MORTALITY AND SURVIVAL OF THE HIMALAYAN MAHSEER *TOR PUTITORA* IN A REGULATED SECTION OF THE RIVER GANGA BETWEEN RISHIKESH AND HARIDWAR[1]

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Key words: Himalayan Mahseer, *Tor putitora,* mortality rate, survival rate, river Ganga

Studies were conducted to assess the mortality and survival rates of the Himalayan Mahseer *Tor putitora* in the foothills section of the Ganga 285-290 m above msl (29° 56' N lat., 78° 10' E long.), where the river has been extensively regulated through two barrages and an array of canals for hydropower generation, irrigation and recreation. The mortality and survival rates of samples measuring 14.5 to 98 cm in length were observed to be 0.414 and 0.586 (pooled sample), 0.348 and 0.652 (1993-94), 0.487 and 0.513 (1994-95), 0.499 and 0.501 (male) and 0.381 and 0.619 (female) respectively, in the 1+ to 9+ age-group fishes. The weighted mortality and survival rates were 0.323 and 0.67 (pooled sample), 0.346 and 0.654 (1993-94), 0.47 and 0.53 (1994-95), 0.436 and 0.564 (males) and 0.467 and 0.567 (females) respectively, while instantaneous mortality rate was 0.589, 0.53, 0.693, 0.855 and 0.555 in the pooled sample, 1993-94, 1994-95, males and females respectively. Mortality was high in the higher age groups in captivity.

INTRODUCTION

The age composition of the stock, the relative strength of different age groups and the maximum life span are, within certain limits, species characteristic. Fishes with short life cycle, with a population which consists of only a few age groups, are adapted to living under conditions of very high and variable mortality. On the other hand, species which form populations containing many age groups and with late mortality are adapted to living under conditions of a relatively stable food supply, negligible annual fluctuation in the mortality of mature individuals, and little effect of predator fishes. If a substantial part of a population should die, its replacement is slow and this is reflected in the age composition which is a function of replacement, growth and death (Nikolsky 1976).

Smith (1983) and Wankowski *et al.* (1988) studied the mortality rates in *Nemadactylus macropterus*, but information on the mortality of *T. putitora* is not available in India and in Garhwal region.

MATERIAL AND METHODS

Fishing mortality rates were estimated from commercial landings from the foothills section of the Ganga near Ajeetpur, a riverside village located downstream of Haridwar. The fish samples were taken randomly from the fish contractor at Ajeetpur or from the Raiwala fish market (where fish is supplied from Ajeetpur). Fish samples were given an abdominal incision and preserved in 10% formalin. In the case of large fishes, length and weight was recorded on the spot and scales were collected.

The age of the samples was determined with the help of key scales (Bagenal 1978) obtained from the base of dorsal and pectoral fins from fishes measuring 14.5 to 98 cm. Preliminary screening indicated that the number of rings was similar in the dorsal and pectoral scales. Thus only dorsal fin region scales were selected. To determine the age, the scales were analysed with a Carl Zeiss Jena Documeter. The number of

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annuli in each key scale was recorded. Annulus formation was determined by the criteria suggested by Bagenal (1978) and adopted by Nautiyal (1990). According to him, a zone of closely spaced ridges is followed by a zone of widely spaced ridges. The annulus is usually considered to be at the outer border of the closely spaced ridges.

The mortality and survival rates were determined by the age frequency method (Rounseefell and Everhart 1985), using the following equations.

The annual mortality rate (r) = (1-s) or (1-e δ) where *s* (rate of survival) was computed in the following manner:

$$\log s = \frac{\left[\sum_{y=x}^{n-1} \log f(y)\right] - \left[\sum_{y=x-1}^{n} \log f(y)\right]}{n}$$

where f(y) = age frequency at any age (y)

The instantaneous mortality rate (δ) was computed as follows:

$$\delta = \log_{10}(1/s)\,(1/\log_{10e}) = \log_e(1/1\text{-}r)$$

where $1/\log_{10e} = 2.303$

Observations

The rates obtained for the year-class samples 1993-94 and 1994-95 were 0.348 and 0.487 respectively. The mortality rate for the pooled data (1993-1995) was 0.414 (Table 1). The survival rate for the pooled data was recorded as 0.586. Relatively higher survival rate was recorded in the 1993-94 year sample (0.652) as compared with 1994-95 year sample (0.513). The weighted mortality rate was found to be 0.346, 0.47 and 0.323 for the 1993-94, 1994-95 and pooled year samples, respectively. The weighted survival rates were 0.65, 0.53 and 0.67 for 1993-94, 1994-95 and pooled samples (Table 1).

Mortality rate was observed to be 0.499 for males and 0.381 for females. The survival rates were recorded as 0.501 and 0.619 in male and female, respectively. Weighted mortality rates were found to be 0.436 and 0.467, while survival rates were 0.564 and 0.567 in male and female respectively. The instantaneous mortality rate was 0.855 in male and 0.555 in female (Table 1).

The 1+ and 2+ age groups showed zero mortality rates in the year class sample 1993-94, male and female. Zero mortality was also observed in the 3+ age group during 1994-95. Low mortality and higher survival rates were observed in the lower age classes (3+, 4+) while higher mortality and lower survival rates were seen in the higher age groups (8+, 9+; Table 2).

Discussion

Studies indicate that information on the various aspects of population structure is important for managing natural populations, especially commercially exploited fish stock. The age structure, like other parameters of the population, may change from time to time,

Table 1
COMPUTATION OF MORTALITY AND SURVIVAL RATES IN *TOR PUTITORA* FOR DIFFERENT YEARS AND SEXES

Parameters	1st year (1993-94)	2nd year (1994-95)	Pooled samples	Male	Female
Instantaneous mortality rate	0.530	0.693	0.589	0.855	0.555
Mortality rate	0.348	0.487	0.414	0.499	0.381
Survival rate	0.652	0.513	0.586	0.501	0.619
Weighted mortality rate	0.346	0.470	0.323	0.436	0.467
Weighted survival rate	0.654	0.530	0.677	0.564	0.567

TABLE 2
COMPUTATION OF MORTALITY AND SURVIVAL RATES OF *TOR PUTITORA* IN THE POOLED SAMPLES

A	B	C	D	E	F	G	H
Age (y)	Freq. (f)	log f	log f(y) -f (y-1)	D times (2.303)	(1-D)	Antilog (DX√f)	weighted by f(y)
1	14	1.146					
2	62	1.792					
3	58	1.763	-0.029	0.066	0.971	0.935	-0.220
4	43	1.633	-0.130	0.299	0.870	0.741	-0.851
5	20	1.301	-0.332	0.764	0.668	0.465	-1.484
6	11	1.041	-0.260	0.598	0.74	0.549	-0.860
7	8	0.903	-0.138	0.317	0.862	0.727	-0.389
8	3	0.447	-0.456	1.050	0.544	0.349	-0.642
9	1	000	-0.447	1.029	0.533	0.341	000
Total	223		1.792	4.123	5.188	4.107	4.446/26.1
(Mean)			(0.256)	(0.589)	(0.741)	(0.586)	=0.169

Instantaneous mortality rate (δ) = 0.589
Mortality rate (r) = 0.414
Survival rate (s) = 0.586

Weighted survival rate/ s(w) = 0.677
Weighted mortality rate r (w) = 0.323
1-0. 169 = 0.831

adapting to change in the environmental conditions. The data on age structure can also be used to draw inferences on the health of the population, its mortality and survival rates (Nikolsky 1976, Bagenal 1978 and Rounseefell and Everhart 1985).

In our study, survival rates were found to be higher than the mortality rates. Relatively higher annual mortality and lower survival rates were found in males (0.499, 0.501) than in females (0.381, 0.619). In the Atlantic salmon also, this difference has been reported by Nikolsky (1980). He also stated that each species has a definite mortality rate. A species with a short life cycle exhibits a relatively higher death rate than one with a long cycle and late maturity such as the Himalayan mahseer.

We reiterate that the numbers of a species before the harvestable size are not a true index for the calculation of mortality/survival rates because the fish at this size/age are vulnerable to fishing gear. Similar results (high mortality in higher age classes and low mortality in the lower age classes) were also obtained by Tandon and Johal (1996) in *C. mirigala* and *L. rohita* from Gobindsagar, and by Graham (1956) in cod and haddock. According to Gulland (1978), the mortality varies continuously with age. It is usually more convenient and more reliable, within an acceptable approximation, to consider that fishing mortality changes abruptly, being zero on the pre-recruits below a certain age and constant from a given age upwards.

It was concluded that mortality in captivity increased with age. Tandon and Johal (1996) stated that increase in mortality between particular age classes is due to substantial increase in the exploitation rate. According to Ricker (1962) and Gulland (1975), the variations in the percentage mortality between different age classes are due to the available stock, shifting of year class, and probably also due to sampling error. Rounseefell and Everhart (1985) stated that weighted values do not depart far from the values computed by the conventional methods, although it may be an advantage to weight when the samples are small.

ACKNOWLEDGEMENT

The authors are grateful to the Ministry of Environment and Forests, Govt. of India, New Delhi, for financial assistance.

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