The relationship between respiration rates and ETS activity in fishes in relation to swimming activity

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Fish respiration

- Respiration in the deep-sea is difficult to measure
- Electron transfer system (ETS) activity is used as a proxy
- Mesopelagic fishes perform important diel vertical migrations
- Respiration at different swimming capacities
- Respiration/ETS ratio at different swimming activities
Intermittent flux swimming tunnel repirometer

(Rummer et al., 2016)
M&Ms

- 21 gilthead sea bream (47.1 ± 9.8 g).
- Fasted for 24 hours.
- Acclimation time 5 hours at 0.5 BL·s⁻¹.
- Fixed speed experiments: one fish for each speed at 0.5, 1.25, 2, 2.75, 3.5, and 4.25 BL·s⁻¹. Eight flush-wait-measurement cycles for each speed. Three replicates for each speed (18 fishes).
- Increasing speed: same fish for all speed measurements (3 replicates) 5 flush-wait-measurement cycles for each speed (30 cycles/fish).
Swimming speed (BL/s) vs. Oxygen consumption (µl O₂·mg DW⁻¹·h⁻¹)

<table>
<thead>
<tr>
<th>Curve data</th>
<th>Parameter a ± Std. Error (µl O₂·mg DW⁻¹·h⁻¹)</th>
<th>Parameter b ± Std. Error (s·BL⁻¹)</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without increase speed</td>
<td>0.541 ± 0.065</td>
<td>0.315 ± 0.035</td>
<td>0.960</td>
</tr>
<tr>
<td>Increase speed only</td>
<td>0.470 ± 0.051</td>
<td>0.260 ± 0.032</td>
<td>0.946</td>
</tr>
</tbody>
</table>

Fixed speed

Increasing speed

Oxygen consumption (µl O₂·mg DW⁻¹·h⁻¹) vs. Swimming speed (BL/s)
ETS activity measurements

Swimming speed (BL/s)

<table>
<thead>
<tr>
<th>0.5</th>
<th>1.25</th>
<th>2</th>
<th>2.75</th>
<th>3.5</th>
<th>4.25</th>
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</tbody>
</table>

Increasing speed

ETS specific activity by dry animal mass (µl O₂·mg DW⁻¹·h⁻¹)

<table>
<thead>
<tr>
<th>0.5</th>
<th>1.0</th>
<th>1.5</th>
<th>2.0</th>
<th>2.5</th>
<th>3.0</th>
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</table>

Head samples values
Middle samples values
Tail samples values

Swimming speed (BL/s)

0 1 2 3 4 5

ETS activity by dry animal mass (µl O₂·mg DW⁻¹·h⁻¹)

0 1 2 3 4 5 6

Increasing speed

Swimming speed (BL/s)

0 0.5 1.25 2 2.75 3.5 4.25

Increasing speed
R/ETS relationship:
- Varied between 0.4 and 1.5
- Similar to those determined for zooplankton (Hernández-León and Gómez, 1996).

Diel vertical migration swimming speed is 2 BL/s (Davison et al., 2013).
- Fish contribution to active transport of carbon as a function of energy expenditure in swimming
- Maximal R/ETS relationship during migration is 0.9
- Minimal R/ETS relationship during migration is 0.4

Next
- To find an appropriated test fish.
- To keep mesopelagic fish individuals alive for real O₂ consumption rates measurements.
- Unknown contribution of buoyancy ability to reduce energy expenditure by swimming.
Thanks