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# SWIMMING PERFORMANCE AS A WELL-BEING INDICATOR OF REARED SEA-BASS *DICENTRARCHUS LABRAX* (LINNAEUS, 1758). PRELIMINARY RESULTS

## *PERFORMANCE DI NUOTO COME INDICATORE DI BENESSERE DELLA SPIGOLA DI ALLEVAMENTO* DICENTRARCHUS LABRAX *(LINNAEUS, 1758). RISULTATI PRELIMINARI*

***Abstract***

*Measurements of swimming ability, such as critical swimming speed has been recently used as an useful indicator of fish welfare. This paper presents preliminary results of critical swimming speed trials on reared sea-bass (*Dicentrarchus labrax*; Osteichthyes: Perciformes) as an Operational Welfare Indicator (OWI). Swimming performances were conducted on 43 reared sea-bass. Both Absolute critical swimming speed (cms$^{-1}$) and relative critical swimming speed (body lengths per second) show significant ($R^2$=0.58, $R^2$=0.41 respectively) linear correlations with fish total length. In addition, a subsequent $U_{crit}$ (recovery test) was conducted on a sub-sample of 13 fish and results didn't show any significant difference between $U_{crit1}$ and $U_{crit2}$, confirming a general well-being of the tested specimens.*

***Key-words****: fish welfare, critical swimming speed, repeat swimming,* Dicenthrarcus labrax.

## Introduction

Swimming performance is crucial for determining fish survival in natural environment, as it can affect the spawning behaviour, the prey-predator relationship and the habitat utilization (Wolter and Arlinghaus, 2004).

Measurement of swimming ability, such as critical swimming speed ($U_{crit}$) has been widely used to evaluate the effects of environmental conditions (Farrell *et al.*, 1998) and recently as a useful indicator of farmed fish welfare (McFarlane *et al.*, 2004). Rearing procedures represent indeed the most common sources of stress in aquaculture. Stressors reflect on fish physiology, leading generally to an increase of energy demanding (Cooke *et al.*, 2000), metabolism inefficiency and ultimately can affect the swimming capability (McFarlane *et al.*, 2004).

In addition, the repeatability of the critical swimming speed (recovery test) is considered a useful indicator of fish health (Jain *et al.*, 1998; Farrell *et al.*, 1998).

This paper presents preliminary results of critical swimming performance as an Operational Welfare Indicator (OWI) for reared sea bass (*Dicentrarchus labrax*).

## Materials and methods

Fish used in this study were farmed at density <10 kg (m$^3$)$^{-1}$ in 4500 litre tanks, with natural photoperiod, fed satiation once a day, replacement of water five times per day and constant temperature (18 °C). Trials were carried out for 43 sea bass ranging in size between 23-38 cm total length (subdivided in three size classes: 23-27 cm, 27.1-33 cm, 33.1-38 cm) and 90-600 g total weight. For swimming performance trials we used a calibrated Blažka style swimming tube with a total length of 123 cm, an inner tube diameter of 24 cm and an external one of 35 cm (Fig. 1).

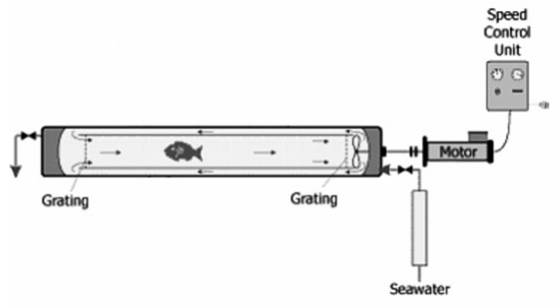


Fig. 1 - Blažka style swimming tube: functional design.
*Respirometro secondo Blažka: schema di funzionamento.*

Each fish was fasted for a period of 24 hours prior the trials to ensure a post-absorptive state (glycogen consuming stage) (McFarlane *et al.*, 2004). Each sea bass was transferred as soon as possible into the tube, left undisturbed without flow for a minimum of 30 minutes (acclimation tube time), and then subjected to a flow of 10 $cms^{-1}$ for a minimum of 20 minutes (acclimation flow time). After, water velocity was increased at 10 $cms^{-1}$ steps every 20 minute intervals until the fish touched the back grating for more than 5 seconds (fatigue). Absolute $U_{crit}$ ($cms^{-1}$) was calculated as follows: $U_{crit} = U+((t/\Delta t)*u)$ (Brett, 1964), where $U$ is the last fully completed velocity interval, $t$ the time of fatigue (s), $\Delta t$ the interval time,

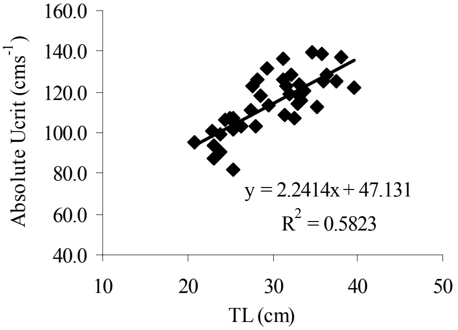


Fig. 2 - Significant ($p<0.05$) positive correlation between TL and absolute $U_{crit}$ described by a linear model. Analysis of variance of the regression: $F_{exp}= 4.08< F_{obs}= 54.36$ (n=43).
*Correlazione positiva e significativa ($p<0.05$) fra lunghezza totale e $U_{crit}$ assoluto secondo un modello lineare. Analisi della varianza della regressione: $F_{exp}= 4.08< F_{obs}= 54.36$ (n=43).*

*u* the incremental increase in swimming speed in cms$^{-1}$. According to Smit *et al.* (1971), a correction for the specimens with a maximum width greater than 10% of the inner tube diameter (solid blocking effect) was made using the formula: $U_c=U_m(1+(D_{fish}/D_{cylinder}))$, where $U_m$ was the water velocity in absence of fish, $D_{fish}$ the maximum width of the fish in cm and $D_{cylinder}$ the inner diameter of the swimming tube in cm. Relative $U_{crit}$ was calculated as absolute $U_{crit}$×total fish length$^{-1}$ and expressed as body length (cm) per second.

A second $U_{crit}$ test was carried out on a sub-sample of 13 fish after a short recovery period (60 minutes at 10 cms$^{-1}$).

An analysis of variance of the regression was made to evaluate the relationships between total length and absolute $U_{crit}$, as well as total length and relative $U_{crit}$, while a *t test* was performed to compare $U_{crit1}$ and $U_{crit2}$ in the recovery tests.

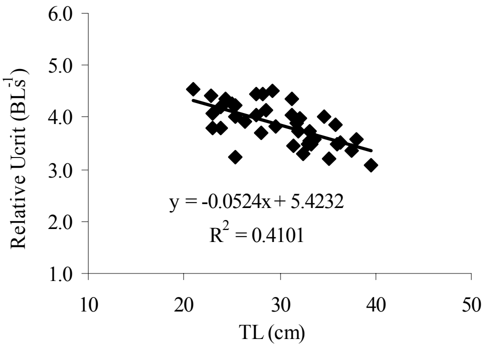


Fig. 3 - Significant ($p<0.05$) negative correlation between TL and relative $U_{crit}$ described by a linear model. Analysis of variance of the regression: $F_{exp}= 4.13< F_{obs}= 25$ (n=43).

*Correlazione negativa e significativa ($p<0.05$) fra lunghezza totale e $U_{crit}$ relativo secondo un modello lineare. Analisi della varianza della regressione: $F_{exp}= 4.08< F_{obs}= 27.11$ (n=43).*

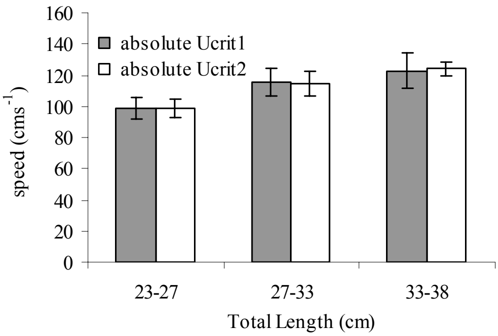


Fig. 4 - Recovery test for the three size classes. No significant difference between $U_{crit1}$ and $U_{crit2}$ ($p> 0.05$).

*Recovery test per le tre classi di lunghezza totale. Differenze non significative fra $U_{crit1}$ and $U_{crit2}$ ($p> 0.05$).*

## Results

Results indicated a mean absolute $U_{crit}$ in the range of 97-127 $cms^{-1}$ and a mean relative $U_{crit}$ in the range of 3.6-4.1 $BLs^{-1}$ (body lengths per second). Remarkable differences in critical swimming speed were found among the three different size classes. Total length showed a significant ($F_{exp}=4.08<F_{obs}=54.36$; $p<0.05$) positive correlation with absolute $U_{crit}$ ($R^2=0.58$) (Fig. 2), and a significant ($F_{exp}=4.13<F_{obs}=25$; $p<0.05$) negative correlation with relative $U_{crit}$ ($R^2=0.41$) (Fig. 3). Fish subjected to a second $U_{crit}$ test performed as in the first swimming test ($p>0.05$) (Fig. 4).

## Conclusions

The positive correlation between TL (Total length) and absolute $U_{crit}$, as well as the negative correlation between TL and relative $U_{crit}$ are in agreement with Brett (1965) and evidenced that although larger fish attain higher absolute critical swimming speeds, they show reduced swimming ability relative to their size. Data from recovery tests showed no significant difference between $U_{crit1}$ and $U_{crit2}$ (*t-test;* $p>0.05$), indicating a significant repeatability of the performance and thus suggesting a general well-being of the specimens tested.

In conclusion, as $U_{crit}$ indicates fish metabolic *status,* these trials also represent a base-line for further studies on other performance indicators for *Dicentrarchus labrax,* such as electromyograms (EMG).

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