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Comparative Growth and Condition of Striped Catfish (*Pangasianodon hypophthalmus*, Sauvage, 1878) Reared in Two Different Culture Systems

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Abstract: The present study aimed to determine the growth and condition of the fish with reference to length weight relationship (LWR) and condition factor (K) of *Pangasianodon hypophthalmus* (Sauvage, 1878**)** reared in cages and ponds of Selud village, Gujarat, India. Total fish specimens of 503 from cages and 315 from ponds were randomly collected during December 2022 to March 2023 and used to measure the morphometric parameters in study area. The range of total length, standard length and weight (18.5-41.5 cm, 16.5-35 cm and 100-650 g, respectively) were noted from pond fish and (30-48 cm, 24-39 cm and 185-790 g, respectively) from cage fish. The length-weight relationship (LWR) of the fishes was established and correlation coefficient values for pond fishes (0.552) and for cage fishes (0.557) shows a positive correlation between the length and weight variables. The growth constant (b) was determined (2.031 and 2.077) in pond fish and cage fish, respectively which exhibit the negative allometric growth of the studied fish in these culture systems. The variation in length, weight and condition factor of fish in these different culture systems was noted and it was verified by the appropriate statistical tool (t-test) which described that total length, standard length and weight of the pond fishes was extremely significant ($p < 0.05$) and more varied than the cage reared fishes while condition factor of pond fishes was significantly ($p < 0.01$) different as compared to cage reared fishes. The finding of the present study help to opt the farming system by the farmers and applied appropriate management practices for culture practices.

Keywords: Striped catfish, Length-weight relationship, Growth constant, Condition factor, Indigenous

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Introduction

Striped catfish (*Pangasianodon hypophthalmus*, Sauvage, 1878), also known as pangasio, panga, pangasius sutchii etc., is considered one of the important inland aquaculture fish species (Singh and Lakra, 2012; Ayyappan *et al*., 2015; Seshagiri *et al*., 2021). It contributes about 2.52 million ton to the world (FAO, 2022; Jiang *et al*., 2022). The fast growing, acceptance of artificial feed,

adaptability to a wide range of environmental conditions, good market value, and high public demand are the factors for the commercial cultivation of pangasius catfish in many of the southeast Asian countries including Vietnam, India, Bangladesh and Indonesia **(**Kinare and Harkulkar, 2022). Similarly, Indian farmers have also accepted pangasius as a profitable species in aquaculture for more growth and fewer complications in culture operations (Jayasankar and Giri, 2013). The average production of *P. hypophthalmus* was found to be higher than that of carp in the same areas (Lakra and Singh, 2010) and it was found to have three times more net income than traditional carp culture practices (Datta *et al*., 2016). In India, major production systems (ponds, cages and net pens) are involved in striped catfish farming in different states including Andhra Pradesh, Telangana, West Bengal, Jharkhand, Chhattisgarh, Maharashtra, Gujarat, Kerala, Tamil Nadu, Madhya Pradesh, Bihar and Uttar Pradesh (Kumar, 2017; Singh, 2020). The culture practice of striped catfish (*P. hypophthalmus*) was growing rapidly in land-based pond aquaculture systems and cage culture of this fish was initiated in Govind Sagar reservoir by Chaturvedi *et al*. (2015). The production of the fish is directly related to its growth, which is the increment in length and weight over the time period (Rodriguez *et al*., 2017). Morphometric variables including length and weight are used to estimate the growth and condition of fish (Froese, 2006; Ujjania *et al*., 2022). The utility of these morphometric variables cannot be accentuated because they reflect the physiological condition of the fish and are affected by internal factors of the fish, i.e. gonadal development, organic reserves, the presence or absence of food in the gut and external factors i.e. food availability and environmental variability of the surrounded water body (Nikolsky 1969). Hence, these could be used to access general wellbeing (Froese *et al*., 2011). The length-weight relationship facilitates comparative growth studies (Moutopoulos and Stergiou, 2002), life history (Shah *et al*., 2013) and population dynamics of the fish **(**Adeyemi *et al*., 2009). The studies on length-weight relationship based growth for different fish species have been carried out by Ujjania *et al*. (2013) in common carps from village ponds (Gujarat), Panda *et al*. (2016) in different fish species from Chilka lagoon (Orissa), Borah *et al*. (2017) in fish from Deepor beel (Asam), Baitha *et al*. (2017) in indigenous freshwater fish species from Gandak River (Bihar) and Nallathambi *et al*. (2020) in tropical estuarine fish species from Pulicat lagoon. The condition factor (K) provides quantitative information that represents the wellbeing and habitat (indices such as physiological condition and feeding habit) based on length and weight of species (Taymaa *et al*., 2018) as well as maturity stage, spawning, biotic and abiotic factors and food sufficiency, which are the physiologically important values of fish species (Ujjania *et al*., 2012)**.** Similarly, these studies elucidate the impact of different aquaculture systems on the species (Freitas *et al*., 2014). Although plenty of studies have been undertaken for the culture of *P. hypophthalmus* in different culture systems, including pond culture and cage culture systems, there is only a very limited literature available on the comparative growth of this fish among the different aquaculture systems. Therefore, the present study was undertaken to compare the growth performance and condition of *P. hypophthalmus* in cages and ponds in Gujarat.

Materials and Methods

Study area:

The study was conducted from December 2022 to March 2023 in earthen ponds and in floating net cages installed in Selud village which was situated near the bank of the Ukai reservoir in Uchchhal Taluka of Tapi district (Gujarat, India). The dimensions of these earthen ponds were 30x50 m (1500 m^2 area of each) with a 1.2 m average depth. The ponds were prepared by conventional culture operations, including liming and fertilization whereas floating net cages (6 x 4 x 3 m) were installed in the Ukai reservoir with the use of nylon cage nets (30 mm mesh size), light-

weighted iron pipes, iron bars, empty sealed barrels, nylon, thin GI wire and wooden planks.

Sample collection:

For the morphometric variables (length and weight) measurement 315 fish specimens from ponds and 503 fish specimens from cages were randomly collected at the time of harvesting (Table 1). The morphometric measurements were measured from the fish specimens in which total length (TL) was measured from the tip of the snout to the end of the caudal fin and standard length (SL) was taken from the tip of the snout to the caudal peduncle corrected up to 0.5 cm with the help of measuring tape while body weight was taken with the help of a digital balance corrected up to 1.0 g.

Analysis of data:

Growth measurement:

The growth of the studied fish was determined by the establishment of a mathematical relationship among the morphometric variables i.e. the total length and weight, which were to follow the equation of Froese (2006) while relationship from log transformed variables were also established to follow the method of Pauly (1983):

$$W = aL^b$$

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

Where W = weight of fish (g), L = length of fish (cm), a = intercept, b = exponent.

Condition factor (*K*):

The wellbeing of fish was determined by the calculation of the condition factor (K) which was calculated by the following equation by Fulton (1904):

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

Where W = weight of fish (g) and L = total length of fish (cm)

Statistical analysis:

The graphical presentation and calculation of the growth coefficient, correlation coefficient, and condition factor and the validation of the variation of these morphometric variables based on the on the growth and condition factor statistical tool (t-test) were applied in Excel 2010.

Results and discussion

The morphometric variables including total length, standard length and weight were measured during the study and the range of total length, standard length and weight (18.5-41.5 cm, 16.5-35 cm and 100-650 g) of pond fish and (30-48 cm, 24-39 cm and 185-790 g) of cage fish were noted, respectively (Table 1). The length-weight relationship (LWR) of the fishes was established and correlation coefficient values in pond fishes (0.552) and in cage fishes (0.557) shows a positive correlation between the length and weight variables (Table 1 and Figs. 1 A, B). The length and weight ranges of the studied fish shows the normal and good survival of the fish in the cultured aquatic environments. Chowdhary *et al*. (2022) reported similar length and weight of pangasius species in aquatic ecosystems in Uttar Pradesh (India). Radhakrishnan (2021) reported the length and weight range (20.7-68 cm, 70-2300 g) of *P.hypophthalmus* in a riverine ecosystem which was much higher than the length-weight range of the studied fish. In LWR, growth constant (b) were determined (2.031 and 2.077) in pond fish and cage fish, respectively that exhibit negative allometric growth of the fish in these water bodies (Table 1, Figs. 1 A, B). The findings of the present study derive support from the findings of Jerin *et al.* (2023) and Okomoda *et al.* (2018) who have reported negative allometric growth (2.24 and 2.99, respectively) in *P. hypophthalmus.* In contradiction to the present study, Radhakrishnan *et al*. (2021) reported positive allometric growth (3.023) in *P. hypophthalmus* in a riverine ecosystem. Condition factor (K) is used to describe the well-being or condition of fatness, relative degree of robustness and nourishment of the fish (Solomon *et al*., 2017) and generally, the desirable value of K is ≥ 1.0 (Olufeagba *et al*., 2016). Hence, this phenomenon was exploited in many studies as an important

Table 1: Comparative morphological and growth parameters of studied fish

Parameters	Unit	Fishes in pond	Fishes in cage
Number of specimens	N	314	500
Total length (range)	Cm	18.5-41.5	30-48
Standard length (range)	Cm	16.5-35	24-39
Weight (range)	Gm	100-650	185-790
Condition factor	K	0.451-1.658	0.423-1.391

Table 2: Statistical analysis (t-test) of the morphometric variables of studied fish

Parameter	$t_{(cal)}$	Mean difference	SE difference
Total length	35.269*	8.485	0.241
Standard length	35.983*	7.116	0.198
Weight	39.009*	265.300	6.801
Condition factor	2.825*	0.037	0.017

Degree of freedom is 816, level of significance (*5%) and SE is standard error

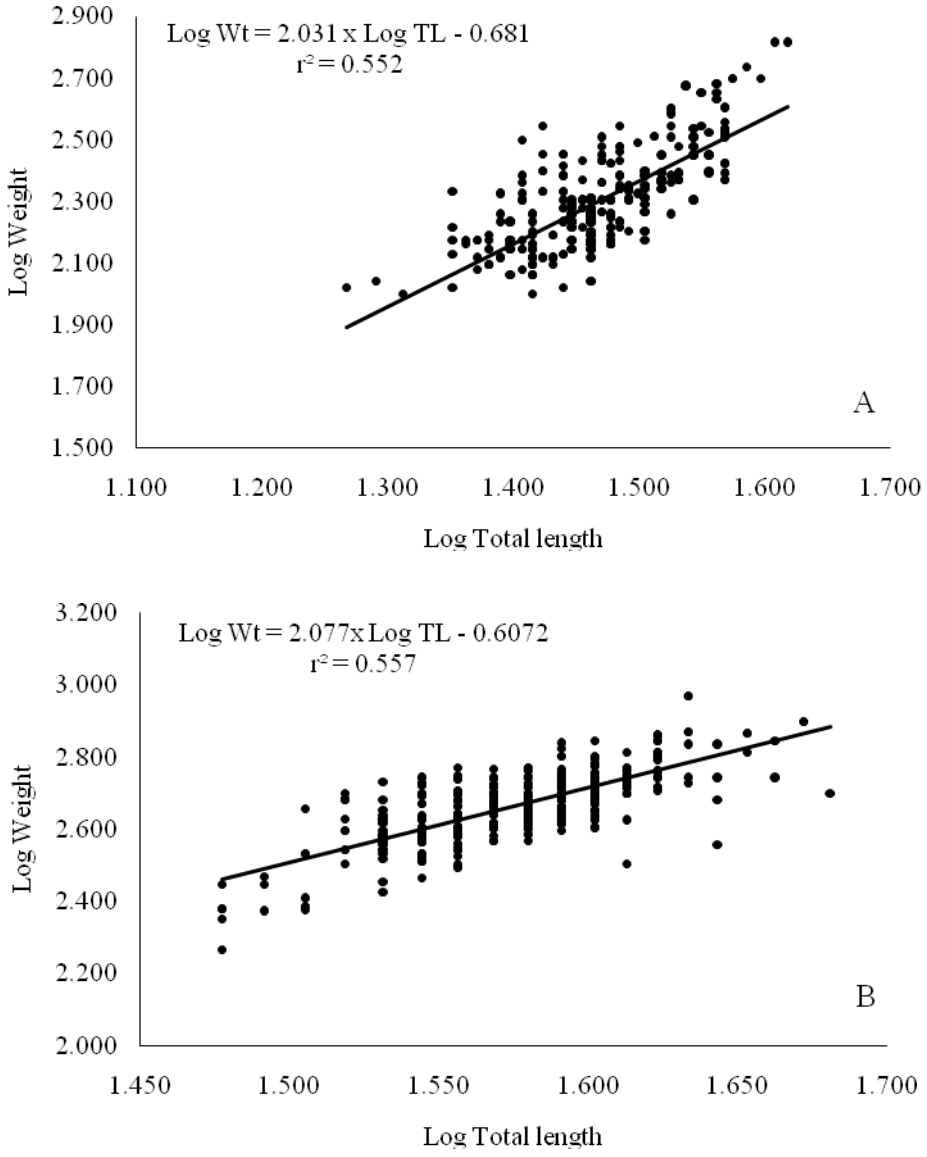

Fig. 1: Length-weight relationship of pond fish (A) and cage fish (B).

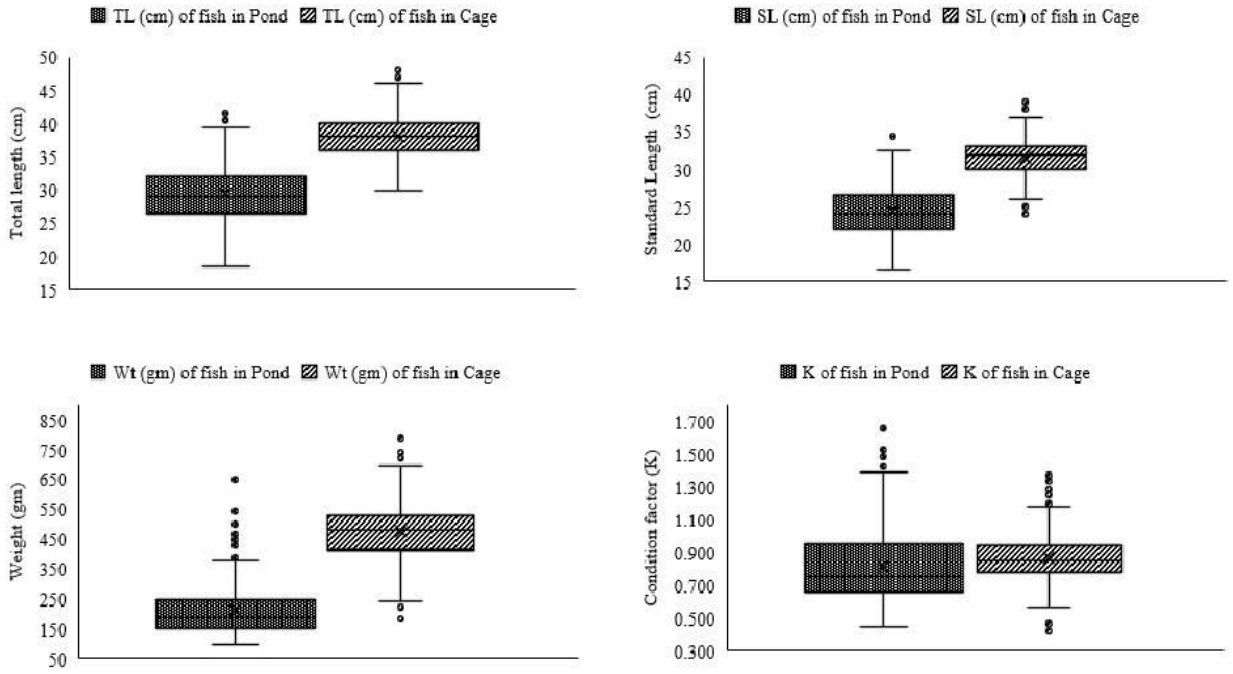

Fig. 2: Box plot of different morphological parameters and condition factor of studied fish.

index for monitoring feeding intensity as well as growth rates in many fish (Oniye *et al*., 2006). In the present study, condition factor (K) was assessed to assess the overall health condition of *P. hypophthalmus* in different culture systems. The observed range of "K value was 0.451–1.658 in the pond culture system and 0.423–1.391 in the cage culture system (Table 1). The variation in the "K value of fish in these different culture systems may be attributed to the aquatic environment, stress, sexes, availability of food, water quality etc. Similar findings in pagasius fishes were also reported by Okomoda *et al*. (2018), Nandi *et al*. (2022) and Jerin *et al.* (2023). The findings on morphometric variables (total length range, standard length range, weight range), length-weight relationship based growth and condition factor of the *P. hypophthalmus* from culture systems i.e. pond and cage were compared and it shows that these were comparatively high in cage cultured fish (Fig. 2). The variation among these factors was verified by the appropriate statistical tool (t-test) which depicted that the range of total length, standard length and weight of the pond fishes was extremely significant ($p < 0.05$) more varied than the fishes of cage reared while the condition factor of pond fishes was significantly ($p < 0.01$) different compared to cage reared fishes (Table 2, Fig. 2). The findings from the present study show that the impact of fish culture systems cannot be overemphasized similarly Ifedayo *et al*. (2020) reported the impact of the culture system on the overall performance of fish production. In aquaculture, tilapia fish production fluctuated in an earthen pond that could be attributed to an increment in salinity, predation and prolific production of the fish in the pond. Therefore, cage culture is advised by Mwachiro *et al*. (2012). The faster growth of tilapia (*O. niloticus*) was demonstrated at a two-fold higher growth rate in the cage culture system (Mensah *et al*., 2014). Mondal *et al*. (2010) reported that Thai climbing perch in cages may be a better option for rural pond aquaculture. In evidence for the present study similar findings on the good growth and condition of the fish in the cage culture were also reported by Kumar *et al*. (2017), Khan *et al*. (2009) and Debnath (2014) which are directly

related to the benefit-cost analysis and suggest that the adoption of cage culture is more profitable than pond culture.

Conclusion

On the basis of the length weight relationship, it is concluded that correlation coefficient values in pond and cage fishes which shows a positive correlation between the variables with good survival of the fish in cultured aquatic environments. On other side, growth constant (b) was observed b< 3.00 in pond fish and cage fish that exhibit negative allometric growth of the fish in both culture system. Apart from this, the variation in length, weight and condition factor of fish in culture systems may be attributed to the fluctuation in aquatic environment. The statistical analysis showed that range of total length, standard length and weight of the pond fishes was extremely significant ($p < 0.05$) more varied than the fishes of cage reared while the condition factor of pond fishes was significantly ($p < 0.01$) different compared to cage reared fishes. The findings from the present study showed that the fishes were in good condition with growth in cage culture than pond culture which is directly related to more revenue generation and beneficial to fish farmers.

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