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ONSET OF SHOALING PREFERENCE IN PUNTIUS SARANA SUBNASUTUS

JILNA ALEX N.[1*] AND JOHN THOMAS K[2]

Christ College, Irinjalakuda, Thrissur 680 125

ABSTRACT

Fishes are social organisms and form social groups in some stage of their life cycle. Loose aggregations of fishes forming a social assembly are called shoals. Fish that join with a shoal usually gains a wide variety of benefits. In the present study, the onset of shoaling behaviour in a freshwater fish, *Puntius sarana subnasutus* was tested using induced breeding technique. In dichotomous choice test, 10-days-old (mean body length = 9 mm) larvae and 20, 30 and 40-days-old juveniles (Mean body length 2.8, 3.1, 4.6 cm respectively) were given the opportunity to swim near shoals of ten fish or a single fish. The larvae on their completion of fin-ray development and start of scale formation to attainment of sexual maturity is said to be juveniles. When introduced into the experimental arena, the larvae as well as the juveniles demonstrated shoaling behavior, swimming near a group of fish rather than a single fish. The fish clearly exhibited an increasing preference to associate with a group corresponding to an increase in their age and the juveniles when become 40-days old, showed little preference for a single fish. The significance of developmental process in shoaling preference of fishes is discussed.

KEY WORDS: Shoaling preference, Larvae, Juveniles, *Puntius sarana subnasutus*

INTRODUCTION

Shoaling behavior in fish has been a focus of behaviuoral studies for over fifty years (Keenleyside, 1955). Shoaling confers a number of individual selective advantages to the group members, mainly related to predator avoidance and better foraging opportunities. The "many eyes" advantages of shoaling predict the benefits of better inspection of surroundings and continual monitoring of the predator. It also forms a "confusion" effect whereby the hunting efficacy of predators is reduced due to disorientation and the inability to target an individual fish (Pitcher and Parrish, 1993). Further, dense groups can be perceived as a large active object and therefore repel predators through mimicry (Breder, 1959). Besides these actual predation advantages, inspection can also have an effect on making success, with inspectors able to advertise their fitness qualities (Evans et al., 2002). Shoaling allows the fish to exploit more feeding patches more rapidly, possibly with the advantages from a better predator inspection, the fish can access patches associated with higher risk. This in turn increases the intensity and efficiency of feeding (Pitcher and parish, 1993; Sackley and Kaufman, 1996). Shoaling also provides better hydrodynamic advantage by reducing the amount of energy required to move for shoaling fishes as opposed to solitary fish (Wright et al., 2006).

However, there are certain costs associated with shoaling. The individuals may experience higher degree of competition when they join a shoal (Krause, 1994) and increase the risk of parasitic infection (Dugatkin et al., 1994). The relative trade-off between these benefits and costs can determine the choice of joining with a particular shoal. An individual fish can take decisions about joining a shoal based on the characteristics of the existing group such as group size (Wong and Rosenthal, 2005), body size (Krause and Ruxton, 2002) colour (Mc Robert and Bradner, 1998), kinship (Frommen et al., 2007; Alex and Thomas, 2011) etc. In the present study we tried to analyse the influence of age on the shoaling behavior of larvae and juveniles of *Puntius sarana subnasutus* and their ability to discriminate difference in group size of two stimulus shoals is tested.

MATERIALS AND METHOD

Puntius sarana subnasutus were collected from canals associated with paddy fields of Irinjalakuda (10^o25', 10^o18'47" N lat. and 76^o17'19", 76^o12'48"E long), Thrissur district, India, during January - March 2009 and acclimatized with laboratory conditions for two weeks in large cement tanks (175cm x 90cm x 90cm). The tanks were provided with sand substratum and water level was maintained at 60 cm. The temperature in the laboratory was constant at 26^0C, with a constant light:dark cycle of 12:12. Under laboratory conditions, they were fed *ad libitum* with a range of commercially available tropical fish food (Marvel feeds, Aquarium systems, India). Gravid pairs were selected and induced to breed using GnRH analogue Ovaprim. Healthy larvae were reared in the laboratory in four glass tanks (45cm x 23cm x 23cm) in a well-aerated condition and fed with *artemia* nauplius larvae.

EXPERIMENTAL PROCEDURE

We tested the ability of the larvae and juveniles to discriminate group size difference between two stimulus shoals. In a dichotomous choice test, 10-days-old larvae (mean body length = 9 mm) and 20-30-40-days old juveniles (Mean body length 2.8, 3.1, 4.6 cm respectively) were given an opportunity to swim near either a single sibling fish or a group of 10 siblings. Shoaling preferences were tested in 30 liter a aquarium (45x23x23 cm), which was divided into two stimulus shoal compartments (measuring 15x23x23 cm each) and a central compartment (measuring 15x23x23 cm) (Fig.1). Perforated clear Plexiglas sheets separated compartments. Ten centimeters in front of each side compartments was marked as preference zone (almost equal to the length of the test fish so that the preference is recorded only when the whole body of the fish is within the preference zone), leaving a neutral zone of in the middle of the tank. An 11w compact fluorescent lamp placed above the tank lighted the set up. Three sides of the aquarium were covered with black paper to prevent interference of external stimuli. Additionally, a black curtain was tightened around the test tank. Two stimulus shoals were introduced into the side chambers. The test fish were always introduced individually into the central compartment in a presentation cage made of transparent, perforated acrylic sheets (15cm x 10cm x 27cm). The total duration of the experiment was sixteen minutes. Ten minutes were given to the test fish to assess the stimulus shoals and thereafter, the movements of the fish were recorded for six minutes using a stopwatch, sitting behind the black screen and looking through a horizontal slit on the screen. We also switched the positions of the stimulus shoals (in half of the experiments) to eliminate the risk of side biases and repeated the preference experiment.

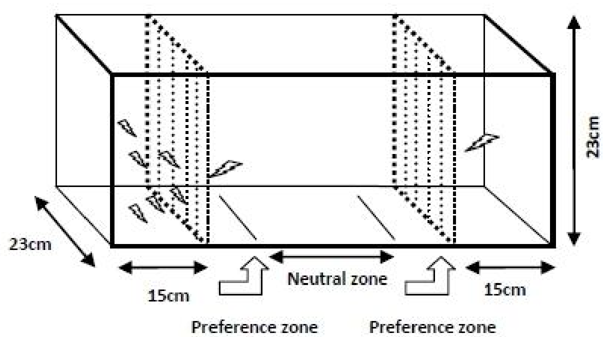

Figure 1 : Diagram showing the experimental setup

Data were analyzed using the parametric dependent sample two-tailed 't' test [SPSS 11.0.1 statistical package].

RESULTS

The larvae as well as the juveniles always preferred to shoal with a group of ten individuals rather than a single fish indicating the overriding influence of group-size on the shoaling behavior and their ability to discriminate shoals of different size. The fish clearly exhibited an increasing preference to associate with a group corresponding to an increase in their age. Even though 10-days-old larvae and 20 and 30- days old juveniles explored near the single fish, they discriminated the group size difference between the stimulus shoals and spent significant time with the larger group ($t = 4.56$, $p = 0.000$; $t = 5.57$, $p = 0.000$; $t = 6.91$, $p = 0.000$ respectively). However, 40-days old juveniles showed very little preference for the single fish ($t = 12.84$, $p = 0.000$) Fig. 2.

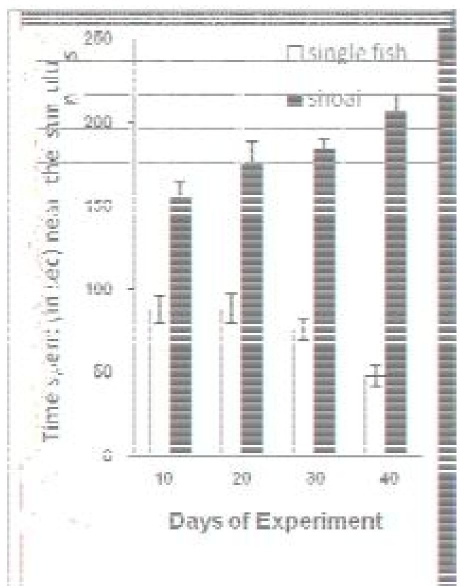

Figure 2 : Preference of juvenile *Puntius sarana subnasutus* for Single (□) / ten (■) sibling stimulus shoals n = 20

Mean time (spent in sec) ± SE

DISCUSSIONS

Fishes are able to discriminate among shoals of different size, based on the circumstances (Krause, et al., 1998, Hoare et al., 2004 and Wong and Rosenthal, 2005) and always preferred to associate with the larger shoal probably due to antipredator advantages (Harger and Helfman, 1991), better foraging opportunity (Pitcher et al., 1982) and better transmission of information (Lachlan, 1998). In the present study also, the fish performed a better discrimination of group-size differences and selected the larger group to shoal. The preference increased correlated with an increase in age of the fish, clearly exemplifying a close association between the age and learning capacity of the fish. Many experiments have clarified the genetic and learned basis of shoaling behaviour (Giles and Huntingford, 1984; Magurran, 1989; Magurran and seghers, 1990). Learning is a complex ontogenic process that allows animals to acquire, store and subsequently use information about the environment. This information complements genetic prowess, allowing animals to fine tune their behavior according to circumstances. The increased preference exhibited by the juveniles to associate with a group may be aroused when their innate ability to form a shoal at the larval stage is supplemented from the learned advantages of associating with a group. This increased social interaction might have been led to subsequent changes in the brain.

Scace et al., (2006) in a study explored the social organization on the brains and behaviours of cichlid fishes using the Insel and Fernald (2004) framework for processing of social information. The social behavior of cichlid fish relied on visual stimuli -> social meaning -> social motivation -> social behavior. In fish, the telencephalon is involved in a variety of social and cognitive behaviours (Demski and Beaver, 2001) and the telencephalic size is correlated with social complexity, social learning, enhanced visual cognition and innovation (Reader and Laland, 2002). In the present study, the increasing preference for a larger group with the increase in age may be correlated with the increase in size of brain of the fish. In 50-52 days old sturgeon fishes the central nervous system acquires definite structure and form stabilization of conditional reflex reactions (Obukhov, 1996). Further studies are necessary to determine the role of brain size of larval and juvenile fishes in differentiating the group-size and the role of other factors such as surface area, contour length, density or extent of shoal movement in aiding this particular behavior.

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