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Individual consistency and context dependence in group-size preference of Eurasian perch

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ABSTRACT

Many fish spend a large part of their life in groups. The size of the group influences potential costs and benefits of group living, and depending on context a fish may prefer different group sizes. Group-size preference may also depend on personality, with social individuals expected to prefer larger groups than asocial fish. This study investigates context-dependent group size preference in two populations of a highly social fish, young of the year Eurasian perch. The perch were given a choice between a group of two and a group of eight conspecifics under three different situations: the small group was feeding, the small group had access to shelter, and a control treatment with no extra stimuli. In general, the perch associated more with the large group, but significantly less so during the food treatment. Perceived access to shelter did not affect group size preference compared to the control treatment. Consistent individual differences in social attraction were found within each context, but not among all contexts. Also, an individual's sociability did not correlate with its degree of boldness, indicating a lack of a behavioural syndrome between the two personality traits in the studied populations. The results highlight the importance of considering environmental context when studying social behaviour in obligate social fish, and show the complexity of the concept of sociability as a personality trait by demonstrating context dependence in individual consistency in social behaviour.

1. Introduction

Many fish spend a large part of their life in groups. Group living provides benefits for individuals in terms of reduced predation risk, but also entails costs such as increased resource competition (Krause and Ruxton, 2002). The size of the group may balance potential costs and benefits of group living, and depending on context a fish may prefer different group sizes (Hoare et al., 2004). For example, it may benefit an individual to be highly social (i.e. being in a large group) under risk of predation, but less so when exploiting a food resource.

Not only context may influence an animal's group size preference. There is accumulating evidence for consistent individual variation in the tendency to seek company of others, a personality dimension referred to as sociability (Réale et al., 2007). In fish, sociability is less studied than, for example, boldness or aggression (Conrad et al., 2011), a somewhat surprising fact given the importance of social behaviour in fish ecology. Individuals of guppies (*Poecilia reticulata*), sticklebacks (*Gasterosteus aculeatus*) and mosquitofish (*Gambusia affinis*) have been defined along an asocial to social axel, based on their attraction to groups of conspecifics (Budaev, 1997; Ward et al., 2004; Cote et al., 2010). Recent studies also point to a negative correlation between a fish sociability and its willingness to take risks (e.g. Ward et al., 2004), suggesting a possible behavioural syndrome between these two trait categories (Sih et al., 2004). Such negative correlations would be expected in a context where the group provide strong protection for the individual (e.g. leaving the group increases predation risk), but may not hold true in a context where less risk applies, or if the reward for being less social is very high.

When quantifying sociability in fish, binary choice experiments have often been used, in which individuals are defined according to the proportion of time they spent associating with groups of conspecifics rather than being alone (Budaev, 1997; Ward et al., 2004; Cote et al., 2010, 2012). Although such setup certainly is

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useful in facultative social animals when being without company is an option, it may fail to reveal individual differences in highly or obligate social species. In highly social fish species, absence of company may have detrimental effects on individuals, resulting in distorted behaviour and elevated stress levels (Parker, 1973; Strand et al., 2007; Schleuter et al., 2007). In such species, screening for sociability with a choice experiment contrasting group participation with absence of company would generate very little variance among the fish tested, as all fish would prefer to associate with the group nearly 100% of the time (Hellström unpublished data on young of the year perch). Still, there is reason to believe that individual variation in sociability exists even in obligate gregarious species, although such variation may be expressed in terms of different group size preference rather than in terms of the choice of being social or solitary.

This study investigates social variation in a highly social fish, young of the year (YOY) Eurasian perch (*Perca fluviatilis*). Our hypothesis is that a larger group size would be preferred for protection, but that this preference may be offset if the smaller group provides other benefits. Context dependent group size preference is tested by making fish choose association with either a large or a small group in three different contexts: when the small group is feeding, when the small group resides in shelter, or in a control treatment with no other stimuli than the small and the large group, respectively. Further, consistent individual variation in group size preference over time and context was tested to reveal existence of personality types with regards to sociability. Finally, we investigated whether an individual's degree of sociability was correlated with its willingness to take risks (boldness), to establish the existence of a behavioural syndrome and explain individual differences in group size preference. We investigate whether the direction and strength of such behavioural trait correlation would differ depending on context, and expect a stronger negative correlation in the control treatment where being less social is less rewarding for individual fish.

2. Material and methods

In August 2009, juvenile perch were captured by beach seining in lake Ängersjön, and lake Fisksjön, two similar lakes close to the city of Umeå (63°47′N; 20°17′E) in northern Sweden (see also Hellström and Magnhagen, 2011). The fish were immediately transported to Umeå Marine Research Centre (UMF, 45 km south of Umeå), where they were kept in two tanks (60 cm high, 470 l, one tank for each lake) with continuously running water (12–13 °C, light regime 13L:11D,) for four days. During this time they were fed daily with pre-frozen red chironomid larvae (7% of total body mass). There was no mortality in the tanks. Before the start of the experiments, the size was measured as total length (TL, mm) and body mass (M, to the nearest 0.1 g) (mean ± s.d.; Ängersjön, TL: 57.6 ± 3.9 mm, M: 1.9 ± 0.3 g, n = 64, Fisksjön, TL: 60.3 ± 5.7 mm, M: 2.2 ± 0.6 g, n = 64). Body condition was estimated as Fulton condition index ($K = M^{*}TL^{-3}$) (Bagenal and Tesch, 1978).

Experiments started at day five after capture (Table 1). Fish were caught randomly from the storage tank, sedated with MS222, weighed, measured and tattooed, with an individual colour code (using blue, red and green tattoo colours from Tattoo-Flame©) on the basis of the caudal fin. Subsequently, the fish were randomly assigned to one of in total 16 groups (8 groups per lake), with four fish per group. In those groups, the fish were first tested for boldness in presence of a predator (day 9; Table 1) and subsequently tested individually for group size preference (day 10–13, Table 1). The fish from lake Ängersjön and lake Fisksjön were kept separate at all times, never mixing fish from the two lakes in any experimental setting.

Table 1
Experimental schedule.

Day	Treatment
0–4	Acclimatization to indoor conditions in tanks
5	All fish sedated, measured, tattooed and stocked to aquaria
6–8	Acclimatization to experimental aquaria
9	Boldness test in presence of a predator
10	Random fish 1&2 from each group: Group size preference test
11	Random fish 1&2 from each group: Group size preference test with food and vegetation
12	Random fish 3&4 from each group: Group size preference test
13	Random fish 3&4 from each group: Group size preference test with food and vegetation

The predators used in the boldness test consisted of older perch with a body length (fork length, FL) ranging from 16–22 cm (n = 16), caught in a small stream near the laboratory. The predators were allowed to acclimatize 7 days before the experiments. Before and after the experiments, predators were housed in a circular glass-fibre tank (60 cm high, 470 l) with continuously running water (12–13 °C; light regime 13L:11D). At the end of the experiments all predators were released at the location they were captured.

2.1. Boldness test

After marking, each group was transferred to an experimental aquaria and allowed to acclimatize for two days. The aquaria were 170 l (95 × 41 × 44 cm) and had continuously running water (14–15 °C; light regime: 13L:11D). One-third of each aquarium was used for the predator (a large perch) and the rest for the group of juvenile perch (Fig. 1a). A plastic net with a mesh size of 5 mm was placed between the predator's space and the small perch. The space containing the juvenile perch was divided into two equally sized sections, with the section furthest away from the predator containing artificial vegetation. Artificial vegetation was also present in the predator section. The aquaria had gravel on the bottom.

During acclimatization and between observations, an opaque plastic screen was placed next to the net to prevent the fish habituating to the predator.

Fish were observed two times during one day. Previous to each observation, the juvenile perch were enclosed by the opaque screen in the section containing vegetation. Chironomid larvae (approx. 75 larvae, corresponding to 3% of the total fish weight) were then poured into the aquaria, between the predator section and the screen that enclosed the juvenile perch, and allowed to sink to the bottom. The opaque screen was then removed, making the large perch visible to the juvenile perch through the net, and the observation started. For 10 min, an observer recorded the behaviour for each individual fish using a computer program which recorded one behavioural unit every second (see Magnhagen and Borcherding, 2008 for a more detailed description of the program). Three different activities were recorded by pressing different keys designated for the different behaviours: occurrence in the vegetation, occurrence in the open, and feeding. All data were collected by two observers, who switched randomly between every observational round to avoid any bias due to the observer. After each observation, the opaque screen was put back next to the net.

2.2. Group size preference test

After finishing the boldness test, fish were transferred to 170 l (95 × 41 × 44 cm) holding aquaria, one group per aquarium. From here, individual fish were selected at random to be tested alone in the shoal-size experiments. 12 h before the start of the experi-