Indian J. Fish., 62 (1): 128-130, 2015

Note

Comparative analysis of boldness in four species of freshwater teleosts

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ABSTRACT

The present study compared boldness (latency to initiate exploration of a novel area) in four species of freshwater fish collected from an irrigation canal. The results revealed that the stinging catfish (*Heteropneustes fossilis*), armed with poisonous pectoral spines, was the boldest and unarmed attentive carplet (*Amblypharyngodon melettinus*) the shyest. There was no significant difference in the boldness of Malabar mystus (*Mystus oculatus*) and climbing perch (*Anabas testudineus*), the other two subject species, and their boldness can be positioned in between that of stinging catfish and attentive carplet. The results are discussed in the light of relation between boldness and predator apprehension in fish.

Keywords: Behaviour syndrome, Exploratory behaviour, Poisonous fish, Swim-way apparatus

Fishes actively explore their habitat because updated knowledge of the environment is vital for a stress free life. Exploration is defined as "a species-specific behaviour pattern concerned with gathering of information regarding the surroundings" (Maximino *et al.,* 2008). The extension of activities from home range to unfamiliar areas and unknown objects are beneficial to the individual, since such activities may lead the explorer to new sources of biologically significant resources (Conrad *et al.*, 2011). However, exploration of novelty is often associated with risk; sometimes the novel object may be lethal (*e.g.* predator) or the explorer may perish as an easy food for predators in a novel environment due to the lack of knowledge about escape route and location of refuge (Conrad *et al.*, 2011).

The disposition to initiate exploration of a novel habitat or an object is often counted as the measure of boldness (the propensity to take risk), a personality trait (Toms *et al.*, 2010). Based on exploratory tendency, individuals of a fish population can be segregated into three categories *viz.,* bold (high susceptibility to take risk), shy (prone to take less risk) and intermediate (Budaev, 1997). Bold individuals are more likely to stray from their home range or discover novel food sources, grow faster, possess enhanced learning ability and achieve a dominant position in the shoal. All these features make boldness of a species a major target of natural selection (Conrad *et al.*, 2011). Knowledge of boldness has wider application in culture, conservation and control of piscine species (Sih *et al.*, 2012) and contemporary ichthyology consider 'phenotype management' based on the boldness of focal species as an excellent strategy to enhance the success of restocking and reintroduction of endangered species as well to increase the survival and growth of individuals in aquaculture ponds (Conrad *et al.*, 2011; Sih *et al.*, 2012).

Even though individual and inter-population variation in boldness is being studied in many piscine species, very few studies comparing boldness of different species sharing a habitat is available in the literature (Blanchet *et al.,* 2007). Since boldness is correlated with vital behaviours (referred as behavioural syndrome), like aggression towards conspecific and heterospecific individuals, dominance, resources sharing and susceptibility to predation, this trait can determine the patterns of intra and interspecific interactions and hence the structure of piscine community in a habitat (Conrad *et al.,* 2011). Additionally, there are studies available to prove that presence of alien invasive piscine species that are bold and aggressive in nature could modify the exploratory tendency and niche of native fishes, affecting their growth and survival (Blanchet *et al.,* 2007; Cote *et al.*, 2010). Unfortunately, even though having wider implications, very few wild piscine species inhabiting the Indian subcontinent have been tested for their boldness (Binoy and Thomas, 2003). The present study compared the boldness of four species of freshwater teleosts *viz*., stinging catfish *Heteropneustes* *fossilis* (Bloch, 1794), Malabar mystus *Mystus oculatus* (Valenciennes, 1840), climbing perch *Anabas testudineus* (Bloch, 1792) and attentive carplet *Amblypharyngodon melettinus* (Valenciennes, 1844).

Stinging catfish *H. fossilis* (6.74 ± 2.19 cm; mean total length, TL ± SD), Malabar mystus *M. oculatus* (6.48 ± 2.24 cm; TL ± SD), climbing perch *A. testudineus* (7.04 ± 2.17 cm; TL ± SD), and attentive carplet *A. melettinus* (6.5 ±1.86 cm; TL ± SD) were collected from an irrigation canal in Nadavaramba (10.33°N; 76.22°E), Thrissur District, Kerala State, India and transported to the laboratory in Bangalore, Karnataka State with the help of professional aquarium keepers. The fishes were kept in five separate glass tanks (60×32×32 cm; length × breadth × height) with sand substratum. The tanks were filled with water up to a height of 30 cm and the fishes were fed with artificial food pellets *ad libitum.* in the morning and evening. Excess feed were siphoned out 30 min post-feeding. Temperature was maintained at 25±1°C and light: dark cycle 12:12. All fishes were fed 3 h before the experiment to avoid the influence of hunger on boldness.

After allowing 4 days to acclimatise to laboratory conditions, 22 individuals from each species were tested for boldness using swim-way apparatus (Yoshida *et al.*, 2005). An aquarium (60×32×32 cm) was converted into a swim-way apparatus by dividing it into two chambers, Chamber A (20 × 32 × 32 cm) and Chamber B (40 × 32 × 32), using an opaque plexiglass sheet with a guillotine door (8×4 cm; height × breadth) (Yoshida *et al.*, 2005). Sidewalls and ceiling of chamber A was made opaque using acrylic sheets to provide necessary shade for fish staying inside. The subject fish was introduced individually, into chamber A (start chamber) and 5 min was given for acclimatisation, after which the guillotine door was raised and the fish was free to swim out of the start chamber to explore the unfamiliar open environment in chamber B. The initiation of exploration of swim-way (Chamber B) was scored when fish stuck its head out of the start chamber past the opercula. If subject fish failed to emerge out of the start chamber after six min, the trial was terminated and it was allocated a ceiling value of 360 s. Non-parametric statistical methods, Kruskal-Wallis test followed by *post hoc* analysis using Steel-Dwass test, were used for analysis as data never followed normal distribution even after transformation. All fishes were released back to the site of collection after the experiment.

A significant variation was observed in the boldness of four subject species (Kruskal-Wallis, Test, χ^2 = 30.01; n = 22; p< 0.001; Fig.1) and the stinging catfish was found to be the boldest. Members of this species took significantly less time to initiate the exploration of novel area than Malabar mystus (Steel-Dwass test, tij = -2.67; p <0.05), climbing perch (tij = -3.14; p<0.01) and attentive carplet (tij = -4.88; p<0.001). On the contrary, attentive carplet was very shy and this fish spent significantly more time inside the start chamber of swim-way apparatus in comparison to Malabar mystus (tij = -2.81; p<0.05), climbing perch (tij = -3.56; p<0.05) and stinging catfish. Interestingly, no significant difference was observed in the boldness of climbing perch and Malabar mystus (tij = -0.28; p>0.05) and the boldness expressed by these two species was in between that of stinging catfish and attentive carplet.

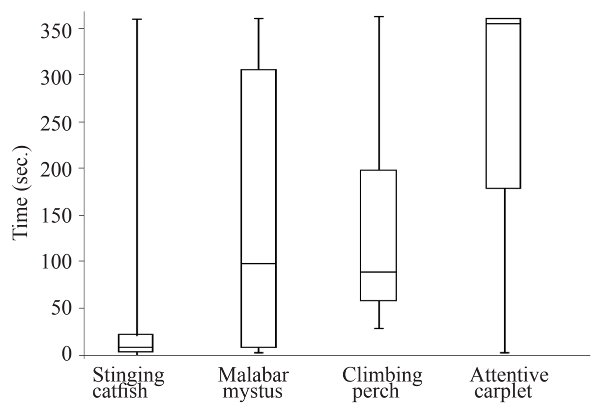

Fig. 1. Latency to initiate the exploration of a novel area (boldness) by different fish species. Values are represented as median and quartiles.

Variation in the boldness of four subject species could be the refection of their adaptations in terms of crypsis-based resistance against predation (Maximino *et al.*, 2008). Any animal, including fish, leaves the shelter and starts exploration of a novel area or an object when neophobia (the fear towards novelty), is overtaken by the urge for exploration. The exploratory apprehensive behaviour of a species can be considered analogous to anti-predator apprehension ("any reduction in attention to other activities as a result of increasing the allocation of attention to detecting and/or responding to potential predators") (Kavaliers and Choleris, 2001). Therefore, a species vulnerable to predator attack often responds to predator's attendance (or its possible presence) by escalating the utilisation of shelters (Maximino *et al.*, 2008). Being equipped with a pair of sharp, bony poisonous spine along the leading edge of the pectoral fins, which can be erected and locked into place when threatened and can cause severe pain and ischemia if pricked (Wright, 2009), stinging catfish is avoided by most of the predators. Hence, having very less pressure from predators, this fish quickly overcame the anxiety induced by novel environment and went for exploration, leaving the shelter.

The attentive carplet, which does not possess any 'armour' against the predators adopted crypsis-based anti-predator strategy and took a very long time for the initiation of exploration of novel, brightly lit open area of swim-way apparatus. However, climbing perch and Malabar mystus, which exhibited a degree of boldness in between poisonous stinging catfish and unarmed attentive carplet are equipped with some morphological characteristics that can protect them from predators. Malabar mystus is provided with serrated pectoral spines (but not equipped with venom gland), making it a tough prey for both aquatic and terrestrial predators, while the sharp spines present on the margin of the operculum of climbing perch is known to cause death to some piscine, reptilian and avian predators, when the spines get locked in the throat or stomach (Hitchcock, 2008). Here it is important to note that even though the genetic make up and genetically determined morphological traits can contribute to the boldness of a species, researchers has proven that this trait exhibit divergence in accordance with the socio-ecological scenario experienced by the individual during development (Conrad *et al.*, 2011). Hence future studies focusing on the development of boldness and contextual variation in the expression of this trait in different species sharing a habitat can elucidate the role of this behavioural characteristic in determining adaptation, interspecific interaction, and thus the structure and sustainability of fish community in an aquatic ecosystem (Sih *et al.*, 2012)

Acknowledgements

Author gratefully acknowledges Science Engineering Research Board, Department of Science and Technology, Government of India for funding this research under Start-up Research Grant (Young Scientist).

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Date of receipt : 04.01.2013
Date of acceptance : 16.07.2014