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Author Affiliation:
[1]Department of Aquatic Biology (VNSGU), Surat (Gujarat), India
[2]Division of Aquaculture (ICAR-CIFE), Mumbai (Maharashtra), India

***Corresponding author:**
Ujjania NC,
Department of Aquatic Biology (VNSGU), Surat (Gujarat), India
Email: ncujjania@vnsgu.ac.in

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Growth and condition of Indian major carps (*Catla catla*, *Labeo rohita* and *Cirrhinus mrigala*) cultured in earthen ponds with saline water

Ujjania NC[1]*, Manish Pradhan[1], Ujjania VK[2]

ABSTRACT

The objective of present study was to determine the growth and condition of Indian major carps (*Catla catla*, *Labeo rohita*, and *Cirrhinus mrigala*) reared in a saline water earthen pond. The fish specimens and water samples were collected during April to June 2024. The morphometric measurements like total length, standard length, and weight were taken from 260 fish specimens and were used for growth and condition estimation. In contrast, water samples were used to analyse the critical water quality parameters, including temperature, pH, salinity, dissolved oxygen, nitrate-N, nitrite-N, ammonical-N, and total hardness, to assess the conduciveness of the aquatic environment of the studied pond. The range and mean values of total length 19.00-49.50 cm (29.61±1.11), 8.00-45.00 cm (24.97±0.55), and 20.40-40.50 cm (26.70±0.58), standard length 15.50-40.00 cm (23.73±0.88), 14.50-39.50 cm (20.28±0.46) and 15.50-34.00 (21.80±0.47) and weight 94.00-1953.00 g (480.26±64.69), 60.00-759.00 g (206.04±15.77) and 77.00-688.00 (223.96±17.79) were observed for the studied fish catla, rohu and mrigal respectively. The critical water quality parameters were noted to be water temperature (30.8-39.0 ℃), pH (7.60-8.30), salinity (5.16-7.27 ppt), dissolved oxygen (5.60-6.90 ppm), nitrate-N (4.80-5.00 ppm), nitrite-N (0.19-0.25 ppm), ammonical-N (0.20-0.25 ppm) and total hardness (220.00-300.00 ppm) were noted from the studied pond during the study. Indian major carps are mainly cultivated in freshwater resources. However, the present study has revealed that they can also be reared in earthen ponds containing saline water with 100% survival, good growth, and optimal conditions. The results of the current research not only help to utilize salt-affected areas or empty shrimp ponds to cultivate freshwater fish, but also help to generate employment and income for fish farmers.

Keywords: Catla, rohu, mrigal, length-weight relationship, condition, growth, saline water, and earthen pond

1. INTRODUCTION

Aquaculture is a significant economic farming activity that is considered one of the fastest growing food production sectors in the world, contributing significantly to livelihood, employment, and revenue generation. India was ranked second in the world for aquaculture production with a total fish production of 17.54 million metric

tons in 2022–23 which contributes about 8.0 percent of fish production of the world (Annual Report, 2024). The sustainable uses of inland water resources throughout the country, including saline water are can be achieved through aquaculture. Indian major carps (*Catla catla, Labeo rohita*, and *Cirrhinus mrigala*) are economically significant freshwater fish species that are widely cultivated in various aquatic resources of the Indian subcontinent (Jhingran and Khan, 1979). These fish species are considered highly valued because they have a fast growth rate, excellent meat quality and adaptation to various environmental conditions (Manam and Quraishi, 2024). The carps contribute around 87% of the total freshwater aquaculture production among all freshwater species farmed in India (Paul and Giri, 2015) and play vital role in food security and livelihoods (Miller, 2009; Gogoi et al., 2015).

Fish farming practices and thereby fish production are suggested to be influenced by the different physical, chemical, and biological properties of water, including primary and secondary production (Ujjania and Soni, 2017; Chibhade et al., 2020; Shah et al., 2022). Salinity is one of the essential physical properties of water which influence the survival, growth, and metabolism (Mubarik et al., 2015), and variations have resulted in low growth, health problems, and mortality of fish (Gholampoor et al., 2011; Kumar et al. 2017; Singh et al, 2018). Therefore, it is imperative to know the use of saline water for freshwater fish cultivation (Pillai et al., 2003; Ahirwal et al., 2021; Singh et al., 2023) for the expansion and diversification of salt-affected areas. Arockia et al. (2023) reported the feasibility assessment for rearing of Indian major carp in inland saline water. Saline water aquaculture would be profitable options for income generation by utilization of more than one billion hectares of abandoned salt-affected lands worldwide and underlain brackish water resources (Jahan et al., 2025). The numbers studies have been evaluated the survival and growth of freshwater fishes with reference to salinity i.e. for catla (Ghosh et al. 1972; Hoque et al., 2020), for rohu (Murmu et al., 2020; Patel et al., 2023), for mrigal (Baliarsingh et al., 2018; Hoque et al., 2020; Arockia et al., 2023), for grass carp, (Konstantinov and Martynova, 1992; Routray and Routray, (1997), for silver carp, (Chervinski, 1977) and for common carp (Mangat and Hundal, 2014; Singh et al., 2018; Jahan et al., 2020),

The basic information on fish biology obtained from length-weight relationships (LWR) of the fish, and thus it is helpful to estimate the weight from the length of the fish (Koutrakis and Tsikliras, 2003; Ujjania et al., 2013; Soni and Ujjania, 2017) and to estimate fish crop biomass (Petrakis and Stergiou, 1995), which helps to convert growth-in-length to growth-in weight equations for the prediction of weight-at-age of the fish (Pauly, 1993). Similarly, it is also helpful to calculate condition indices and to compare the morphology of fish populations (Safran, 1992). The information on somatic growth of fish can be used to determine whether it was isometric or allometric by length-weight relationship (LeCren, 1951; Ricker, 1975; Balai et al., 2017).

The study of salinity and survival of Indian major carps with optimal growth is more critical from an aquaculture prospective. Therefore, in the present study, Indian major carp species (*Catla catla, Labeo rohita*, and *Cirrhinus mrigala*) were reared in an earthen saline water pond to determine their survival, growth, and condition. The finding of this study is not only helpful for the utilization of salt-affected areas to cultivate the freshwater fish but also helpful for the generation of income and employment for the fish farmers.

2. MATERIALS AND METHODS

Study area

Fish specimens for the present study were collected from the small earthen pond (0.35 ha) which has saline water and is actively used for fish farming. This pond was located at Narghat village in Purba Medinipur district (West Bengal). These fish specimens were collected by cast net for the measurement of morphometric parameters during the months of April to June 2024.

Measurement of length and weight

A total of 260 specimens of Indian major carps, *Catla catla* (86), *Labeo rohita* (102), and *Cirrhinus mrigala* (72) were collected by the cast net, and these were used to measure the total length (cm), standard length (cm), and body weight (gm). The total length (TL) was measured from the tip of the snout to the extended tip of the caudal fin, standard length (SL) was measured from the tip of the snout to the caudal peduncle using the measuring tape corrected up to 0.5 cm, and at the same time while body weight (WT) was taken after removing water and mucus from the body of fish by digital balance corrected up to 1.0 g. The length weight key (Biswas, 1993) and the parabolic equation (Froese, 2006) were used to calculate the statistical relationship between length and weight.

$$W = aL^b$$

$$\text{Log } W = \log a + b \log L$$

Where: W = weight of fish (gm), L = length of fish (cm), a = Coefficient and b = Exponent

Coefficient of correlation (r):

The coefficient of correlation (r) shows the relationship between variables and it was calculated using the statistical procedure of Snedecar and Cochran (1967).

Condition factor (K):

The condition factor (K) was calculated by the following equation of Fulton (1902).

$$K = (W \times 100) / L^3$$

Where: W = Weight of fish (gm) and L = Total length of fish (cm)

Water quality analysis

Water quality parameters of the studied pond were analysed before starting the experiment, during the experiment, and after the experiment. These vital water quality parameters including temperature, pH, salinity, dissolved oxygen, nitrate-N, nitrite-N, ammonical-N and total hardness were analysed every fortnight with the help of a water quality test kit.

Statistical analysis

The statistical analysis, including regression coefficient, correlation coefficient, and graphical presentation was developed using the computer package MS-Excel 2011.

3. RESULTS & DISCUSSION

In the present study, 100% survival was noted and fish were active and showed regular feeding and swimming behaviour (Table 1). The range and mean values of total length 19.00-49.50 cm (29.61±1.11), 8.00-45.00 cm (24.97±0.55) and 20.40-40.50 cm (26.70±0.58), standard length 15.50-40.00 cm (23.73±0.88), 14.50-39.50 cm (20.28±0.46) and 15.50-34.00 (21.80±0.47) and weight 94.00-1953.00 g (480.26±64.69), 60.00-759.00 g (206.04±15.77) and 77.00-688.00 (223.96±17.79) were noted for catla, rohu and mrigal respectively (Table 1). The length-weight relationship of Indian major carps viz., catla, rohu and mrigal were determined from logarithmic-transformed total length and weight data of the fish. The length and weight variables of the studied fishes are highly correlated as shown from the linear correlation diagram (Fig. 1 A, B & C). The correlation coefficient (r^2) 0.976, 0.970 and 0.935 were noted at 0.05 Cl for catla, rohu, and mrigal, respectively (Table 1 and Fig. 1 A, B & C). In the present study, the growth constant (b) for catla (3.204), rohu (3.096) and mrigal (3.069) was observed (Table 1). The value of growth constant (b = 3) is considered an isometric growth and if it fluctuates (either b>3 or b<3) then it is considered positive or negative allometric growth. The findings of the current study showed the isometric growth for rohu and mrigal while it was positive allometric growth for catla (Table 1 and Fig. 1 A, B & C). The condition factor (K) of Indian major carps was analysed in the present study and the range with mean 1.02-1.94 (1.35±0.03), 0.83-1.71 (1.13±0.01) and 0.80-1.73 (1.04±0.02) was observed for catla, rohu and mrigal respectively (Table 1).

Table 1. Morphometric and growth observations of Indian major carps

Parameter	Catla	Rohu	Mrigal
	Min. – Max. (Mean±SE*)	Min. – Max. (Mean±SE*)	Min. – Max. (Mean±SE*)
Number of specimens (n)	86	102	72
Survival rate (%)	100	100	100
Total length (cm)	19.00-49.50 (29.61±1.11)	18.00-45.00 (24.97±0.55)	20.40-40.50 (26.70±0.58)
Standard length (cm)	15.50-40.00 (23.73±0.88)	14.50-39.50 (20.28±0.46)	15.50-34.00 (21.80±0.47)
Weight (g)	94.00-1953.00 (480.26±64.69)	60.00-759.00 (206.04±15.77)	77.00-688.00 (223.96±17.79)
Growth constant (b)	3.204	3.096	3.069
Intercept (a)	-2.172	-2.084	-2.085
Correlation coefficient (r^2)#	0.976	0.970	0.935
Condition factor (K)	1.02-1.94 (1.35±0.03)	0.83-1.71 (1.13±0.01)	0.80-1.73 (1.04±0.02)

*SE is the standard error, #0.05 Cl

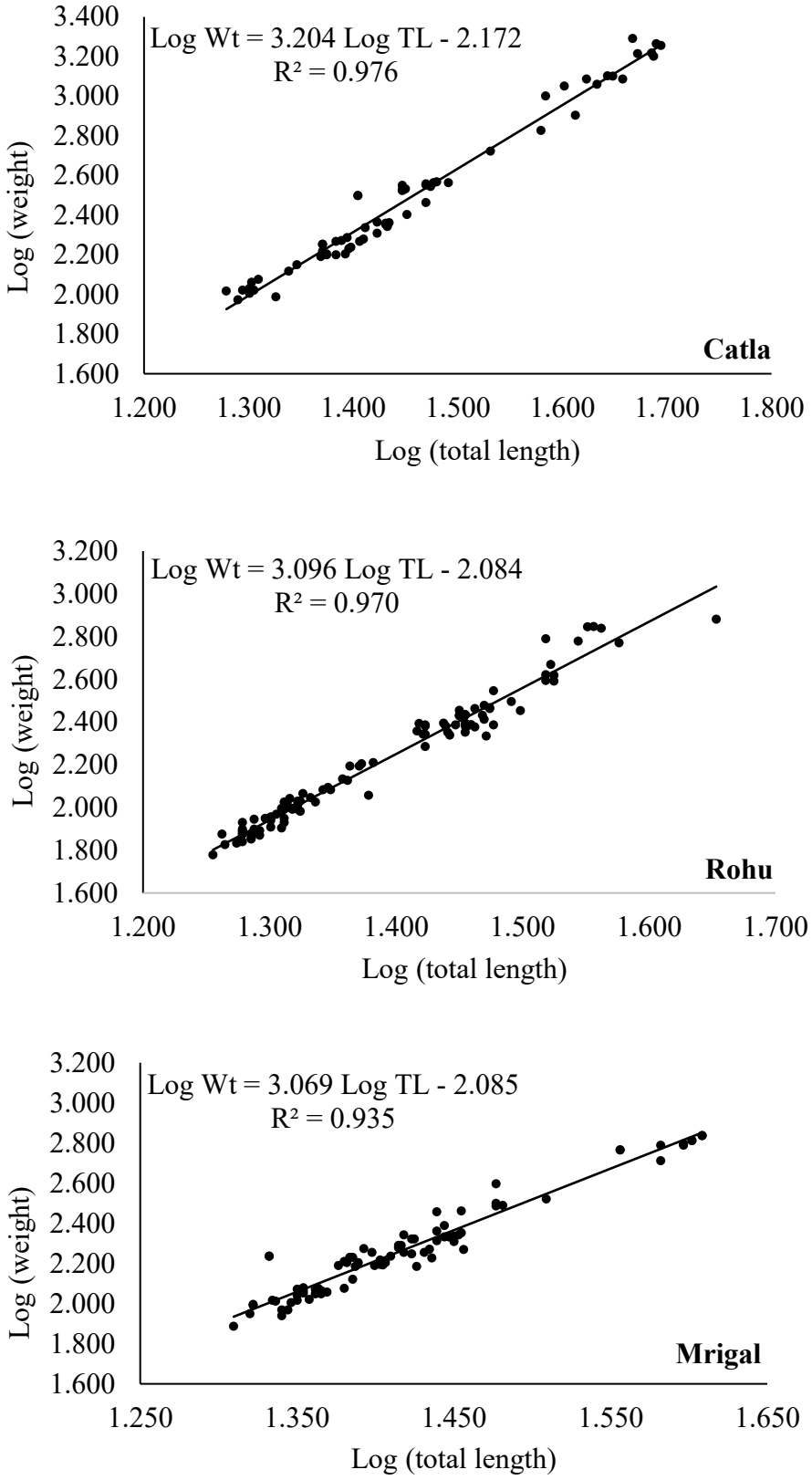

Figure 1. Length-weight relationship (LWR) of morphometric variables (total length and weight) of Indian major carps

Table 2. Observation on water quality parameters in the studied pond

Parameter	Range	Mean±SE*
Temperature (℃)	30.80-39.00	35.93±2.58
pH	7.60-8.30	8.00±0.21
Salinity (ppt)	5.16-7.27	6.04±0.63
Dissolved oxygen (ppm)	5.60-6.90	6.30±0.38
Nitrate-N (ppm)	4.80-5.00	4.93±0.07
Nitrite-N (ppm)	0.19-0.25	0.23±0.02
Ammonical-N (ppm)	0.20-0.25	0.23±0.02
Total hardness (ppm)	220.00-300.00	256.67±23.33

*SE is the standard error

Although optimum growth in terms of length and weight for different major carps reared in saline water was reported by Chughtai et al. (2015) from Pakistan. Murmu e al. (2020), Ahirwal et al. (2021) and Singh et al. (2023) form India. Supporting the findings of the current study, Jahan et al. (2020) reported optimal growth, gonad development, fertilization, and survival of *Cyprinus carpio* species on 0–5 ppt salinity of inland saline groundwater similarly, Patel et al. (2023) also reported that freshwater fish, *L. rohita*, survive at 7.2 ppt salinity. The results on growth and condition factor indicated good condition of the fish in the studied saline water pond, and these findings on LWR and condition factor of these three species are in agreement with the findings of Ujjania et al. (2022) for common carp, Ujjania et al. (2023) for catla, Ujjania et al. (2024) for grass carp, and Ujjania et al. (2025) for catla from selected small water ponds. The results of the present study are very close to the findings reported by various researchers in freshwater ponds that indicated the conducive environment and appropriate growth of the Indian major carps in saline water ponds.

The water quality parameters as described in table 2 which were studied for reference purposes and noted water temperature (30.80-39.00 ℃), pH (7.60-8.30), salinity (5.16-7.27 ppt), dissolved oxygen (5.60-6.90 ppm), nitrate-N (4.80-5.00 ppm), nitrite-N (0.19-0.25 ppm), ammonical-N (0.20-0.25 ppm) and total hardness (220.00-300.00 ppm). These findings show that the water quality parameters during the study were optimum and conducive for the survival and growth of studied fish. The similar water quality parameters with 100% servility and optimum growth were reported by Pillai et al. (2003) in the field conditions, Chughtai and Mahmood (2012) and Chughtai et al. (2015), in a saline waterlogged area. Murmu et al. (2020), Ahirwal et al. (2021), and Singh et al. (2023) also reported similar findings on water quality parameters for the culture of *Labeo rohita*, *Gibelion catlaī*, and *Cyprinus carpio*, respectively, in saline water.

4. CONCLUSION

From the present study, it may be concluded that there is survival, growth, and condition of Indian major carps (*Catla catla, Labeo rohita*, and *Cirrhinus mrigala*) were optimum in saline water which indicates tremendous scope for further expansion of carp culture in saline water ponds by altering the farm management strategies and monitoring of the water quality. Saline aquaculture offers the valuable opportunity to make productive use of such degraded lands and low-quality water in India. Accordingly, fish farmers will get more yield and better returns from the water bodies in salt-affected areas or abounded shrimp ponds.

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Author's Contribution

All authors contributed equally to this evaluation's conceptualization, literature synthesis, evaluation, interpretation and authorized the final manuscript.

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Conflict of interest

The authors declare that they have no conflicts of interests, competing financial interests or personal relationships that could have influenced the work reported in this paper.

Ethical approval

In this article, the animal regulations are followed as per the ethical committee guidelines of Department of Aquatic Biology (VNSGU), Surat (Gujarat), India & Division of Aquaculture (ICAR-CIFE), Mumbai (Maharashtra), India; the authors observed the growth and condition of Indian major carps (*Catla catla*, *Labeo rohita* and *Cirrhinus mrigala*) cultured in earthen ponds with saline water. The Animal ethical guidelines are followed in the study for species observation, identification & experimentation.

Informed consent

Not applicable.

Data availability

All data associated with this study will be available based on the reasonable request to the corresponding author.

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