AGE AND GROWTH OF *SALMOSTOMA UNTRAHI* (PISCES: CYPRINIDAE) FROM BHADRA RESERVOIR, KARNATAKA

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Web supplement

ABSTRACT

Age and growth of Salmostoma untrahi *from Bhadra reservoir region of Karnataka were studied using length frequency analysis during July 1999 to June 2001. The growth increments were different between the sexes of* S. untrahi *and the growth rate decreased in both sexes with advancement of age. In general, a sigmoidal growth pattern was observed. Male and female fishes attained 117.89mm and 120.99mm at the end of first year and 128.89mm and 139.48mm at the end of second year respectively. Fluctuations in the growth rate were probably due to the influence of various factors such as geographical, quality and quantity of food, and population density. The life span of the fish was about 1-2 years.*

KEYWORDS

Age, growth, length frequency, life span, Salmostoma untrahi

Fresh water fisheries of India are of utmost national importance in augmenting the country's food resources and as material for scientific study. Reservoir ecosystems have been recognized for their great potential for fish production. At the present level of management, the average fish yield of Indian reservoirs is only between 10-16kg/hectare/year (Jhingran, 1991).

Salmostoma fishes are included in the Class Cypriniformes and Family Cyprinidae (Jayaram *et al*., 1982; Talwar and Jhingran, 1991). Ten species of *Salmostoma* are found in Indian freshwaters, of which *Salmostoma untrahi*, a small fish is one of the dominant species in the Bhadra reservoir of Karnataka. They generally occur in large numbers and yield valuable minor fisheries in certain areas. Most of them take baits and are therefore popular with anglers. The dried fish of *S. untrahi* is used in poultry, in addition to human consumption. The cost of this fish is much cheaper than other freshwater fishes. Yet, no detailed work has been carried out on the biology of this species in the Malnad region of Karnataka. This paper deals with the age and growth of this species along the backwater of Bhadra reservoir region.

MATERIALS AND METHODS

A total of 1432 fishes were examined under the study and 37 to 97 specimens of *S. untrahi* were collected using gill nets at monthly intervals from backwaters of Bhadra reservoir ($13^0$42'N & $75^0$38'E), during the period from July 1999 to June 2001. Age and growth was studied by analysis of length frequency data (Petersen, 1891; Devaraj, 1983). For analysis of size frequency distribution, the lengths were grouped into 5mm size categories (see Table. 1), and was converted to percentages, and represented as bar diagrams for each month. From the data on lengths at ages, the mean lengths at age 1,2,3 months were determined. These data formed the basis for calculation of growth rate as well as age of fish. Von-Bertalanffy's (1938) growth equation $L_t - L_\infty [1-e^{-k(t-t_0)}]$ was fitted using the age-length data, where L_t - length at age 't', L^∞ - asymptotic length, t_0 - age at zero length and k - coefficient of catabolism. The growth parameters L_∞, k and t_0 were determined by the analytical method (Bagenal, 1955) and by Ford-Walford plot (Ford, 1933; Walford, 1946; Beverton & Holt, 1957).

RESULTS

Distribution of length frequency data

Male and female fishes attained 128.89mm and 139.48mm at the end of first year and 117.89mm and 120.99mm at the end of second year respectively.

The frequency distribution of size classes both monthly and according to sex is shown in Images 1-4[w], respectively. In case of males, during 1999-2000, it was seen that in July and August unimodal distribution was observed at 98mm. In September only one mode was found at 93mm. In October two modes were observed at 93mm and 103mm respectively. In November, December and January one mode was found at 93mm, 98mm and 98mm respectively. In February one more mode was observed at 118mm. During March and April bimodal distribution each were noticed at 93, 118mm and 88, 98mm respectively. In May and June one mode was seen at 98mm (Image 1[w]).

For females during 1999-2000 one mode could be seen in July at 98mm. In August and September one mode each were recognized at 103mm respectively. In October and November again, one mode each was found at 108 and 98mm. In December three modes were noticed at 98, 108 and 118mm. In January one mode was seen at 108mm. In February three modes each could be traced at 108, 118 and 133mm respectively. Again bimodal distribution could be recognized during March at 103 and 113mm respectively. In April two modes each were noticed at 93 and 113mm. In May two modes each were noticed at 88 and 123mm. In June only one mode could be found at 98 mm (Image 2[w]).

It clear from Image 3[w] that in males during 2000-01 it was observed that in July, August, September, October and November only one mode could be traced at 88mm. In December bimodal distribution could be recognized at 88 and 98mm respectively. While, in January and February one mode can be traced at 93mm. In March, April and May unimodal distribution could be observed at 98mm. Nevertheless, in June bimodes were found at 83 and 98mm.

[w] See Images 1-8 in the web supplement at www.zoosprint.org

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Similarly, in females during July, August and September one mode could be recognized at 88mm. From October to February except December one mode could be noticed at 93mm. In March again unimode was found at 103mm. While, one mode was observed at 113mm during April. In May and June also unimode could be recognized at 98mm and inn December another mode was recorded at 118mm.

Table 2 presents the mean length at monthly intervals and monthly growth rate for males and females obtained from scatter diagram of modes (Image 5[w]). The Von-Bertalanffy growth curve utilizing the growth parameters obtained by the analytical method are presented in Table 3 and 4 for male and female respectively.

Growth Equation

From biological point of view, it is necessary to fit the growth equation with respect to length or weight to understand any fish population. The Von-Bertalanffy's growth equation as per graphical (Image 4[w]) and analytical (Image 5[w]) method for both the sexes are as follows:

		Graphical method	Analytical method
1999-2000			
	Male	L_t - 148 [1-$e^{-0.1754(t-0.30)}$]	L_t - 142.2234 [1-$e^{-0.2016(t-0.256)}$]
	Female	L_t - 158 [1-$e^{-0.1754(t-0.40)}$]	L_t - 161.9672 [1-$e^{-0.1693(t-0.3352)}$]
2000-01			
	Male	L_t - 138 [1-$e^{-0.1754(t-0.40)}$]	L_t - 132.094 [1-$e^{-0.1895(t-0.2304)}$]
	Female	L_t - 151 [1-$e^{-0.1400(t-0.30)}$]	L_t - 144.013 [1-$e^{-0.1566(t-0.2904)}$]

The growth equation of *S. untrahi* was fitted for mean length age data obtained by scatter diagram using analytical and graphical method. The growth rates recorded showed a declining trend with the passage of time. The growth rates were faster during the monsoon season. In males, during 1999-2000 growth rate in the first and second month was found to be 21mm and 23mm respectively. From third month onwards the growth rate gradually decreased and reached 8mm in the seventh month. In eighth and ninth months the rate of growth was constant i.e., at 6mm. From tenth month onwards the growth rate gradually decreased and reached as low as 2mm in the twelfth month. Similarly, in females the rate of growth in the first and second months was found to be 19mm and 24mm. From third month onwards growth rate gradually decreased and reached to 9mm in the seventh month. In eighth month the rate was increased to 10mm and again decreased and reached 5mm in the tenth month and further increased to 6mm in the eleventh month and reached lower rate in the twelfth month (3 mm).

In males during 2000-01 the growth rate in the first month was found to be 19mm and 22mm during second month. In the third month growth it reduced to 14mm. The growth rate reduced to 12mm in the fourth month. Thereafter, it gradually decreased and reached 10mm during the sixth month. From seventh to ninth months, the growth rate was constant. During the tenth month, rate of growth was found to be 5mm and in the eleventh and twelfth month the rate reached to 4mm. Similarly, in females the rate of growth in the first month was 16mm and reached 19mm in the second month. From third month onwards, growth decreased and reached 8mm in the seventh month. In the eighth month, the growth rate again increased to 9mm and further decreased to 7mm and 4mm in the ninth and tenth months respectively. In the eleventh month again growth rate further increased to 5mm and later reached a low as 3mm in the twelfth month.

Von-Bertalanffy's growth equation has been found to be useful in describing adequately the growth functions of many fishes (Beverton & Holt, 1957). The expected length obtained by Von-Bertalanffy's growth equation and growth parameters obtained by least square method and graphical method were found to be in good agreement. The asymptotic length obtained (L_∞) in the present study is more than the length maxima (L_{max}) recorded. From this it seems probable that the life span of *Salmostoma untrahi* vary between 1-2 years.

DISCUSSION

As reported above, there was an inverse relationship in growth rate as a function of age. This may probably be due to the fact that the growth is dependent on food quality and quantity, population density and other environmental factors. The influence of all these factors is believed to have a role in the results obtained in the present study.

From general pattern of distribution, it may be inferred that *S. untrahi* in the Bhadra reservoir grows rapidly in '0' year and first year. This differential growth rate of *S. untrahi* obeys the growth laws of Medawar (1945). Ramakrishnaiah (1972) studied the age and growth of *Hilsa ilisha* from Chilka lake and found that during zero, one-year and two-year old fish attain 162, 237 and 387mm size respectively. The average monthly growth rate of the species was 20 and 13mm during first and second years respectively.

In *S. untrahi* the females grow faster than the males in both the years. The higher growth recorded coincided with the early attainment of maturity in females, unlike in males. Similar observations were reported by Brown (1957) and Johar (1981). However, a slow growth rate was observed after the attainment of maturity in both the sexes. This can be attributed to the continuous recruitment of small juveniles into fishing grounds which may influence the growth rate of adults (Moffett, 1965; Dall *et al.*, 1990).

As reported above, there was an inverse relationship in growth rate as a function of age. This may probably be due to the fact that, fishes growth is dependent on sex and size of the animal or geographical (Rao, 1969a,b) and, quality and quantity of food, light, temperature and population density (Dall *et al*., 1990). The influence of all these factors is believed to have a role in the results obtained in the current study. The growth curves fitted by Von-Bertalanffy's model are in close agreement with the observed ones. This confirms to the typical growth pattern of sigmoidal or S-shaped growth form (Dall *et al*., 1990).

For most of the fishes growth is a continuous process, though generally with fluctuating velocity. Brown (1957) described

that the growth in size occurs during fry and juvenile periods but the adult animal generally does not grow larger and the senile animal may even shrink and shows progressive loss of faculties. The present findings confirm the opinion of Brown (1957) and Johar (1981) that the average specific growth decreases after the onset of sexual maturity and age in most fishes.

The present study is in close agreement with the views of above workers that the growth is retarded among the older fishes. Similar observations were presented by Natarajan and Jhingran (1963) in *Catla catla*. The asymptotic length (L_∞) obtained in the present study is more than the length maxima (L_{max}) recorded. From this it seems probable that the life span of *S. untrahi* vary between 1-2 years. Males and female fishes were found to achieve 117.89mm and 120.99mm at the end of first year; 128.89mm and 139.48mm at the end of second year, respectively. The values observed are in complete agreement with observations of Ramamurthy *et al.* (1975).

However, growth curves based on the parameters like K and L^∞ are extremely variable within species (Pauly *et al*., 1984; Longhurst & Pauly, 1987). Thus, as per Dall *et al.* (1990) growth parameters of species and locations are not directly comparable. The same holds good in the present investigation also. Hence, all the results obtained here, in this study should be viewed taking into consideration, the population structure, sampling criteria and problems associated with parameterization of growth curves.

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Table 1. Number of fish studied under each months and different size groups from 1999-2001

Months	Sex		Length groups	1999-2000		2000-2001	
	M	F		M	F	M	F
				(mm)			
Jul. 1999	16	44	71-75	-	-	01	-
Aug.	30	30					
Sep.	48	12	76-80	01	-	04	01
Oct	14	46					
Nov	29	11	81-85	13	02	37	17
Dec.	53	07					
Jan. 2000	43	05	86-90	73	08	135	49
Feb.	39	15					
Mar.	45	08	91-95	140	37	136	78
Apr.	54	11					
May	45	11	96-100	157	71	127	51
Jun.	56	41					
Jul.	18	19	101-105	71	59	35	27
Aug.	31	29					
Sep.	30	30	106-110	15	38	04	13
Oct	37	23					
Nov	59	14	111-115	-	12	-	03
Dec.	42	27					
Jan. 2001	45	15	116-120	02	08	-	01
Feb.	45	15					
Mar.	47	13	121-125	-	04	-	-
Apr.	48	12					
May	34	16	126-130	-	01	-	-
Jun.	43	27					
			131-135	-	01	-	-
Total	**951**	**481**		**472**	**241**	**479**	**240**

[w] See Images 1-8 in the web supplement at www.zoosprint.org

***Table 2. Mean length (mm) at monthly intervals from the scatter diagram for* Salmostoma untrahi**

Sex	Male		Female		Male		Female	
Year	1999-2000		1999-2000		2000-2001		2000-2001	
Months (t)	Mean length (Lt) (mm)	Monthly growth rate	Mean length (Lt) (mm)	Monthly growth rate (mm)	Mean length (Lt) (mm)	Monthly growth rate (mm)	Mean length (Lt) (mm)	Monthly growth rate (mm)
1	21.0	-	19.0	-	19.0	-	16.0	-
2	44.0	23.0	43.0	24.0	41.0	22.0	35.0	19.0
3	61.0	17.0	61.0	18.0	55.0	14.0	50.0	15.0
4	75.0	14.0	75.0	14.0	67.0	12.0	64.0	14.0
5	88.0	13.0	88.0	13.0	78.0	11.0	75.0	11.0
6	98.0	10.0	99.0	11.0	88.0	10.0	85.0	10.0
7	106.0	8.0	108.0	9.0	94.0	6.0	93.0	8.0
8	112.0	6.0	118.0	10.0	100.0	6.0	102.0	9.0
9	118.0	6.0	126.0	8.0	106.0	6.0	109.0	7.0
10	123.0	5.0	131.0	5.0	111.0	5.0	113.0	4.0
11	127.0	4.0	137.0	6.0	115.0	4.0	118.0	5.0
12	129.0	2.0	140.0	3.0	119.0	4.0	121.0	3.0

Table 3. Expected length (mm) of* Salmostoma untrahi *obtained by Von-Bertalanffy's growth equation during 1999-2000 (data based on length frequency), analytical method

t	$(t-t_0)$	$-k(t-t_0)$	$e^{-k(t-t0)}$	$1-e^{-k(t-t0)}$	$Lt = L_\infty [1-e^{-k(t-t0)}]$
			Male		
1	0.7439	-0.1499	0.8608	0.1392	19.79
2	1.7439	-0.3516	0.7035	0.2965	42.17
3	2.7439	-0.5513	0.5751	0.4249	60.43
4	3.7439	-0.7547	0.4701	0.5299	75.36
5	4.7439	-0.9563	0.3843	0.6157	87.56
6	5.7439	-1.1579	0.3141	0.6859	97.55
7	6.7439	-1.3595	0.2568	0.7432	105.70
8	7.7439	-1.5611	0.2099	0.7901	112.37
9	8.7439	-1.7627	0.1715	0.8285	117.832
10	9.7439	-1.9643	0.1402	0.8598	122.28
11	10.7439	-2.1659	0.1146	0.8854	125.92
12	11.7439	-2.3675	0.0937	0.9063	128.89
			Female		
1	0.6648	-0.1125	0.8936	0.1064	17.23
2	1.6648	-0.2818	0.7544	0.2456	39.78
3	2. 6648	-0.4511	0.6369	0.3631	58.81
4	3. 6648	-0.6204	0.5377	0.4623	74.87
5	4. 6648	-0.7897	0.4539	0.5461	88.45
6	5. 6648	-0.9590	0.3832	0.6168	99.90
7	6. 6648	-1.1283	0.3236	0.6764	109.55
8	7. 6648	-1.2976	0.2732	0.7268	117.71
9	8. 6648	-1.4669	0.2306	0.7694	124.61
10	9. 6648	-1.6362	0.1947	0.8053	130.43
11	10. 6648	-1.8055	0.1644	0.8356	135.34
12	11. 6648	-1.9748	0.1388	0.8612	139.48

Table 4. Expected length (mm) of* Salmostoma untrahi *obtained by Von-Bertalanffy's growth equation during 2000-01 (data based on length frequency), analytical method

t	$(t-t_0)$	$-k^{(t-t0)}$	$e^{-k(t-t0)}$	$1-e^{-k(t-t0)}$	$Lt = L_\infty [1-e^{-k(t-t0)}]$
			Male		
1	0.7696	-0.1458	0.8643	0.1357	17.92
2	1.7696	-0.3353	0.7151	0.2849	37.63
3	2.7696	-0.5248	0.5916	0.4084	53.95
4	3.7696	-0.7143	0.4895	0.5105	67.43
5	4.7696	-0.9038	0.4050	0.5950	78.59
6	5.7696	-1.0933	0.3351	0.6649	87.83
7	6.7696	-1.2828	0.2772	0.7228	95.48
8	7.7696	-1.4723	0.2294	0.7706	101.79
9	8.7696	-1.6618	0.1898	0.8102	107.02
10	9.7696	-1.8513	0.1570	0.8430	111.35
11	10.7696	-2.0408	0.1299	0.8701	114.93
12	11.7696	-2.2303	0.1075	0.8925	117.89
			Female		
1	0.7096	-0.1111	0.8948	0.1052	15.15
2	1.7096	-0.2677	0.7651	0.2349	33.83
3	2.7096	-0.4243	0.6542	0.3458	49.79
4	3.7096	-0.5809	0.5594	0.4406	63.45
5	4.7096	-0.7375	0.4783	0.5217	75.13
6	5.7096	-0.8941	0.4089	0.5911	85.12
7	6.7096	-1.0507	0.3497	0.6503	93.65
8	7.7096	-1.2073	0.2990	0.7010	100.95
9	8.7096	-1.3639	0.2556	0.7444	107.20
10	9.7096	-1.5205	0.2186	0.7814	112.53
11	10.7096	-1.6771	0.1869	0.8131	117.09
12	11.7096	-1.8337	0.1598	0.8402	120.99