



Age structure, growth rate and exploitation pattern of *Cirrhinus mrigala* (Ham. 1822) in Vallabhsagar reservoir, Gujarat, India

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Mrigal, *Cirrhinus mrigala* (Ham. 1822), one of the Indian major carps widely distributed in Indian inland waters, has considerable aquaculture potential. Knowledge on factors such as age, growth and exploitation pattern is important in fisheries management. Here, we investigated the age structure, growth increment and exploitation pattern of mrigal in Vallabhsagar reservoir, Gujarat (India). Age composition of the studied fish was 1+ to 9+ age groups with mean total lengths 40.78, 50.99, 59.82, 66.32, 70.72, 74.56, 77.80, 80.22 and 82.50 cm. The corresponding growth rate in terms of length were 40.78, 10.21, 8.83, 6.50, 4.40, 3.84, 3.24, 2.42 and 2.28 cm observed for these age groups. The growth increment was maximum at the initial age group whereas it was moderate to low in the subsequent years of the age. The exploitation patterns of fish were 3.94 for +1, 32.02 for +2, 22.17 for +3, 25.12 for +4, 2.96 for +5, 6.16 for +6, 4.43 for +7, 2.46 for +8 and 0.74% for +9 age classes. Results depict that exploitation pattern of fish was high at early age fish stock than the higher age classes. The exploitation pattern for 1+ to 3+ age classes was 58.13%, and 41.87% contributed by 4+ to 9+ age classes. Higher catch rate of younger fishes is not a good sign for natural stocking of fish i.e., mrigal in the Vallabhsagar reservoir.

Keywords: Age composition, Indian major carp, *Naini*, Mrigal, Ukai dam, Vallabhsagar reservoir

Mrigal (*Cirrhinus mrigala* Ham., 1822), a member of Indian major carps (Fam. Cyprinidae), also known as 'Naini' or 'Mrigal', is widely distributed in the inland waters of Indian subcontinent and significantly contributes to inland fisheries of India as well as has good aquaculture potential¹. Age and growth rates are two important biological attributes which provide the essential biological counts such as life span, mortality, sexual maturity, harvestable size, stock composition, etc. which are important for successful fishery

management². The age of fish refers to the numerical expression of the time duration that fish has lived whereas growth of animals is considered change in body size between two points or increase in volume mass^{3,4}.

The age and growth of different fish species are usually analyzed by means of hard parts⁵ and such studies for Indian major carps were conducted by Johal & Tondon⁶ from three reservoirs of north India. Similar attempts were made from Jaisamand Lake, Rajasthan, from Siliserh reservoir, Alwar (Rajasthan)⁷ and from other water bodies of southern Rajasthan⁸. Such studies are also reported from Harike wetland, India⁹, Rana Pratap Sagar, Rajasthan¹⁰ and from reservoirs of Chattisgarh¹¹ and also from culture based reservoir¹² and from Vallabhsagar reservoir, Gujarat¹³. The ratio of different age classes in population at a given time representing the exploitation pattern of population¹⁴. The exploitation pattern of *Tor putitora* from foothills of river Ganga¹⁵ and *Aorichthys seenghala* from Yamuna and Ganga has been reported already¹⁶. Studies on the exploitation pattern of *Cirrhinus mrigala* are also not uncommon¹⁷⁻¹⁹.

Determination of age, growth and exploitation pattern of fishes are useful to solve the basic life history problems and also essential for formulating future policies and management of the fishery. Considering these important biological aspects, we investigated the exploitation pattern of *Cirrhinus mrigala* in Vallabhsagar reservoir in Tapi, Surat (Gujarat).

Material and Methods

For age determination, scale samples from 406 fish specimens were collected during June 2013 to May 2014 from the Vallabhsagar reservoir which is one of the largest reservoirs of Gujarat and situated at 73° 32' 25" to 78° 36' 30" E longitudes and 20° 5' 0" to 22° 52' 30" N latitudes. It was constructed across the Tapi River in 1972 in Tapi district of Gujarat (Fig. 1). From each fish specimen about 5-6 scales were collected and secured in hard paper envelope with keynote information like, total length, standard length, weight, date of collection, fish species, etc.

For further analysis, scales were soaked in 1% KOH solution for 5-10 min and washed with tap water to

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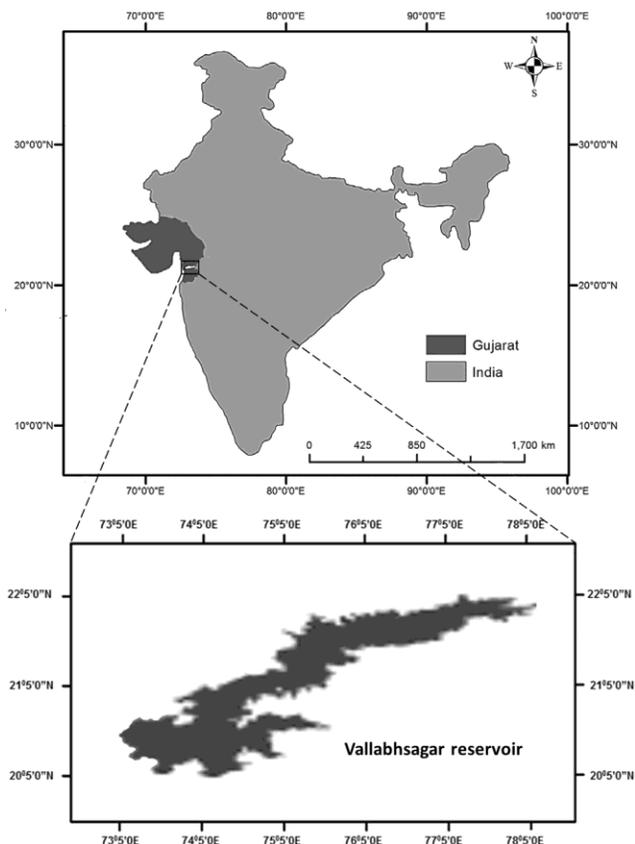


Fig. 1 — Location of study area Vallabhsagar reservoir, Tapi, Gujarat, India

remove deposited materials and mucous. Plain dried, clean and transparent scales were used to examine scale radius (S) and radius of each annuli (S₁, S₂, S₃, S₄... S_n) with the help of 4P scale reader²⁰. These scale readings were used to calculate the length at previously formed annuli with help of following formula²¹:

$$L_n = a + \frac{S_n}{S} \times (L-a)$$

The calculated age class and its percentage share in catch were used²² to determine the exploitation pattern of mrigal from Vallabhsagar reservoir.

Results and Discussion

Age structure

The findings of present study depict that in all 9 growth rings were visible (Fig. 2) on the scale which suggest that fish population can be grouped into 1 to 9 age groups (Table 1). Ujjania⁸ recorded 6, 7 and 6 age groups in mrigal of Mahi Bajaj Sagar, Surwania Dam and Aasan pond, respectively from southern Rajasthan. Kamal²³ reported 7 growth rings and length groups of 20.1-22.0, 40.1-42.0, 60.1-62.0, 68.1-70.0, 76.1-78.0,



Fig. 2 — Growth rings (1 to 9) on the scale of mrigal from Vallabhsagar reservoir

Table 1 — Age structure and growth patterns of mrigal Total length (cm)

Age group	N	Total length (cm)			Growth rate
		Min.	Max.	Mean	
1+	16	35.91	45.68	40.78	40.78
2+	130	43.81	56.69	50.99	10.21
3+	90	54.83	64.36	59.82	8.83
4+	102	61.64	68.27	66.32	6.50
5+	12	68.80	73.48	70.72	4.40
6+	25	72.15	76.98	74.56	3.84
7+	18	76.09	79.99	77.80	3.24
8+	10	79.08	82.32	80.22	2.42
9+	3	82.01	83.00	82.50	2.28
Pooled	406	35.91	83.00	67.07	

82.1-84.0, 90.1-92.0 and 92.1-94.0 cm in *C. mrigala* from the river Yamuna. On the other hand, 8 rings on the scale of Indian major carp (*Cirrhinus mrigala*) from the tributary of Ganga river¹⁹, 10 age classes in mrigal from Yamuna river²⁴ were also reported.

Growth and growth rate

The present observations show that the fish attained the 40.78 to 82.50 cm length in 1+ to 9+ age groups with mean lengths of 40.78, 50.99, 59.82, 66.32, 70.72, 74.56, 77.80, 80.22 and 82.50 cm. The corresponding growth rate in terms of length were 40.78, 10.21, 8.83, 6.50, 4.40, 3.84, 3.24, 2.42 and 2.28 cm for these age groups, respectively (Table 1 & Fig. 3). The growth rate was observed inversely related to the age of fish. It is observed that growth was high at initial stage of life and the moderate to low was at later stage. Similar growth trends in mrigal were reported^{8,13,25} in different water bodies.

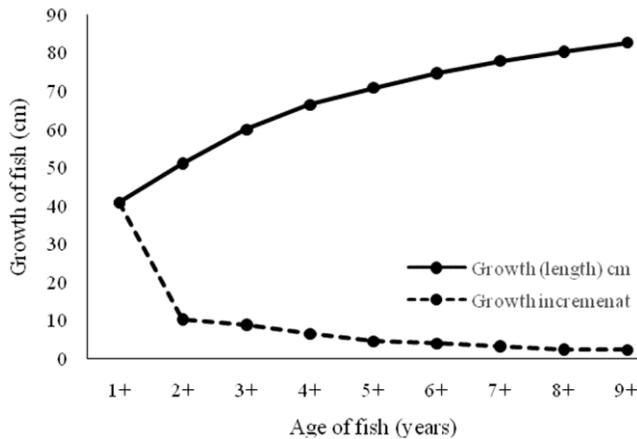


Fig. 3 — Growth and growth increments of mrigal from Vallbhsagar reservoir

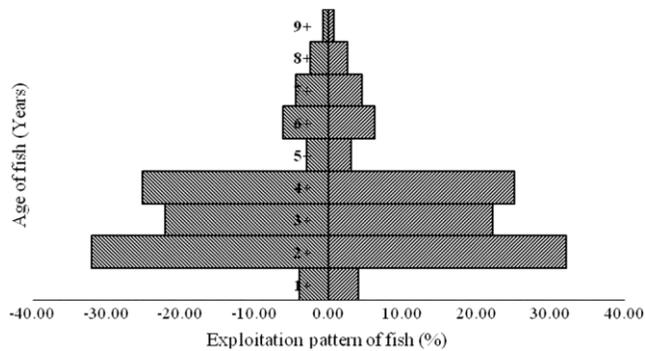


Fig. 4 — Exploitation pattern of mrigal from Vallbhsagar reservoir

Exploitation pattern

The exploitation pattern of mrigal in the present study showed varying share in the catch wherein the values were 3.94% for +1, 32.02% for +2, 22.17% for +3, 25.12% for +4, 2.96% for +5, 6.16% for +6, 4.43% for +7, 2.46% for +8 and 0.74% for +9 age classes (Fig. 4). These exploitation patterns of the fish show that the early age classes of fish were more exploited than higher age classes. It was further observed that 1+ to 3+ age classes had combined share of 58.13% while rest of 41.87% was contributed by 4+ to 9+ age classes. Similarly, it was reported that age groups 2+ to 4+ accounted for 73% in *Tor putitora* in foothill section of the river Ganga⁵, lower and middle size groups were more exploited in *Aorichthys seenghala* from the rivers¹⁶ and in *C. mrigala* from the Yamuna River at Allahabad²³. The age structure of mrigal in tributary of Ganga river was dominated by 3+ age group¹⁹, 0+ and 1+ age groups were dominated of *Barilius bendelisis* in Himalayan mountain streams²⁶ while 1+ age group in *Cyprinus carpio* from the Yamuna River at Allahabad²⁷.

The observations of age structure and exploitation patterns can be well explained with the use of urn shaped pyramid which depict that in the harvested catch population of immature fishes were more compared to the mature fishes. The urn shaped figure is obtained when the birth rate is drastically reduced and the pre-reproductive group dwindles in proportion to the older age groups of the population²². Similar findings were also reported for the *Cirrhinus mrigala* in different water bodies^{19,24}.

Conclusion

On the basis of these findings, it could be concluded that studied fish containing 9 year class of age with normal growth and growth rate. The younger fishes are more (32.02%) comparatively elder fishes (0.74%) in the catch which is not good sign for natural stocking of the waterbody. Such kind of study and its findings are useful for planning long term sustainable fishery of mrigal in this reservoir, and also design the fishing policy in such a way that in fish catch the share of older fishes like 3+ age classes increases. This would ensure better recruitment of mrigal by encouraging natural spawning of young mature fish.

Conflicts of interest

Authors declare no conflict of interests.

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