



Observations on the agonistic behaviour of *Lepadogaster lepadogaster purpurea* (Pisces: Gobiesocidae)

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Agonistic behaviour of captive *Lepadogaster lepadogaster purpurea* was described, forming the first record of such behaviour in the family Gobiesocidae. Both male and female engaged in similar behaviours. The agonistic interactions were related mainly to the control of shelter sites and larger fish tended to chase away and take over the shelter of smaller fish.

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Key words: agonistic behaviour; *Lepadogaster lepadogaster purpurea*; clingfish.

Clingfishes are widely distributed on rocky coasts (Briggs, 1986, 1990), but knowledge of their social behaviour is extremely scarce. This is probably because most species are very small and cryptic and occupy microhabitats, such as among algae (*Diplecogaster* spp., *Eckloiaichthys* spp.: Breder & Rosen, 1966), under boulders (*Lepadogaster* spp., *Chorisochismus* spp.: Breder & Rosen, 1966), inside cavities (*Lepadogaster* spp.: personal observations), and even among the spines of sea urchins (*Diplecogaster* spp.: Patzner *et al.*, 1992) and associated with crinoids (*Lepadichthys* spp.: Fishelson, 1966). Available data refer mainly to the spawning habitat, descriptions of egg masses, parental care and sexual dimorphism (Breder & Rosen, 1966; Gibson, 1969, 1982; Thresher, 1984). As far as we know, no descriptions of agonistic behaviour are available for the family.

Lepadogaster lepadogaster purpurea (Bonnaterre) is a common clingfish in the intertidal zone of the Eastern Atlantic and the Mediterranean (Briggs, 1986, 1990). In this paper, the agonistic behaviour of *L. l. purpurea* in captivity is described.

Fish were collected in December 1992 (group 1), March 1993 (group 2), August 1994 (group 3) and October 1994 (group 4) under boulders during low tide with a hand net at Arrábida, on the Atlantic coast of Portugal (38°28' N, 8°59' W), and kept in 63 × 32 × 31 cm and 80 × 40 × 38 cm aquaria with gravel and boulders to provide shelter. Natural photoperiod was maintained by a fluorescent light (15 W), and temperature varied from 14–17.5° C (group 1), 18–24° C (group 2) and 21–24° C (groups 3 and 4). They were fed with shrimp (*Palaemon* spp.), common cockles (*Cerastoderma* spp.), and other live marine invertebrates. A total of 24 fishes (total length: males: mean 6.95 cm, s.d. 0.48, range 6.3–7.8 cm, $n=12$; females: mean 5.45 cm, s.d. 0.69, range 4.5–6.8 cm, $n=12$) was observed for 190 h, including 110 h of focal and scanning sampling (*sensu* Martin & Bateson, 1993). Each group was composed of three males and three females. Males were larger and more colourful than females with reddish unpaired fins and more conspicuous blue eye spots. Details of behaviour patterns were based on frame-by-frame and slow motion analysis of videotape recordings. Statistical analysis was performed using the PC computer program Statgraphics (version 4.0) and the simulation statistical program ACTUS (Estabrook & Estabrook, 1989) designed for the analysis of contingency tables. This program uses random numbers to simulate 1000 tables, each with the same row and column total of the original table. Each simulated table is compared with the original data table and values smaller than 50 are considered to be

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TABLE I(a). Outcomes of agonistic interactions between resident and intruder fish of contrasting body sizes

	Larger resident	Larger intruder
Wins outcome	42	19
Loses outcome	3	13

TABLE I(b). Statistical analysis using ACTUS

	Larger resident	Larger intruder
(i)		
Wins outcome	942	86
Loses outcome	19*	995
(ii)		
Wins outcome	96	950
Loses outcome	994	12*

(i) Cases in which simulated values did not exceed observed values; (ii) cases in which observed values did not exceed simulated values. $\chi^2=13.10$, d.f.=1, $P<0.001$. For details of ACTUS see Estabrook & Estabrook (1989).

* $P<0.05$ (one tailed).

one-tailed significant ($P<0.05$). The significance of χ^2 is assessed by the number of times out of 1000 that the value of χ^2 for the simulated tables is equal to or greater than that for the original table (Estabrook & Estabrook, 1989).

Fishes spent most of their time resting upside-down and attached by their sucker to the underside of boulders. However, when two individuals met, the first stage of agonistic interaction involved the fish turning its head towards the opponent and erecting all its unpaired fins. When they got closer, assuming a parallel or anti-parallel position, this display sometimes changed to a rhythmic undulation of the body in which the fully erected unpaired fins were presented to the opponent with the tail often beating the other fish. They also occasionally performed lateral head jerking of about 10° at a frequency of two to three movements per second with the head turning towards one or both sides of the body. Sometimes, the body was tilted laterally with the sucker attached to the substratum, turning the dorsal region towards the other fish. In these displays, the mouth was sometimes opened for periods of up to 5–6 s. If the opponent did not retreat or flee, one fish often charged the other by rapid swimming and butting, or they engaged in mouth fighting. These fights were common among fishes of similar size. The opponents opened their mouths up to an angle of 170° , and they pushed against each other using the pectoral fins and tail movements. The longest mouth fighting observed lasted 6 s. Agonistic interactions ended suddenly when one fish fled. Sometimes the winner chased the opponent.

The agonistic repertoire described above was common to both sexes. The frequency of intra- and intersexual interactions did not differ significantly from a random distribution (goodness of fit χ^2 test=4.0, d.f.=2, $P>0.05$). The agonistic interactions seemed to be disputes over the control of shelter sites. Not only did the fish spend most of their time in shelters (mean 89.7%, s.d. 11.7, range 59.3–100%, for 12 fishes and 66 h focal observation time; Wilcoxon signed ranks test: $Z=3.059$, $P<0.01$), but in addition most interactions occurred when one fish attempted to enter an already occupied shelter site (mean 85.8%, $n=127$ interactions). Larger fish tended to succeed in driving away the smaller intruders and were sometimes able to dislodge smaller fish and take over their shelter [Table I(a)]. However, there was an effect of residence since larger intruders lost significantly more contests than expected by chance [Table I(b)]. Furthermore, each shelter tended to be occupied by only one fish (in 132 scanning observations in which the

location of each fish was recorded, only in four cases were two fishes in the same shelter).

In rocky intertidal fishes of other families, both sexes may exhibit agonistic behaviour (Gibson, 1969, 1982) and, in at least some species, agonistic interactions are closely related to the control of shelter sites (Gibson, 1968; Almada *et al.*, 1983). *L. l. purpurea* is a very small fish that must rely on the use of shelter sites and crypsis to avoid predators. Thus, it is likely that the agonistic behaviour observed is directly connected with the access to shelter. Whether or not this leads to a fully territorial system or to a more diffuse form of territoriality, as described by Gibson (1968) for the juveniles of *Lipophrys pholis* (L.), is not yet clear and needs further investigation.

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