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Periodic Research

Age determination and growth rate of fresh water fish Puntius conchonius (Ham.-Buch.) by a use of trunk vertebrae

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Abstract

Paper deals with the validation method of ageing by using trunk vertebrae as an instrument. The section of trunk vertebrae shows that the life span of *Puntius conchonius* in maximum three years and average age is about two years. The cause of ring formation is probably spawning stress. In the present investigation with the help of back calculation method it was calculated that the first, second and third ring was formed at an average fish length of 49.49 ± 5.37, 62.38 ± 0.84 and 68.11 ± 3.28mm respectively. Age determination based on the length frequency distribution was noticed, fish is attained a length of 50mm, 60mm and 70mm after first, second and third year of age. The growth parameters of *P. conchonius* indicated that the specific rate of linear growth (C_l) is 26.045 between first and second year and 9.196 between second and third year. The index of species average size (ϕh) was 22.703. The values of growth constant (C_{lt}) were 0.348 between first and second year and 0.131 between second and third year with an average value of 0.239. The values of growth characteristics were 11.509 between first and second year and 5.458 between second and third year with an average of 8.483.

Keyword: *Puntius conchonius,* Trunk vertebrae, Age determination and growth rate, Length frequency distribution, Growth Parameters.

Introduction

Puntius conchonius (Ham.-Buch.) is a fresh water fish and is commonly known as minor carp fish. It is locally called as “Damra” in Uttarakhand region, India. This fresh water species abundantly found in Mandal River (Bahuguna, 2007). Age and growth studies are important for the problems associated with management of fisheries. Age determination of fish from scales, otoliths, vertebrae, fins, spines, fin rays and other a structure is a matter of routine with most exploited fish stocks. Monitoring of a population of known age require long time and is quite expensive method. Hence, the best validation method for age determination is to study of annulus formation of fish seems to be marginal growth analysis. A great deal of work has been done on age determination and growth estimation in fishes but main contributors are Lee,1920; Dobriyal and Singh 1990; Tandon et.al., 1993; Johal et.al., 2000; Gursoy et.al., 2005; Tsikliras et.al., 2005; Pathani and Joshi, 2006 etc.

Little information is available on the biology of this species. A few studies are available to sexual dimorphism in P. conchonius (Dobriyal et. al., 2007) and length-weight relationship between body and brain in P. conchonius reported by Bahuguna et.al., (2007). At present no published information is available on age and growth of P. conchonius from this sub-continent. The result of the age and growth study would be useful in future for the artificial propagation and stocking of this species in ponds.

Material and Methods

Fish samples were collected month wise during July 2003 to June 2005 in Mandal River (Map.1and Photo1.1). A total of 450 specimens of P. conchonius ranging size from 36-85mm in total length and 1920-9875mg in weight were used for the analyses. Length of fishes was measured on the fish measuring board to the nearest mm and weight up to gm by using a digital electronic balance. Age determination and growth rate mechanism of P. conchonius was studies by the vertebrae method and was also confirmed by the length frequency distribution method (450 specimens). The trunk vertebrae from 120 specimens were observed in the present study. Specimens were dissected (open) and transverse section of its centrum was cut with the help of a clean sharp razor. It was then kept in clove oil to impart transparency. Finally the cleared trunk vertebrae were

kept in an envelope for further examination. The fish length and vertebrae radius relationship was examined with the help of standard regression analysis. Viz., Y = a + bx

Where:
X = fish length (an independent variable).
Y = vertebrae radius (a dependent variable).
a & b = constant.

Vertebrae were subjected for further examination, which includes the identification of annuli and its measurements focus. Besides, minimum width in terminal zone (i.e. the distance from last annuli to margin) was also noticed of each vertebra in each month round the year. The data was further analyzed to find out the month and probable cause of annuli formation.

Back Calculation for vertebrae:

The growth rate of fish was calculated by back calculation method as suggested by Lea (1910). The formula read as: $\mathbf{l_n = V_n / V. l}$

Where:
l_n = Length of fish when annulus "n" was formed,
l = Length of fish when vertebrae sample was obtained,
V_n = Vertebrae radius of annulus "n" at l_n,
V = Vertebrae radius.

Growth Parameters:

The growth parameters were calculated as suggested by Tandon and Johal (1996). These were including specific rate of linear growth, Index of species average size, Growth characteristics, Growth Constant and the age at first Maturity.

Specific rate of linear growth: $C_l = l_n - l_{n-1} / l_{n-1} \times 100$

Index of species average size: $\phi h = \sum^{nj+a} h; \quad h = l / n_{j+a}$

Growth characteristics: $C_{th} = \log l_n - \log l_n\text{-}1 / 0.4343 \times l_n\text{-}1$

Growth Constant: $C_{lt} = \log l_n - \log l_n\text{-}1 / 0.4343 \times t_2+t_1/2$

Where:
l_n and l_n –1 are mean computed total length of fish at ultimate and penultimate year of life.
J = Juvenile,
a = adults,
n = number,
h = absolute increment in length,
$t_2 + t_1$ are the time intervals between ultimate and penultimate age classes and the value of $t_2 + t_1/ 2$ is equal to 1.5.

Results and Discussion

It is observed that the vertebrae structures of *P. conchonius* were found very suitable for age determination. Vertebrae are found circular in most of the cases (Plate 1.1, 1.2 and 1.3). The opaque and hyaline zones were clearly distinct, hence the ring, which is all around the diameters, was considered as annuli. Each annulus comprised of two growth rings. Data on the age and growth in *P. conchonius* based on the various length groups is given in Table 1.1. The relationship between fish length and vertebrae radius is shown in Figure 1.1. It was calculated as:

VR = -20.0010 + 0.87123 FL, r = 0.72983.

Where:
VR = vertebrae radius,
FL = fish length,
r = Coefficient of correlation.

Time of annulus formation:

In the present investigation maximum three age rings wear counted (Plate 1.1, 1.2 and 1.3). Minimum width in terminal zone for vertebrae was also observed during July-August (Fig. 1.2).

Growth rate of fish by back calculation method:

The growth rate of *P. conchonius* was also determined by the back calculation method based on trunk vertebrae. It was observed that the first ring was formed at an average length of 49.49 mm. The second and third rings were appeared at an average length of 62.38mm and 68.11mm respectively. The annual increment (h) of 49.49mm, 12.89mm and 5.73mm were observed from first to third year (Table-1.2).

Growth parameters:

Summary of the growth parameters of *P. conchonius* (Table 1.3) indicated that the specific rate of linear growth (C_l) is 26.045 between first and second year and 9.196 between second and third year. The index of species average size (ϕh) was 22.703. The values of growth constant (C_{lt}) were 0.348 between first and second year and 0.131 between second and third year with an average value of 0.239. The values of growth characteristics were 11.509 between first and second year and 5.458 between second and third year with an average of 8.483.

Conformation of result by length frequency distribution (Peterson's methods):

Examinations of the length frequency distribution were presented in Fig 1.3. For this purpose about 450 fishes were collected round the year (July-2003 to June 2005). After micro-level examination, it was observed that the fish attends a length of 50mm, 60mm and 70mm during first, second and third year respectively.

The study of age determination in fish depends on annual growth marks in certain skeletal part of fish, which are formed as a result of irregular growth and metabolism. Temperature and spawning are the important causative factors responsible for annulus formation (Holcik, 1967; Natrajan and Jhingran 1963; Linfield, 1979). On the basis of regression analysis we could obtain straight-line relationships between fish length and vertebrae radius. Age rings, which were maximum three, were studied by vertebrae and were confirmed by the length-frequency distribution method. On the basis of minimum width in terminal zone of vertebrae, it is concluded that the months of ring formation were July-August when natural environment was disturbed due to monsoon. Another cause of ring formation may be spawning stress as the fishes perform heavy spawning during May-July which might have disturb the growth rate.

According to Qasim (1973) in general, all fishes have annual cycles of maximum growth corresponding to summer and autumn when

temperature and food supply are moderate and suitable ambient conditions. Lea (1910) observed in the young herrings that the rate of increase in length, deducted from the scales was greater when there was a rise of temperature in springs but it decreased before the temperature attained its maximum. Dobriyal and Singh (1990) in *Barilius bendelisis* also identified the growth rings as spawning marks. According to Kohli and Goswami (1989) who worked on the pectoral spine of *H. fossilis*, the annual rings were formed in May-June, which is the spawning period of fish in Assam. It was observed that the feeding intensity was low during this period. Hence, the formation of growth rings can be attributed to the cumulative effect of "nutrition and spawning".

Correction factor is also considered for age determination of fish, Tandon and Oliva (1977) used it for fish vertebrae relationship in *Silurus glanis*, a sheat sish in Czechoslovakia. In the present study we used back calculation for vertebrae study instead correction factor. In the present investigation maximum 3 age rings were noted in vertebrae structure. The maximum width in terminal zone was observed during April to June in vertebrae (15-18 omd), thus indicating these months are most distant months of age ring formation. The probable months of age ring formation were observed July-August, and the least minimum width in terminal zone was observed in these months too. It can be easily concluded that vertebrae tool of age determination confirm only one frequency of ring formation in *P. conchonius*. During the month of May and June highly mature eggs occurs in the abdominal cavity, so it affects the feeding intensity of fish therefore low feeding factor was noticed during these months. We may say that like a spawning stress, low feeding was also a causative factor for ageing in *P. conchonius*.

In the present investigation with the help of back calculation method it was noticed that the first, second and third ring was formed at an average fish length of 49.49 ± 5.37, 62.38 ± 0.84 and 68.11 ± 3.28mm respectively. Lagler (1977), who worked on the length frequency method, is based on the expectancy that the frequency analysis of a species of any one age group collected on the same data will show variations around the mean length according to normal distribution. Thus, there will be clumping of fish of successive ages at successive length when sampled at randomly. Age determination based on the length frequency distribution was recorded, fish is attained a length of 50mm, 60mm and 70mm after first, second and third year of age.

The growth annual increment (h) of *P.conchonius* shows that the length increment (h) was 49.49mm, 12.89mm and 5.73mm first, second and third year of life respectively. The specific rate of linear growth (C_l), between first and second year was found 26.045 and between second and third year age was recorded 9.196. The species average size (ϕh) was noted to be 22.70. The value of growth characteristics of vertebrae was (C_{th}) observed for *P.conchonius* in the present investigation showed normal growth 11.509 during first and second year. But very slow growth occurred between second and third year age of *P. conchonius* (8.483). The average growth of *P. conchonius* was noticed 8.483 for vertebrae respectively. On the basis of above observation it may concluded that the life span of the *P. conchonius* is maximum three years. The fish were matured at a size of 52mm (male) and 54mm (Female).

Table1.1: Data on the Age and Growth of *Puntius conchonius* based on various length groups.

Fish length (mm)	V.R. (Ocular Micrometer division) 1 Omd = 0.016mm	VRn_1 (OMD)	VRn_2 (OMD)	VRn_3 (OMD)	Ln_1 (mm)	Ln_2 (mm)	Ln_3 (mm)
36 – 45	-	-	-	-	-	-	-
46 – 55	20 - 40* 30.80 ± 8.67	16 - 22 18 ± 7.61	-	-	35.40 - 40.26 38.28 ± 2.59	-	-
56 – 65	26 - 45 35.60 ± 5.86	14 - 23 20.12 ± 4.52	-	-	39.86 - 48.60 46.77 ± 3.68	-	-
66 – 75	30 - 53 43.23 ± 7.81	17 - 25 22.85 ± 1.95	26 - 35 29.97 ± 3.70	34 - 49 43.27 ± 5.14	40.73 - 53.75 51.15 ± 6.61	55.40 - 63.90 61.23 ± 5.23	64.75 - 67.51 65.13 ± 2.79
76 – 85	50 - 61 56.28 ± 3.98	20 - 32 25.12 ± 7.61	34 - 41 35.57 ± 2.07	43 - 56 49.28 ± 4.11	48.80 - 59.19 56.24 ± 1.49	58.81 - 65.33 63.79 ± 1.04	66.44 - 74.36 68.68 ± 3.20

VR = Vertebrae radius, VRn_1 = Vertebrae radius at annulus n_1, Ln_1 = Length of fish at the time of annulus n_1 formation.
*= Min-Max
Average ± SD

Table 1.2: Back calculated length of *P. conchonius* based on age class collected from river Mandal during July 2003 to June 2005.

Age class	No of fish studied	Average fish length at the time of capture (mm)	L_{n1} (mm)	L_{n2} (mm)	L_{n3} (mm)
I	19	(55.85 ± 2.68)	(49.82 ± 4.02)	-	-
II	21	(69.75 ± 4.85)	(43.96 ± 3.10)	(62.98 ± 5.33)	-
III	10	(79.95 ± 2.87)	(54.69 ± 3.60)	(61.79 ± 1.11)	(68.117 ± 3.28)
Average values		(68.516 ± 12.10)	(49.49 ± 5.37)	(62.38 ± 0.84)	(68.117 ± 3.28)
h (annual increment)			49.49	12.89	5.73

Ln_1 = Fish length at the time of annulus formation. n_1.

Table 1.3: Summary of growth parameters of P.conchonius.

Parameters	Year of life (Age classes)				
L.(mm)	49.490		62.380		68.117
h (mm)	49.490		12.890		5.730
Φ h (mm)			22.70		
C_l		26.045		9.196	
C_{lt}		0.348		0.131	
			0.239*		
C_{th}		11.509		5.458	
			8.483*		

L = Average length at the time of annulus formation, h= annual growth increment, Φ h= index of species average size, C_1= Specific rate of linear growth, C_{lt} = growth constant, C_{th}= growth characteristics, * = average value.

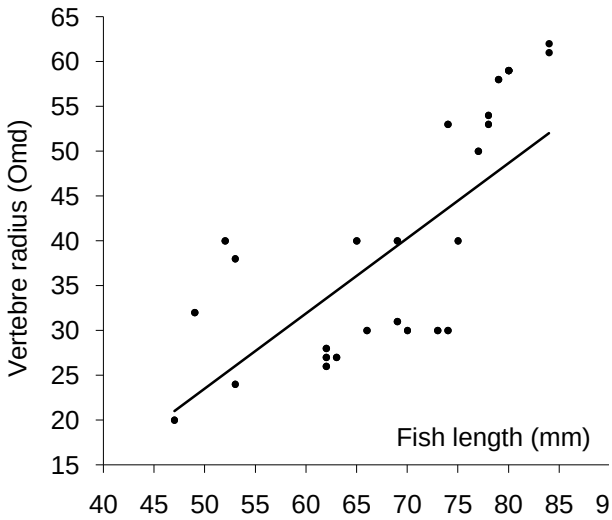

Fig.1.1: Regression between fish leng and vertebre radius in *P. conchoniu* (Ham.Buch.)

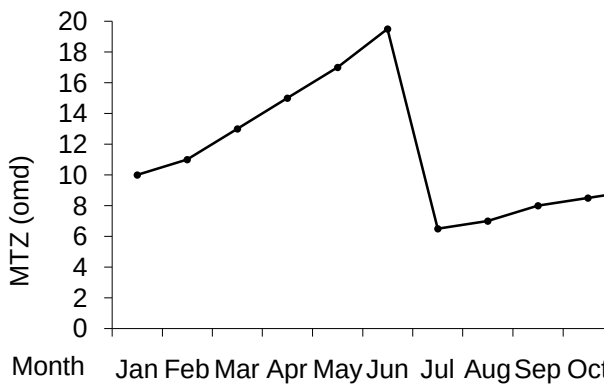

Fig:1.2: Minimum width in terminal zone of age the vertebrae of *P. conchonius*.

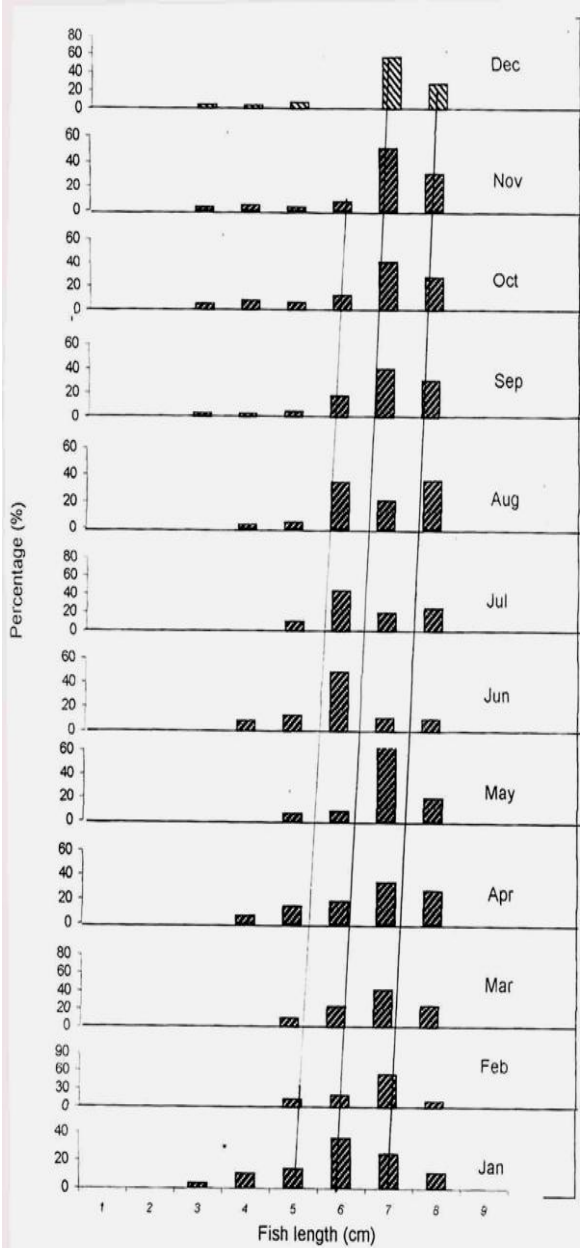

Fig.1.3: Length frequency distribution of *P.conchonius.*

Photo 1.1: Female and male fish *Puntius conchonius.*

Plate 1.1: One year ageing trunk vertebrae

Plate 1.2: Two year ageing trunk vertebrae

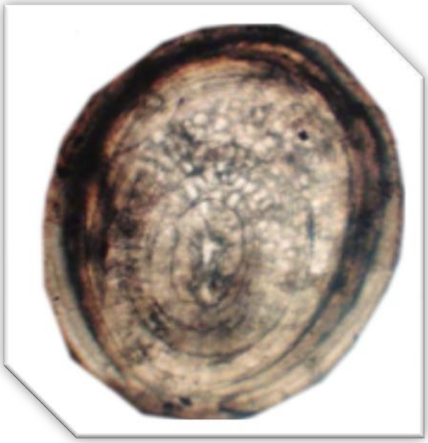

Plate 1.3: Three year ageing trunk vertebrae

Map.1: Sampling sites of Mandal River.

Conclusion

Puntius conchonius is the most important ornamental cyprinid fish of Garhwal region. This paper deals with the age and growth determination in *Puntius conchonius* by reading of trunk vertebrae that allowed the identification of 3 age groups. The width of the growth rings diminishes as the age increases. The growths of the trunk vertebrae are proportional to the fish growth. The period of highest growth rate happens during the first year of life. During the first year *P. conchonius* grows 49.49 cm, the second year 62.38 cm and the third, 68.11 cm. The strategy of the quick growth during the first year of life allows *P. conchonius* to diminish the natural mortality. Age determination based on the length frequency distribution was recorded, fish is attained a length of 50mm, 60mm and 70mm after first, second and third year of age. On the basis of minimum width in terminal zone of ring formation in vertebrae, it was concluded that the months of ring formation were July-August when natural environment was disturbed due to monsoon. Another cause of ring formation may be spawning stress as the fish perform heavy spawning during May-July which might have disturb the growth rate.

Suggestions

Puntius conchonius species is available only in the river Mandal of Garhwal in abundance. It is of rare occurrence in other streams. *P.conchonius,* the fish under study, shows clear-cut sexual dimorphinism. Age rings, which were maximum three, were studied by vertebrae and were confirmed by the length-frequency distribution method. I recommend that in studies involving the rate of survival and growth, age composition of this species, the vertebrae may be used as the most reliable structure for the age determination of *P.conchonius.*

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