Revisiting oxygen supply and demand
oxygen availability, metabolic rate and thermal limits
in aquatic ectotherms

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Outline

Oxygen defined thermal niches

How much oxygen is available?

Oxygen and thermal limits in an insect

Conclusion
Oxygen defined thermal niches?

Mismatch oxygen supply and demand
- internal: circulation & ventilation
Oxygen defined thermal niches?

Mismatch oxygen supply and demand
- internal: circulation & ventilation
- external: double jeopardy?
Oxygen defined thermal niches?

\[ O_2 \text{ demand} \quad \text{Temperature} \]

\[ O_2 \text{ concentrations} \]

How much oxygen is available?
Solubility $\alpha O_2 \ (mol \cdot m^{-3} \cdot Pa^{-1})$
Partial pressure $\text{PO}_2$ (Pa)
Diffusivity \( DO_2 \ (m^2 \cdot s^{-1}) \)
Oxygen Supply Index (OSI) \((\text{mol} \cdot \text{m}^{-1} \cdot \text{s}^{-1})\)
How much oxygen is available?

\[ \dot{M}_{O_2} = D_{O_2} \cdot A \cdot \frac{\alpha_{O_2} \cdot \Delta p_{O_2}}{L} \]

Oxygen Supply Index (OSI) \( \propto D_{O_2} \cdot \alpha_{O_2} \cdot \Delta p_{O_2} \)
How much oxygen is available?

Oxygen Supply Index (OSI) $\propto D_{O_2} \cdot \alpha_{O_2} \cdot \Delta p_{O_2}$

You tube: ‘ecology’ + ‘oxygen’
Oxygen defined thermal niches?
Oxygen and thermal limits in an insect

Stonefly, *Dinocras cephalotes*
Oxygen and thermal limits in an insect

Oxygen supply

Oxygen and thermal limits in an insect

324 measurements (before & after)
167 data points
52 individuals
Oxygen and thermal limits in an insect

$R^2 = 0.2427$

324 measurements (before & after)
167 data points
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Oxygen and thermal limits in an insect

Sources of variation:
- temperature & body mass $Q_{10}(10-15)$

![Graphs showing metabolic rate (µg O₂ per hour) vs body mass (mg dry weight) at different temperatures: 5°C, 10°C, and 15°C.](image)

$r^2 = 0.157$, $r^2 = 0.222$, $r^2 = 0.534$
Sources of variation:
- differences in atmospheric pressure
- oxygen conformer
- individual

Oxygen and thermal limits in an insect

Metabolic Rate
(15 °C, bm contrast)

$r^2=0.261$

Metabolic Rate
(10 °C, bm contrast)
Oxygen and thermal limits in an insect

Oxygen and thermal limits in an insect

Conclusion

New perspective of aquatic (larval) stages

OSI reconciles viewpoints: \textit{solubility and }PO_2\textit{ }

More oxygen available in warmer waters

Implications:

• no double jeopardy

• solutions more feasible