Climbing perch (*Anabas testudineus* Bloch) recognizes members of familiar shoals

Though fishes were once considered as organisms with three-second memory, recently it has been shown that they exhibit complex abilities like intraspecific and inter-specific communication skills, cooperation in the context of predator detection, capacity to transmit cultural traditions[1], and capability for individual recognition of shoal mates[2–4]. Individual recognition of conspecifics is an expression of higher cognitive abilities of a species and is important in the context of decision-making[5] like mate choice[6], school selection[7], and anti-predator behaviour[8]. The ability to discriminate familiar from unfamiliar conspecifics[9] has been demonstrated in a wide variety of fish species like bluegill sunfish[2], three-spined sticklebacks[3], fathead minnows[4], etc.

It has been demonstrated that given a choice, *Anabas testudineus*, a common tropical freshwater fish, popularly known as the climbing perch preferred to stay with a larger shoal of unfamiliar conspecifics to that of a smaller shoal composed of familiar conspecifics[10]. Shoals are aggregations of fishes that remain together for social reasons, whereas synchronized and polarized swimming groups of fish are known as schools[11]. However, when the number of individuals of the unfamiliar shoal was equal to that of the familiar shoal, they preferred to stay with the familiar shoal[10]. These results show that though the climbing perch is able to discriminate a familiar shoal from an unfamiliar one, shoal selection behaviour of the fish is based on the size of the shoal. The present study addresses the question of whether the climbing perch is able to identify an isolated individual from a familiar shoal and exhibit differential response to it and to another unfamiliar individual.

A. testudineus prefers to live in shoals and exhibits synchronized air-gulping behaviour. Unlike shoals, fish schools are made up of conspecifics alone. Mixed-species shoals are also found in nature[12]. Living in a shoal gives the chance to get familiarized with the shoal mates (conspecific or heterospecific)[13]. Familiarity among shoal mates reduces aggressive behaviour[14].

Climbing perches (125 in number; standard length 6 ± 2 (Mean ± SE) cm) were collected from five ponds of Irinjalakuda (10°25′, 10°18′47″N lat. and 76°17′19″, 76°12′48″E long.) Thrissur district, Kerala, India, during October and December 2004 and transferred to the laboratory. They were kept in groups of ten in glass tanks (120 × 60 × 60 cm) for 30 days to make them familiar with each other. The tanks were filled with pond water up to 40 cm and provided with a sand substratum. Artificial food pellets (Marvel feeds; Aquarium Systems, India) were given to the fishes, twice daily. Water was changed once in three days.

Experiments were conducted in an apparatus made up of a 70 l aquarium (85 × 32 × 32 cm). It was divided into three chambers; two side chambers (16 × 32 × 32 cm each) and a central chamber (53 × 32 × 32 cm; Figure 1)[10]. The partitions were made of perforated, transparent acrylic sheets. Three sides of the aquarium were covered using black paper. For analysing the ability to identify an isolated familiar shoal mate, the test fish was introduced into the central arena in a presentation cage made of transparent, perforated acrylic sheets (15 × 10 × 27 cm). The presentation cage was provided with a sliding door on the top and the bottom of the cage was open so that the test fish could be released into the central arena by raising it. The water level in the set-up was 28 cm. A compact fluorescent lamp (11 W) was lighted on the top of the set-up. All tests were conducted in a room isolated from all other external interferences.

In order to test the preference of climbing perch to an isolated familiar conspecific or to another unfamiliar individual, a conspecific from the home cage of the test fish (the fish whose ability to recognize an isolated individual from a familiar shoal has to be tested) was introduced into one of the side chambers of the apparatus. In the opposite side chamber, an unfamiliar conspecific fish (from a different tank) was introduced. After placing the presentation cage at the centre of the middle chamber, the test fish was introduced into it by opening the sliding door on the top. Ten minutes were given for the fish to assess each stimulus fish on either side of the arena. In order to avoid interference due to the presence of the experimenter, the presentation cage was suspended using a string tied to a pulley and the test fish was released into the central arena by lifting the presentation cage. The time spent by the test fish near either of the stimulus fishes (within 10 cm from the side chamber; preference zone) or in the central area (non-preference zone) of the middle chamber was recorded. Observations were made from behind a black screen with slits. The time spent by the experimental fish in the preference zone was taken as the indication of its preference for the fish present in the adjacent chamber. The duration of each test was six minutes, after which the fishes were removed from the testing arena and transferred to rearing tanks. No experimental fish was used more than once with any stimulus fish-pair and new fishes were used in each trial. We tested 35 individual fishes and stimulus fishes were also changed after each trial. After completion of the experiment, the fishes were released into their native ponds.

The results indicate that climbing perch introduced into the central chamber (experimental fish) preferred to spend more time near the familiar individual

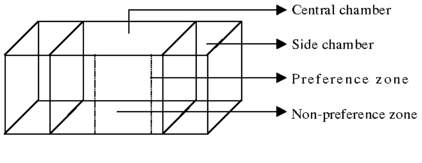

Figure 1. Diagrammatic representation of the experimental set-up.

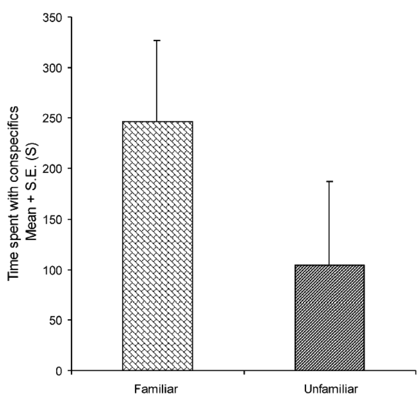

Figure 2. Preference of climbing perch for familiar/unfamiliar shoal mates; $N = 35$.

compared to the unfamiliar individual (Wilcoxon matched pairs signed rank test, $T = 485$, $N = 35$; $P < 0.001$; Figure 2). The test fish spent only a few seconds (<0.5% of the total time) in the non-preference zone. The result of the present study shows that climbing perch possesses the ability to recognize a familiar shoal mate even in isolation and exhibit differential response to it and to an unfamiliar conspecific.

As a shoal-living species, the ability for individual recognition in climbing perch helps to reduce aggression among shoal mates. For instance during the initial days of stocking, climbing perches exhibited aggressive behaviour by nipping each other with the mouth; but by day 3, the aggressive displays reduced significantly and disappeared afterwards. It is possible that the observed reduction in aggression among group-housed climbing perches may be the result of the familiarity that develops among the members as a result of cohabitation.

Shoal choice and shoal cohesiveness is also related with the ability for individual recognition[9]. Recognition of shoal mates also helps to perform group manoeuvres more fruitfully, thus enhancing the benefit of shoal-living[11]. The study shows that the climbing perch prefers to spend more time with the shoal composed of familiar individuals rather than with that formed of unfamiliar conspecifics. However, the size of the shoal has an overriding influence on the preference and selection based on familiarity[10].

One of the advantages of shoal-living is said to be the efficiency of spreading information on food source rapidly among the members of the shoal[15]. Individual recognition and familiarity may further augment this effect. Assessment of the activities of shoal mates is crucial in the context of decision-making, whether to stay in the same shoal or to join another during encounter with other shoals. Certain fishes routinely change shoals and join other shoals composed of poor competitors[16]. As a species endowed with the ability to assess both the size of the shoal[10] and the capacity to identify shoal mates, the climbing perch seems to be a good model for studying cognitive abilities of fish.

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Sexual anomaly in a marine red alga *Polysiphonia unguiformis* Boergesen

The red algae, majority of which are confined to coastal environments, play a pivotal role in the economy of many maritime states in the world. Their use, especially the fossil and coralline algae, as experimental tools and palaeoenvironmental indicators in unravelling the origin of the life on our planet is also well known. Genera like *Polysiphonia* with considerable species diversity, presence or absence of functional and nonfunctional reproductive organs on individual plants and the impact of environmental conditions on the evolution of such reproductive structures is a matter of curiosity among taxonomists.

Red algae (Rhodophyta) are unique in the plant kingdom in having non-motile sperms (spermatia) and a triphasic life cycle. In *Polysiphonia*, there are three phases in the life cycle – gametophytic (haploid plants), carposporophyte (diploid plants) and tetrasporophyte (diploid plants). There are two diploid phases alternating with a haploid phase (diplobiontic type). Tetrasporic and gametophytic plants (male and female) are morphologically similar (isomorphic), whereas carposporophyte is developed on female plant after fertilization[1,2].

The genus *Polysiphonia* first described by Greville[3] is a common red alga coming under the class Rhodophyceae, order Ceramiales, family Rhodomelaceae. Mostly it is attached to other plants or any other substrata. The plant body is small, polysiphonous, heterotrichous, branched and filamentous. The filament is attached by means of rhizoids or hapterae. Normally gametophytic plants (female and male) reproduce sexually by producing eggs (inside the carpogonia) and spermatia in the spermatangia[2]. Both the gametes fuse to form a diploid zygote. The zygote undergoes complicated post-fertilization changes and develops into a carposporophyte, which is in the form of a cystocarp. The carpospores produced inside the