Response of captive seabass and seabream as behavioural indicator in aquaculture

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ABSTRACT: Welfare of cultivate fish at high-density represents an important concern for modern aquaculture. The behaviour of European seabass (*Dicentrarchus labrax*) and seabream (*Sparus aurata*) reared in cages was studied in a fish farm of northern Sardinia (Italy) in autumn 2006 to test whether captive condition had an effect on the movement patterns of these two species. Video images recorded before, during and after the manual feeding distribution allowed us to collect data on different behaviours of captive fish. Thus, behaviours indicating the position of fish in the water column, swimming direction and possible aggressive behaviours (aggression, direction change and collision) showed juveniles and adults of seabass and seabream were overall affected by feeding rhythms and captive overcrowding. Seabream had a major tendency to swim towards the bottom and higher frequency of horizontal swimming and collisions than seabass. The overall behavioural difference between two species was explained in terms of their differences in ecological features in the wild.

Key words: Aquaculture, Welfare, Behavioural change, *Dicentrarchus labrax*, *Sparus aurata*, Mediterranean.

INTRODUCTION – The research of optimal solutions to get sustainable facilities both for minimising environmental effects on the surroundings (Sarà *et al*., 2007) and obtaining fish cultivated following current welfare standards (Hungtinford *et al.*, 2006), involve also studies on captive behaviour of cultivated fish. Indeed, captive overcrowding can have an important impact on behaviour of farmed fish (Hungtinford *et al.*, 2006). Since in the past, behavioural changes were generally assumed to be only temporary and quickly recoverable (Chapman, 1976), only recently specific studies have addressed the effects of overcrowding on customary natural behavioural patterns (Canario *et al.*, 1998). In fact, an increasing amount of evidence has shown that fish held captive for a considerable number of generations at a high density can develop behavioural traits that only distantly resemble the behaviour of wild animals (Andrew *et al.*, 2004). When retained over time (Bégout Anras and Lagardere, 2004), these different behavioural patterns might conflict with today's welfare standards (Hungtinford *et al.*, 2006). In the Mediterranean, European seabass (*Dicentrarchus labrax*) and seabream (*Sparus aurata*) are the most frequently cultivated fish. While seabass is a solitary efficient hunter, seabream have been recorded to form schools with up to hundreds of individuals. Thus, in the present paper, we hypothesised and tested whether behavioural response to captive conditions of both species was different due to their different ecological features in the wild.

MATERIAL AND METHODS – The study was carried out in October 2006 off the North western coast of Sardinia (Alghero Bay, Lat. 40°33'43.9"N, Long. 8°16'09.0"E) at the fish farming facilities of La Maricoltura s.r.l. This fish farm is located about 1 nm off the coast and occupy a surface area of about 2.5 hectares on a 38m water depth average. During the study period, 8 semi-submerged cages ranging in volume from 800 to 2,500m^3 were positioned within this area and some 380,000 seabream (*S. aurata*) and 116,000 seabass (*D. labrax*) specimens were reared in them at a density of about 3kg/m^3. Experiments consisted in the collection of video images by SONY Hi-8 video cameras encapsulated in waterproof boxes (NIMAR Inc., Italy) fixed inside the circular cages at a depth of about 1.5m beneath the surface. Collection of video images lasted 10 minutes before the meal (hereafter before phase), 10 minutes during the meal (hereafter during phase) and 10 minutes after the meal (hereafter after phase). Experiments were planned to reduce any interference given by human presence and were repeated in 2 different days. Video images were analysed in the lab and each 10 minutes of movies were divided into 4 sessions of 30" each. Within each session, we choose 75 frames haphazardly extracted by using the digit table. Each frame lasted 2 seconds. Due to huge density, in each frame, we followed the behaviour of at least 60 fish (i.e. repeating the vision of frame for 60 times). In so doing, we could study the most frequent behavioural categories of seabass (Table 1; Sarà *et al.*, 2007). Behaviour of fish were transformed in percentage, thus each frame reported on 60-fish-base, the number of behaviours mostly expressed. Behavioural data were analysed in order to test the null hypothesis, i.e. that there was no difference in position in the water column and swimming behaviours of two species using a Principal Coordinate Analysis and a five-way PERMANOVA (Permutational Multivariate Analysis of Variance) design (Anderson, 2001) on square root-transformed percent matrixes, using the Euclidean distance and 9999 permutations. Thus, SPECIES (SP: seabass *vs* seabream, 2 levels), PERIOD [PER: feeding in the morning (a.m.) *vs* feeding in the afternoon (p.m.), 2 levels], and PHASE (PH: before, during, and after distribution of feed, 3 levels) were treated as fixed factors in the experimental design. Two different and independent days of measurement (Day, 2 levels) were treated as random factors and nested in the interaction FEED x PER x PH, while 4 different sessions of measurement were treated as random and orthogonal factors (Session, 4 levels). Statistical analyses were performed by means of the software PRIMER 6 plus PERMANOVA.

Table 1. Description of behavioural categories observed in seabass and seabream.

Behavioural categories	Behaviour description
Surface position	Fish swim near surface
Middle column position	Fish swim at 3-5 m from surface
Horizontal swimming	Fish swim horizontally
Swimming vs surface	Fish swim vertically toward surface
Swimming vs bottom	Fish swim vertically toward bottom
Direction change	Direction change in swimming of fish
Collision	Physical contact between two fishes, whose swimming was not directed toward the other
Agonistic	Fish swimming directly toward another until physical contact was reached
Out of sight	Fish swim far from the surface close to the bottom of the cages, out of vision field of cameras

RESULTS AND CONCLUSIONS – During the study period, the dominant direction of water current was north westward. Seabream showed a significant higher frequency of horizontal swimming, swimming towards bottom and collisions ($p<0.05$; Table 2), while seabass were for the most of time out of sight. Statistical analyses ($p<0.05$) confirmed the overall significant differences in captive behaviour between the two species.

Behaviour of both fish appeared to be responsive not to limited resource availability, but to the high unpredictability of where the food was supplied.

The general behaviour of seabass and seabream resembled that of random searching of food in the wild. The position in the water column inside the cages was not predictable and fish to remain close to the surface, continuously swimming with significant levels of turning behaviour.

As an example, turning behaviour has been observed on many occasions in the wild and associated with hunting activity (Domenici *et al.*, 2000), reduction of ration (Hammer, 1997) or predation risk (Pitcher and Parrish, 1993). Our results led us to conclude that behaviour of captive fish is strongly affected by feeding rhythms and that behavioural differences between species depended on their ecological features in the wild.

Table 2. Percent frequency (mean±SE) of behaviours observed in the 2 species and percent contribution of each behaviour to dissimilarity (SIMPER) of captive response between Sparus *aurata* and *Dicentrarchus labrax* (n.e.=not estimable).

Behaviour	*S. aurata*	*D. labrax*	SIMPER
Surface position	0.7±2.8	1.4±4.4	0.8
Middle column position	1.6±4.4	1.3±4.6	1.2
Horizontal swimming	34.8±24.0	19.9±33.5	56.7
Swimming vs surface	5.5±10.2	3.1±6.2	4.4
Swimming vs bottom	19.5±16.5	9.2±13.8	17.0
Direction change	10.2±10.1	10.7±13.8	8.6
Agonistic	3.4±6.0	1.8±8.1	n.e.
Collision	15.3±13.1	2.9±7.9	11.5
Out of sight	0.0	43.8±49.7	n.e.

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