SWIMMING BEHAVIOUR PATTERNS OF *Carassius auratus* AND *Solea senegalensis* AT DIFFERENT VELOCITIES

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Study of swimming behaviour of fish allows optimising tank design for aquaculture and improving fish farm and effluent management. In this experiment swimming behaviour of a freshwater species, *Carassius auratus*, (body length, BL= 3.7 cm, and BL=7.2 cm) and of a benthic marine species, *Solea senegalensis* (BL=10 cm and BL=6.5 cm) with and without presence of sand, was determined. Each fish was carefully located on a counter current water tunnel (84 mm and 54 mm diameter respectively for both species and 1 m long) at different water velocities: from 1.13 to 12.47 cm sec\(^{-1}\) for *C. auratus*, from 6.07 to 30.33 cm sec\(^{-1}\) for *S. senegalensis* without sand and from 7.76 to 38.60 cm sec\(^{-1}\) with sand in the water tunnel bottom. Water tunnel was placed in a controlled room illuminated by blue or red light. Blue light allowed us to distinguish orange *C. auratus* body as well as a small fluorescent tag sutured on the tail to visualize tail beating movements. Red light allowed us to distinguish dorsal fins and tail movements of *S. senegalensis* at its nocturnal conditions. Digital video recordings of 1 to 3 minutes and further analysis of the images were done by an specific image analysis software, using a monochrome camera CCD adding an orange filter to bring tag out when blue light was used. Three swimming activity phases were determined by direct observation: (F1) resting activity defined as a calm swimming, based on voluntary movements or no swimming activity, (F2) constant swimming, at the same counter current water velocity to keep the fish not moving forward; and (F3) exhausting swimming defined as an uncontrolled swimming due to the high water flux velocity. Relation between fish swimming behaviour and velocity was determined through the measurement of the tailbeat frequency at constant swimming taking into account a complete sinoidal wave created by the fish tailbeat in a determined interval of time.

Direct observation shown that at the lower velocity 1.13 cm sec\(^{-1}\) both sizes of *C. auratus* presented calm swimming (F1)100% of the time. At a velocity of 9.16 cm sec\(^{-1}\), the smaller fish (2.47 BL sec\(^{-1}\)) displayed a constant swimming phase (F2) during 52% of the recorded time. The higher velocity of 12.47 cm sec\(^{-1}\) (3.37 BL sec\(^{-1}\)) forced an exhausting and uncontrolled swimming (F3) during 81% of the time, while the rest of the time (18.2 %) the fish was able to keep a constant swimming (F2) using a constant tailbeat frequency of 5.93 tailbeat sec\(^{-1}\). At the same velocity, larger fish (1.73 BL sec\(^{-1}\)) resisted more time at constant swimming (F2) during 37.2 % of time.

For larger *S. senegalensis*, lowest velocity without sand in the bottom promoted no swimming or calm movement (F1) a 100 % of time. At 1.21BL sec\(^{-1}\) (12.13 cm sec\(^{-1}\)) short intervals of constant swimming (F2) were observed during only 8.7 % of time. Longer constant swimming phase (F2) was promoted at 2.42 BL sec\(^{-1}\) kept during 37 % of time and using a constant tailbeat frequency of 2.3 tailbeat sec\(^{-1}\). At the same velocity an important exhausting swimming activity (F3) appeared during 27.3 % of the time. When sand was present in the bottom no swimming phase was well defined just because sand was used as a protection of water flux by means of burying strategies. Smaller sole did not show any defined pattern, both with and without sand, at any velocity in the water tunnel.