Seabream (*Sparus aurata*) hierarchies of social behaviour affects stress responses and immunity

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Abstract

Fish are affected by environmental conditions that can cause stress, which leads to changes in the innate immune system and plasma parameters that increase susceptibility to disease. We examined behaviour under social stress in gilthead seabream (*Sparus aurata*). Social hierarchies ("dominant"; subordinate: "alfa" and "beta") were characterised by behavioural changes, such as "aggressiveness" and "feeding order", and were established after an hour of exposure to social stress. To characterise physiological stress, we measured the plasma levels of cortisol, glucose, and osmolarity, and we observed that the levels of these stress markers were higher in subordinate individuals, "beta" and "alfa", than in the "dominant" individuals. Four experimental models were used: in the first, the paired fish were placed simultaneously and observation had a duration of six months; in the second, three fish were entered at the same time observation had a duration of 24 hours; in the third three fish were placed in a sequential manner and were observed for 15 days; in the fourth model two fish were placed simultaneously in a separate tank in two equal areas by a corrugated and transparent separator after four days was taken off the separator. In these experimental models, we have observed that social stress affects the levels of cortisol in the plasma and the activity of phagocytosis of peritoneal exudate cells demonstrating that social stress appeared to affect the cellular innate immune response of the subordinate individuals. In particular, the social stress more substantially affected the beta specimens. Finally, discriminant analysis clearly separated the subordinate fish groups from the dominant and control groups and a significant separation between the random and sequential models was observed. Moreover, modulation of phagocytic and respiratory burst activities revealed that social stress appeared to affect, in a time dependent manner, the cellular innate immune response of the subordinate specimens.