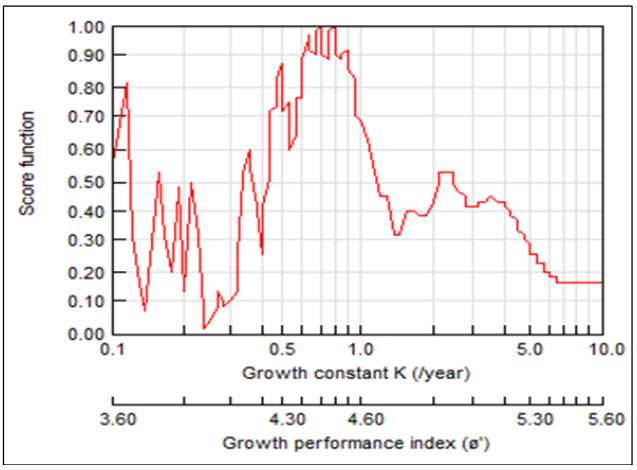

Fig 4: Maximising non-parametric scoring of VBGF fit using Shepherd's method

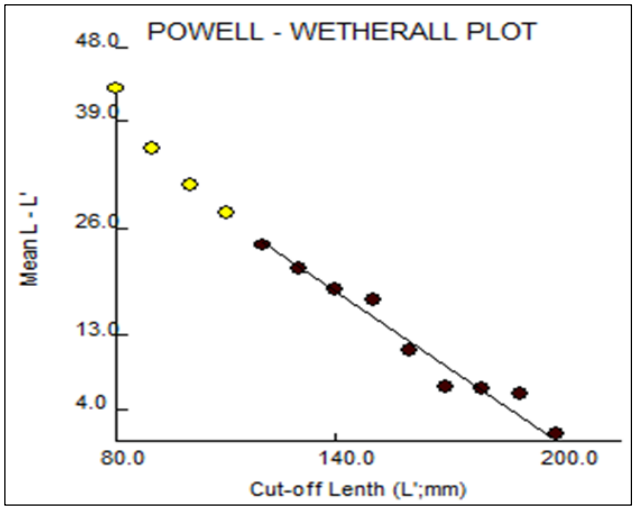

Fig 5: The difference of mean length (mean L- L') against the cut of length using Powel-Wetherall Plot

Estimate of Lα: 220.73
Estimate of Z/K: 3.159
Function: Y =53.08 + (-0.240) * X

The values obtained for the instantaneous rate of total mortality by Jones and van Zalinge Plot is presented in Figure 6. From Jones and van cumulative catch, curve method estimated the value of Z at 2.9694 year^{-1}.

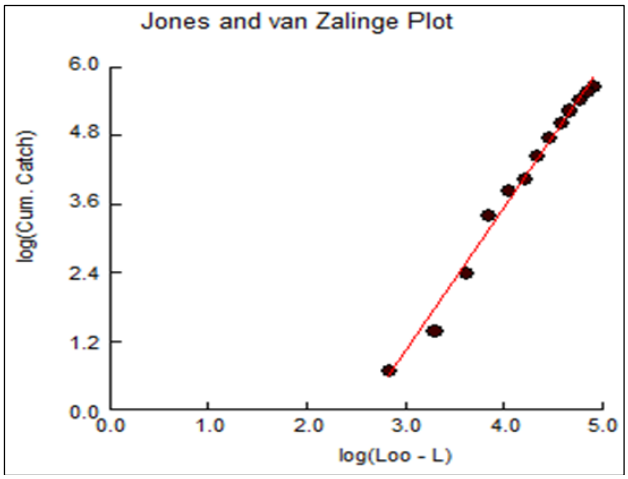

Fig 6: Estimation of Z from Jones and Van Zalinge Plot

Results obtained by all the three methods of direct fit of length frequency were presented in Table 1. Parameters estimated by all the three methods were almost similar. However, L_∞ in mm and K value estimated by ELEFAN was used for further analysis as ELEFAN is considered free from subjectivity compared to other methods.

Table 1: Growth parameter L∞ and K of *Mystus cavasius* obtained by a direct fit of length frequencies

Methodology	L∞ in mm	K value per year
ELEFAN	217.00	0.80
Shepherd's method	215.25	0.79
Powell and Wetherall	220.73	0.94

Estimation of 'T$_o$' By Von Bertalanffy's Plot

The value of 't_o' was estimated as -0.41 years by Von Bertalanffy's plot using monthly mean length and Lα and K obtained by ELEFAN – 1 (Table. 2 and Figure.7).

Table 2: Estimation of 't_o' by von Bertalanffy's plot

Age	L_t	Age 't_o' years (x)	L_α-L_t	L_α-L_t L_t	-L_n(L_α-L_t) (Y) L_t
0.1	17	-0.02	200	0.923	0.08
0.2	32	-0.04	185	0.852	0.16
0.3	46	-0.06	171	0.786	0.24
0.4	59	-0.08	158	0.726	0.32
0.5	72	-0.1	145	0.670	0.4
0.6	83	-.012	134	0.618	0.48
0.7	93	-0.14	124	0.571	0.56
0.8	103	0.16	114	0.527	0.64
0.9	111	-0.18	106	0.486	0.72
1.0	119	-0.2	98	0.449	0.8
1.1	127	-0.22	90	0.414	0.88
1.2	134	-0.24	83	0.382	0.96
1.3	140	-0.26	77	0.353	1.04
1.4	146	-0.28	71	0.326	1.12
1.5	152	-0.3	65	0.301	1.2
1.6	157	-0.32	60	0.278	1.28
1.7	161	-0.34	56	0.256	1.36
1.8	166	-0.36	51	0.236	1.44
1.9	170	-.38	47	0.218	1.52
2.0	173	-0.4	44	0.201	1.6
2.1	177	-0.42	40	0.186	1.68
2.2	180	-0.44	37	0.172	1.76
2.3	183	-0.46	34	0.158	1.84
2.4	185	-0.48	32	0.146	1.92
2.5	188	-0.5	29	0.135	2
2.6	190	-0.52	27	0.124	2.08
2.7	192	-0.54	25	0.115	2.16
2.8	194	-0.56	23	0.106	2.24
2.9	196	-0.58	21	0.098	2.32
3.0	197	-0.6	20	0.090	2.4
3.1	199	-0.62	18	0.083	2.48
3.2	200	-0.64	17	0.077	2.56
3.3	202	-0.66	15	0.071	2.64
3.4	203	-0.68	14	0.065	2.72
3.5	204	-0.7	13	0.060	2.8
3.6	205	-0.72	12	0.056	2.88
3.7	206	-0.74	11	0.051	2.96
3.8	207	-0.76	10	0.047	3.04
3.9	207	-0.78	10	0.044	3.12
4.0	208	-0.8	9	0.040	3.2
		=-16.4			
		t_o= -0.41	0.41 year		

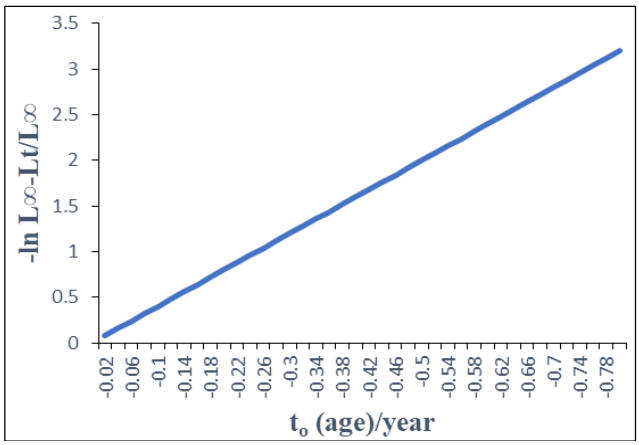

Fig 7: Von Bertalanffy's plot for estimation of 't_o' and K for *Mystus cavasius*

Estimation of length at age

The values of L_α and K estimated by ELEFAN-I were considered for the estimation of average length attained by *Mystus cavasius* at quarterly intervals using Von Bertalanffy's growth formula. The results, presented in Table 3 and Fig 8, indicated that *Mystus cavasius* attains a length of 135, 180, 201 and 210 mm at the end of 1, 2, 3 and 4 years of its life respectively. The maximum size recorded during the period of study was about 205 mm and the corresponding age was calculated at 3.5 years. Thus, according to the present study, the fishable lifespan of the species is 3.5 years.

Table 3: Average length attained by *Mystus cavasius* at different age

Age (Years)	L_t (mm)
0	0
0.25	68
0.5	95.112
0.75	117.2071
1.0	135
1.25	150.1068
1.5	162.2325
1.75	172.1601
2.0	180
2.25	186.9429
2.5	192.3914
2.75	196.8522
3.0	201
3.25	203.4925
3.5	205.9426
3.75	207.947
4.0	210

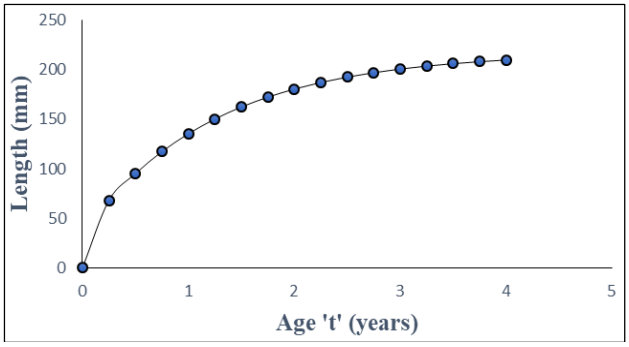

Fig 8: Establishment of von Bertalanffy's growth curve for *Mystus cavasius*

Discussion

Since there is a paucity of published work on the age, growth and population dynamics of *Mystus cavasius*, the results of the present investigation would definitely advance our knowledge on the biology of this fish species and immensely help in formulating relevant conservation and management programs for the protection of this endemic fish of India. Length-frequency data may represent valuable information concerning the life history of a fish species; however, the reliability of the analysis largely depends on the sampling strategy and the size of the samples investigated. The present study indicates that *Mystus cavasius* attain a size of 135 mm, 180 mm, 201 mm and 210 mm total length at the end of 1, 2, 3 and 4 years respectively. The maximum size recorded during the period of study was 205 mm at which the estimated age is 3.5 years. *Mystus cavasius* was found to be exhibit fastest increase in length during the first year of its life span and declined gradually over subsequent years.

Conclusion

This study has provided some basic information on the age and growth for *Mystus cavasius* that will be helpful to fishery biologists. No information is available on age and growth of this species from Central Brahmaputra valley, Assam. Information generated in the present study can be helpful in sustainable management of these resources, besides acting as baseline information for future studies. *Mystus cavasius* was found to exhibit the fastest increment in length during the first year of its life history and declined gradually over subsequent years. The growth rate was found to be good in Kolong River.

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