OXYGEN CONSUMPTION AND LOCOMOTORY BEHAVIOUR DURING A SWIM FITNESS TEST OF EUROPEAN SEABASS (*Dicentrarchus labrax*): RELATION WITH ORIGIN AND EARLY LIFE EXERCISE TRAINING

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Introduction

Swimming capacity plays a crucial role in the fitness of fish, crucial for their survival and reproductive success. Origin and early life experiences may have important consequences for swimming capacity later in life (Zambonino-Infante *et al.,* 2017; Vandeputte *et al.,* 2019). In this study, we investigated the influence of origin and early life exercise training on the swimming economy and locomotory behaviour during later life in the European seabass (*Dicentrarchus labrax*).

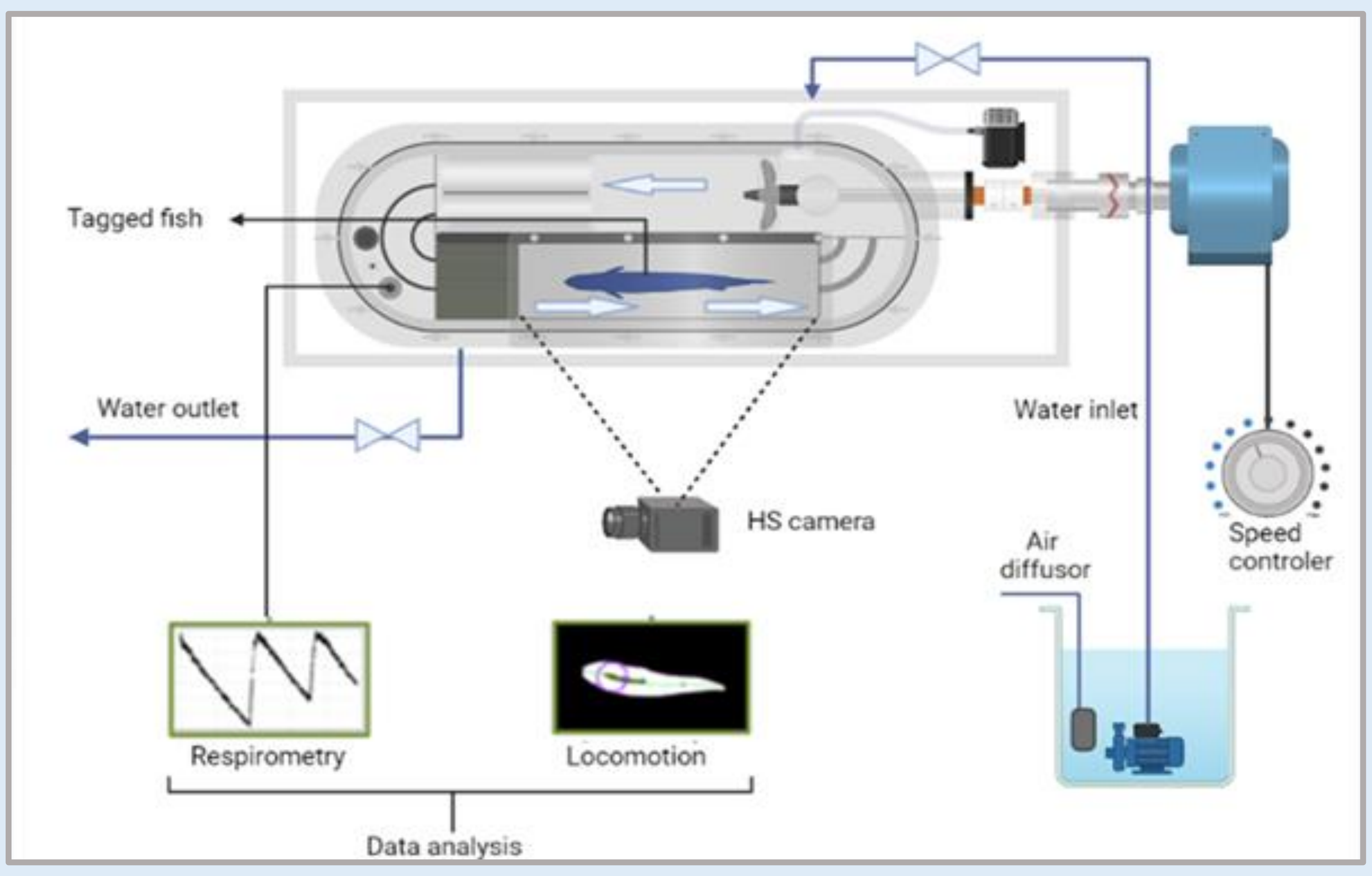

Figure 2. Schematic drawing of a Loligo swim-tunnel with the experimental setting for *Dicentrarchus labrax* swimming performance and locomotion at different speeds.

Materials and Methods

Experimental fish had been subjected to an early life exercise training consisting of swimming against an increased flow of 0.3 $m.s^{-1}$ from 92 to 162 dph. The controls had been reared at regular flow conditions of 0 - 0.1 $m.s^{-1}$ during this period. After training and PIT tagging, fish were reared in common garden until an average weight of about 20 g was reached. Fish were then transported to Wageningen University and Research experimental facilities (CARUS, Wageningen, The Netherlands). The fish (Fig. 1) were grown until approximately 60 g in weight, when the swimming experiments were executed using a 30-L Loligo swim tunnel (Loligo systems, Viborg, Denmark) (Fig. 2).

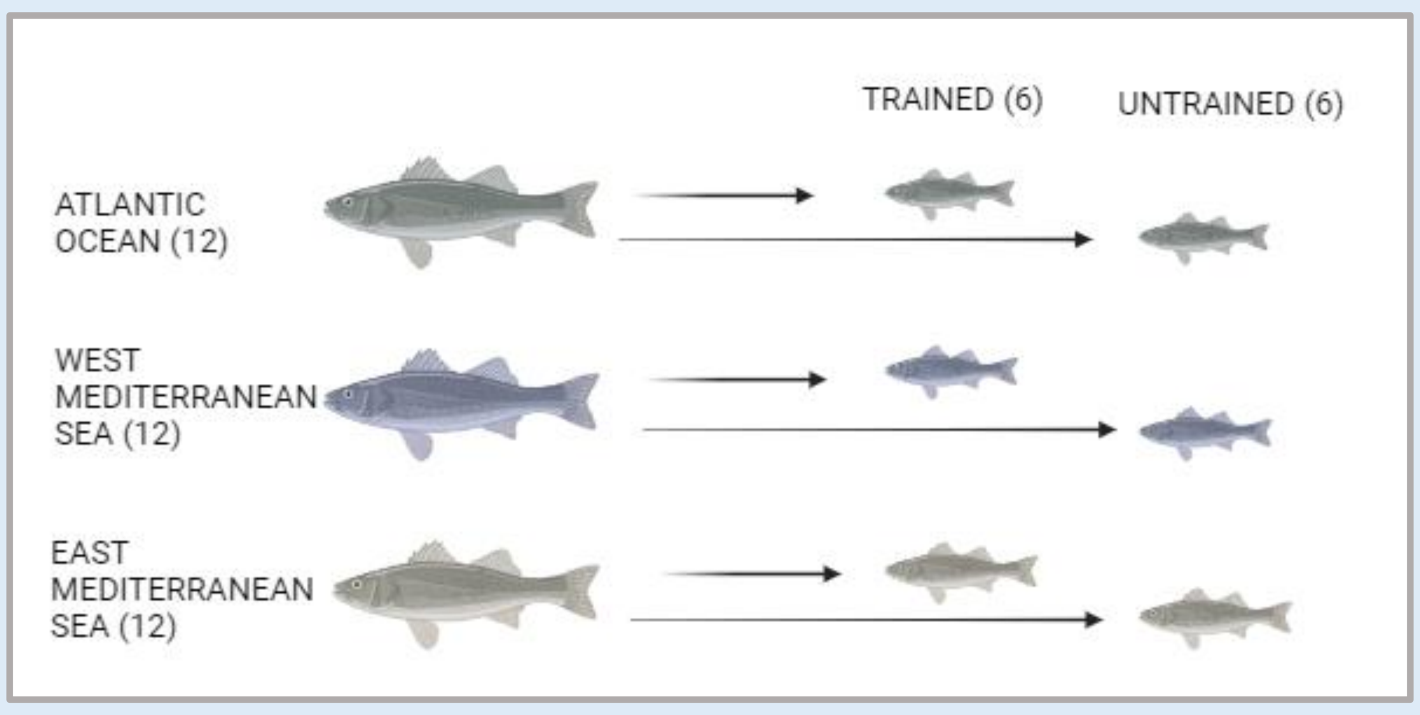

Figure 1. Distribution of the 36 experimental fish used in this study: 3 origins and 2 training conditions gives a n=6 fish per group

The flow in the swim-tunnel was set at five different speeds during the experiment, starting at the lowest speed of 0.1 $m.s^{-1}$ and then increasing stepwise with 0.1 $m.s^{-1}$ per hour up to a maximum speed of 0.5 $m.s^{-1}$. Oxygen consumption and locomotory behavior were assessed at each interval using a galvanic oxygen probe and a Basler 2040-90um NIR USB3 high-speed camera, respectively (see also Arechavala-Lopez *et al.,* 2021).

Results

Table 1 shows swimming performance results. Locomotory behavior parameters tail beat amplitude and frequency, and head width amplitude and frequency, are still being analyzed.

	0.1 $m.s^{-1}$	0.2 $m.s^{-1}$	0.3 $m.s^{-1}$	0.4 $m.s^{-1}$
MO2 ($mg.kg^{-1}$ $.h^{-1}$)	206-231	174-218	190-232	260-459
COT ($mg.kg^{-1}$ $.km^{-1}$)	440-493	241-303	174-215	180-319
	Fatigue and Optimal Speeds values			
Ucrit ($m.s^{-1}$) or ($BL.s^{-1}$)	0.38-0.43 or 2.01-2.48			
Uopt ($m.s^{-1}$) or ($BL.s^{-1}$)	0.30-0.33 or 1.57-1.73			
COT ($mg.kg^{-1}$ $.km^{-1}$) at Uopt ($m.s^{-1}$)	~200			

Table 1. On top: group averages of oxygen consumption (MO2) and Cost of Transport (COT) when swimming at the different speeds. At the bottom: Critical swimming speed (Ucrit) values, average optimal swimming speed (Uopt) calculated at 53-67% of Ucrit and Cost of Transport at the optimal speed.

Uopt values were significantly lower than the 0.69 $m.s^{-1}$ reported for similar sized seabass swimming in Blazka-type swim-tunnels (Graziano *et al.,* 2018) which may well be due to the longer swimming compartment in those tunnels allowing for burst-and-glide swimming behaviour. COT values at Uopt were similar.

Conclusions

- This study raised valuable insights into the swimming economy of juvenile seabass.
- No differences in swimming performance between fish of different origins.
  (… but perhaps differences in swimming behavior?)
- No effect of early life training on swimming performance.

Understanding the swimming economy of seabass has important implications for both scientific research and practical applications in aquaculture (McKenzie *et al.,* 2020). By gaining a deeper understanding of the swimming economy, we can determine climate change impacts and optimize breeding programs, and develop more effective strategies for the cultivation and management of this economically significant fish species.

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References

Arechavala-Lopez, P., Lankheet, M.J., Díaz-Gil, C., Abbink, W. and Palstra, A.P. (2021) Swimming Activity of Gilthead Seabream (Sparus aurata) in Swim-Tunnels: Accelerations, Oxygen Consumption and Body Motion. Front. Anim. Sci. 2:679848. doi: 10.3389/fanim.2021.679848

Graziano, M., Benito, R., Planas, J.V., Palstra, A.P. (2018) Swimming exercise to control precocious maturation in male seabass (Dicentrarchus labrax). BMC Developmental Biology 18:10. doi.org/10.1186/s12861-018-0170-8

McKenzie, D. J., Palstra, A. P., Planas, J., MacKenzie, S., Bégout, M. L., Thorarensen H., et al. (2020). Aerobic swimming in intensive finfish aquaculture: applications for production, mitigation and selection. Rev. Aquac. 13, 1–18. doi: 10.1111/raq.12467

Vandeputte, M., Gagnaire, P.-A., Allal, F. (2019), The European sea bass: a key marine fish model in the wild and in aquaculture. Anim Genet, 50: 195-206. https://doi.org/10.1111/age.12779

Zambonino-Infante, J.L., Mazurais, D., Dubuc, A., Quéau, P., Vanderplancke, G., Servili, A. et al. (2017) An early life hypoxia event has a long-term impact on protein digestion and growth in juvenile European sea bass. J. Exp. Biol. 220 (10): 1846–1851. doi: https://doi.org/10.1242/jeb.154922