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Short Communication

IMPACT OF SALINITY ON THE SILURID CATFISHES: A LABORATORY INVESTIGATION

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ABSTRACT: The present communication evaluates salinity tolerance of two freshwater Silurid catfishes *Clarias magur* and *Pangasianodon hypophthalmus* (Order: Siluriformes) from coastal mainland of Sundarban, India, where climate change induced salinity intrusion is a persistent phenomenon. After 100% mortality of all the fishes had been obtained from 15 to 20 g l^{-1} salinity levels in the first phase of the range-finding test, a non-renewal static toxicity bioassay was performed to determine the median lethal salinity (MLS-50 $_{96h}$) for every fish by direct exposure to various salinities (5-18 g l^{-1}). The MLS- 50 $_{96h}$ of *Clarias magur* and *Pangasianodon hypophthalmus* was found as ≈ 13 g l^{-1}. Overall, the findings of the present study revealed that these two catfish species might be suitable for culture in the brackish water containing salinity up to 10 g l^{-1} and that can be encouraged in the Indian Sundarban and other tropical deltas where brackish water intrusion is a frequent phenomenon.

Key words: Median lethal salinity (MLS-50 $_{96h}$), *Clarias magur*, *Pangasianodon hypophthalmus*, Indian Sundarban.

Increasing salinity level in freshwater and coastal mainland caused by climate change induced sea level rise is now a major global concern and that affects freshwater fish negatively. Changes in salinities beyond their tolerable limit can directly affect ontogenic development, fish metabolism, survival, growth and other physiological functions of freshwater fishes (Boeuf and Payan 2001, Nordlie 2009). Many areas in the Indian Sundarban delta are exposed to saline water intrusion during any kind of extreme weather events. Saline water inundation due to the failure of river embankment, sea level rise and erosion during cyclones and storm surges are heavily impacting freshwater fish culture inside the coastal mainland, which is basically freshwater ecosystem (Dubey *et al.* 2017). Moreover, pond water salinity inside the Sundarban islands is also fluctuates seasonally due to changes in precipitation and temperature. Therefore, it is important to find out the salinity tolerance of important freshwater aquaculture fishes to optimize their basic conditions for culture.

The Asian catfish *Clarias magur* (Order: Siluriformes) belonging to the family Clariidae is a popular food fish item across the delta and is popularly known as 'magur'. It has high commercial importance and culture potential due to its excellent taste and huge demand in the domestic market. The species is an obligatory air breather and able to thrive in adverse ecological conditions. The striped catfish *Pangasianodon hypophthalmus* (Order: Siluriformes) belongs to the Pangasiidae family is an exotic fish variety. Commonly known as 'pangas', this catfish was introduced into India possibly during the late 1990s via Bangladesh for culture in the West Bengal (Singh and Lakra 2012). This fish can endure a wide range of ecological conditions and is suitable for aquaculture due to its faster growth rate, omnivorous feeding habit and cheap price in the local market. Although some studies have been conducted to understand the effect of salinities on the various biophysical aspects of these two catfishes (Sarma *et al.* 2013, Nguyen *et al.* 2014, Jahan *et al.* 2018), very few information are available particularly on the optimization of their culture technique in brackish water. Therefore, the present study aimed to determine the median lethal salinity (MLS- 50 $_{96h}$) of these catfishes which could be a helpful guide during their

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culture technique using saline water.

The study

The fish fingerlings of *C. magur* and *P. hypophthalmus* were collected from local fish seed supplier and transported in oxygenated polythene bags to the NICRA-climate resilient aquaculture wet laboratory of West Bengal University of Animal and Fishery Sciences, India. The total length and weight of the *C. magur* and *P. hypophthalmus* were measured as 5.36 ± 0.27 cm, 2.14 ± 0.15 g and 12.39 ± 0.21 cm, 10.55 ± 0.57 g respectively. After giving prophylactic dips in salt solution (2%), the fish were kept for one week in acclimatization with ambient environment and *ad libitum* feeding. The fish were starved for 24 hours (h) before being subjected to a salinity tolerance experiment.

In the first phase, a range finding test was performed to determine the salinity range (Peltier and Weber 1985) for every fishes. The experiment was carried out in 50-liter glass aquaria (60 cm × 30 cm × 30 cm: L × W × H) in triplicates with continuous aeration and ten individuals fish fingerlings were directly subjected to freshwater followed by 5, 10, 15, and 20 g l^{-1} saline water and observed for 96 h. After 100% mortality of all the fishes had been obtained from 15 to 20 g l^{-1} salinity levels in the first phase of the range-finding test (Fig. 1), a definitive salinity tolerance test was performed in the second phase to find out the median lethal salinity concentration. The MLS- 50 $_{96h}$ is defined as the salinity at which survival of test species falls to 50% after 96 h of direct transfer from fresh water to various test salinities (Watanabe *et al.* 1990). In the second phase, twelve salinity concentrations (5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18 g l^{-1}) each having three replications were applied to find cumulative mortality percentage (0–100%) for 96 h. Mortality was recorded at 24, 48, 72 and 96 h of exposure to each salinity level. The MLS- 50 $_{96h}$ was calculated by the Probit regression model and through the sigmoid dose-response curve (Finney 1971). Important water quality parameters were monitored in each step of experiment and were found to be within acceptable limits and optimum for fish culture.

The MLS- 50 $_{96h}$ and confidence limits estimated using the Probit model for *C. magur* and *P. hypophthalmus* are given in Table 1. Survival of fishes was severely altered only when they were subjected to the salinity of ≈ 15 g l^{-1} and beyond it (Fig. 1). In these cases, 100% mortality was observed within 24 h exposure. The MLS- 50 $_{96h}$ of *C. magur* and *P. hypophthalmus* was ≈ 13 g l^{-1} quite higher than carps and barbs (Order: Cypriniformes) (Pillai *et al.* 2003). The survival rate for *P. hypophthalmus* was recorded 96%, 54% and 46% at 12 g l^{-1}, 13 g l^{-1} and 14 g l^{-1} salinity respectively while survival rate of *C. magur* at 13 g l^{-1}, 14 g l^{-1} and 15 g l^{-1} salinity were documented as 51%, 71% and 97% respectively. Nguyen *et al.* (2014) observed that salinity levels from freshwater to 10 g l^{-1} salinity did not have any negative effects on survival of striped catfish *P. hypophthalmus* while Jahan *et al.* (2018) found median lethal concentration (LC_{50}) of striped catfish is 14 g l^{-1} salinity. Asian catfish *C. magur* could thrive well in 10 g l^{-1} salinity for an indefinite period and their salinity tolerance value is quite higher (≈13 g l^{-1}) which is in agreement with the study of Sahoo *et al.* (2003) and Sarma *et al.* (2013). Information is also available on the salinity stress tolerance of other catfishes like, *Mystus vittatus* (Arunachalam and Reddy 1979), *Heteropneustes fossilis* (Ahmmed *et al*. 2017), *H. longifilis* (Fashina-Bombata and Busari 2003), African catfish *C. gariepinus* (Chervinski 1984), channel catfish *Ictalurus punctatus* (Allen and Avault 1970) and the threshold salinity tolerance lies within 13 g l^{-1} salinity. The study found that the sub-lethal salinities of these two freshwater stenohaline catfish fish species are up to and below 10 g l^{-1} salinity. In case of freshwater stenohaline fish, long-term exposure in salinities more than 10 g l^{-1} severely affected their survival and growth rates (Wang *et al.* 1997, Sahoo *et al.* 2003, Sarma *et al.* 2013).

In brackish water condition, a freshwater fish requires additional energy for the high rate of osmoregulation that could hamper growth when compared to those reared in the freshwater environment (Kilambi and Zdinak 1980). Fish exposed to variable salinities, use approximately 10

Table 1. Median Lethal Salinity (MLS- 50 $_{96h}$) of two Silurid catfishes in Indian Sundarban region.

Sl	Scientific name	(MLS- 50 $_{96h}$)	Confidence Interval (95%)		Cox & Snell R^2	Nagelkerke R^2
			Lower bound	Upper bound		
	Order: Siluriformes					
1	*Clarias magur*	13.09	11.58	13.92	0.41	0.55
2	*Pangasianodon hypophthalmus*	12.85	11.76	13.60	0.37	0.52

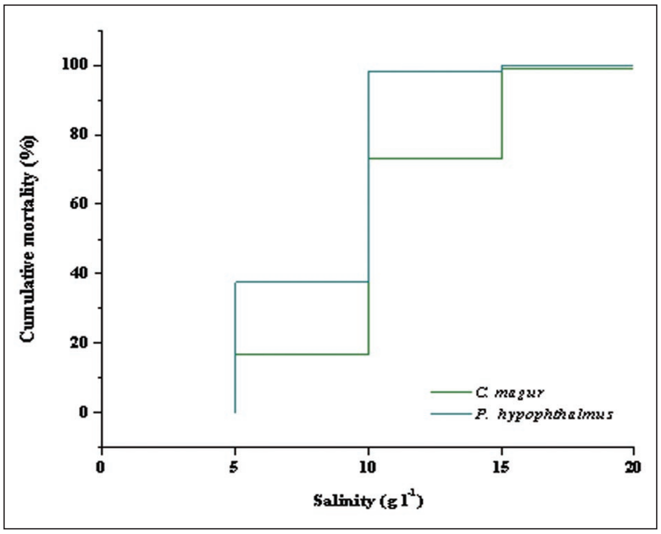

Fig. 1. Cumulative mortality (100%) of two Silurid catfishes in saline water (g l^{-1}) during range-finding test.

– 50% of their available energy to adjust their homeostatic balance (Boeuf and Payan 2001). At increasing salinities, freshwater fishes drink more saline water that requires extra energy for Na^+/K^+–ATPase activities to extract excess ions and higher secretion levels of hormones (like cortisol, thyroid hormones) that deal with stress in elevated salinities (Eckert *et al.* 2001, Varsamos *et al.* 2005). The high-energy costs associated with the maintenance of ionic balance and hormonal regulation have a negative effect on the survival of stenohaline freshwater fish in hyperosmotic environments (Nguyen *et al*. 2014). Although some studies suggest that freshwater fish rearing in oligohaline water (5- 10 g l^{-1}) showed significantly rapid growth rates than those reared in fresh water (Altinok and Grizzle 2001, Dubey *et al.* 2015, Dubey *et al.* 2016a). Therefore, the upshot of the present study can also be utilized in farm site selection and salinity maintenance to maximize commercial productivity in coastal inundation-prone areas.

Conclusion

Based on the outcome of the present study, it can be suggested that these stenohaline freshwater catfish *C. magur* and *P. hypophthalmus* could be encouraged for culture in the coastal areas of the Indian Sundarban landscape where salinity level remains at or below 13 g l^{-1}. However, the present study was conducted under laboratory conditions, comprehensive field-based trials are recommended for better understanding the impact of salinity on survival and growth and optimization of farm salinity to maximize their productivity.

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