Effects of temperature on respiration and filtration in the quagga mussel: a Dynamic Energy Budget (DEB) approach

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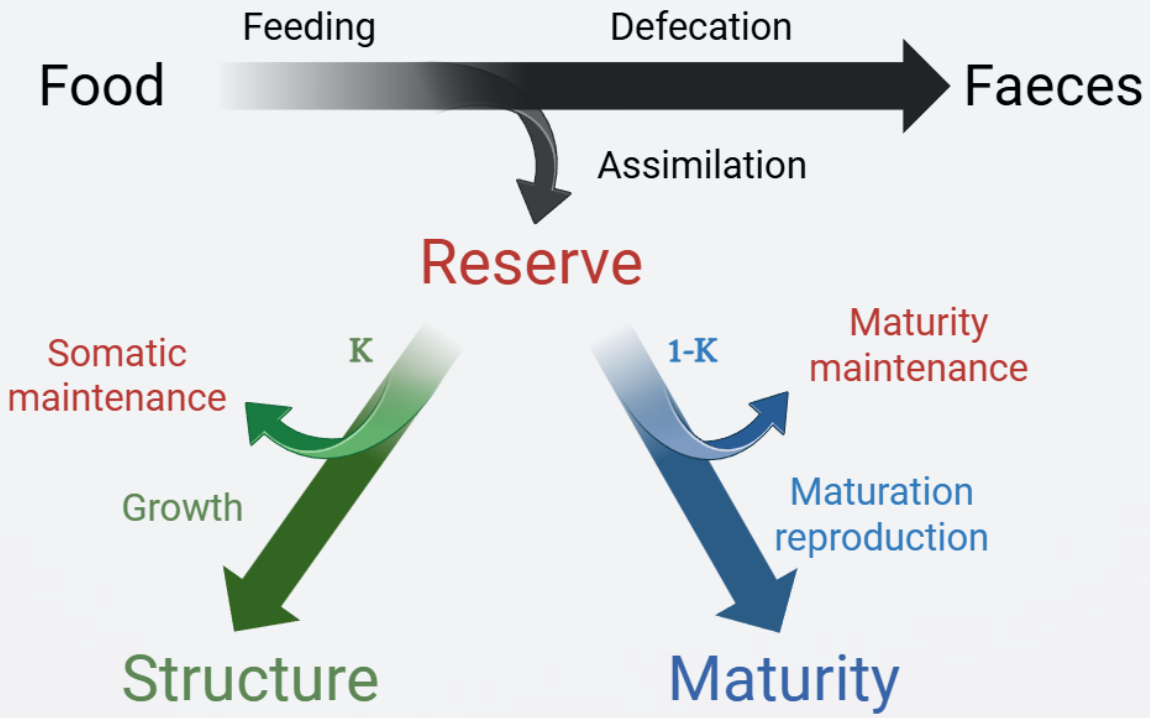
The Dynamic Energy Budget Model

Principle = Modelling energy flows in organisms (assimilation, maintenance, growth, reproduction) (Kooijman, 2010)

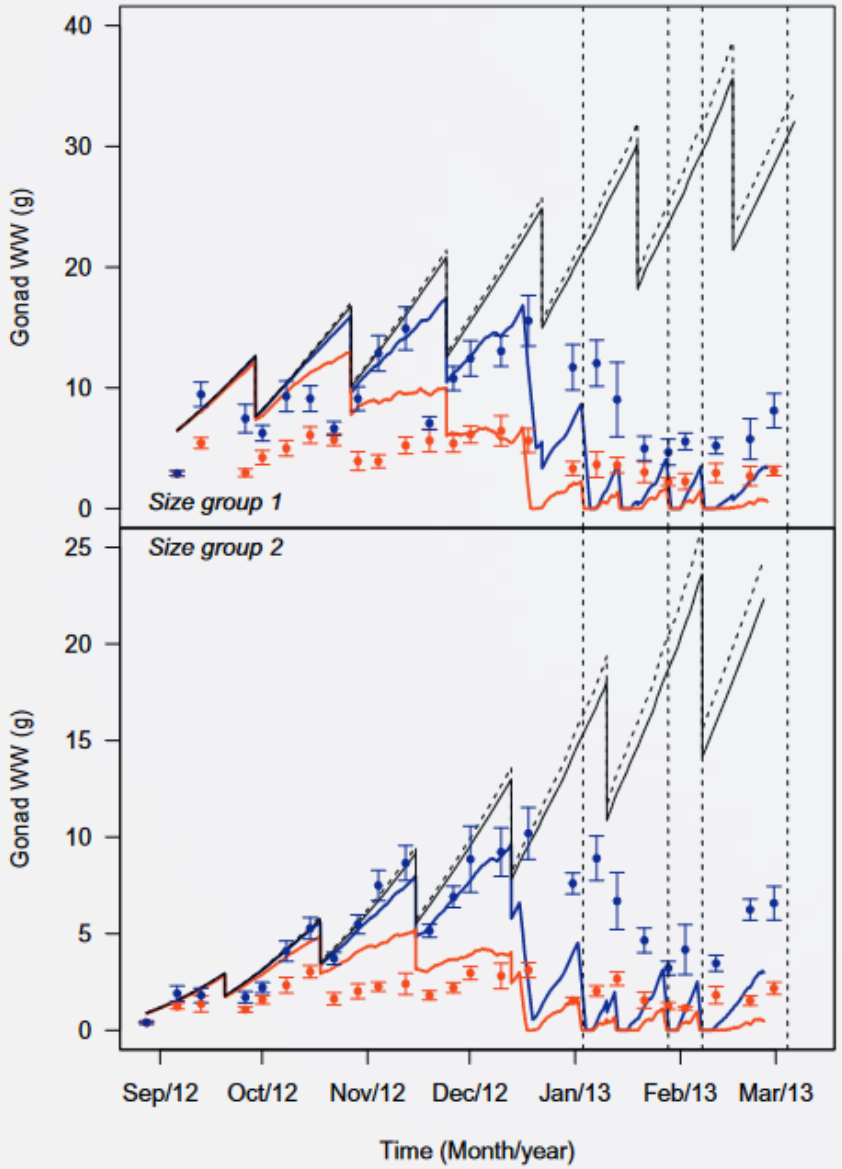


Food assimilation: Some of the energy is lost in feces, while the rest is stored as reserves.

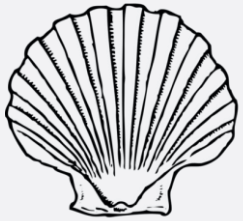
Energy distribution:

- A fraction K is used for structure (growth and somatic maintenance).
- The other fraction (1-K) is allocated to maturity and reproduction (maintenance of maturity and gamete production).

Aguirre-Velarde et al. (2019)

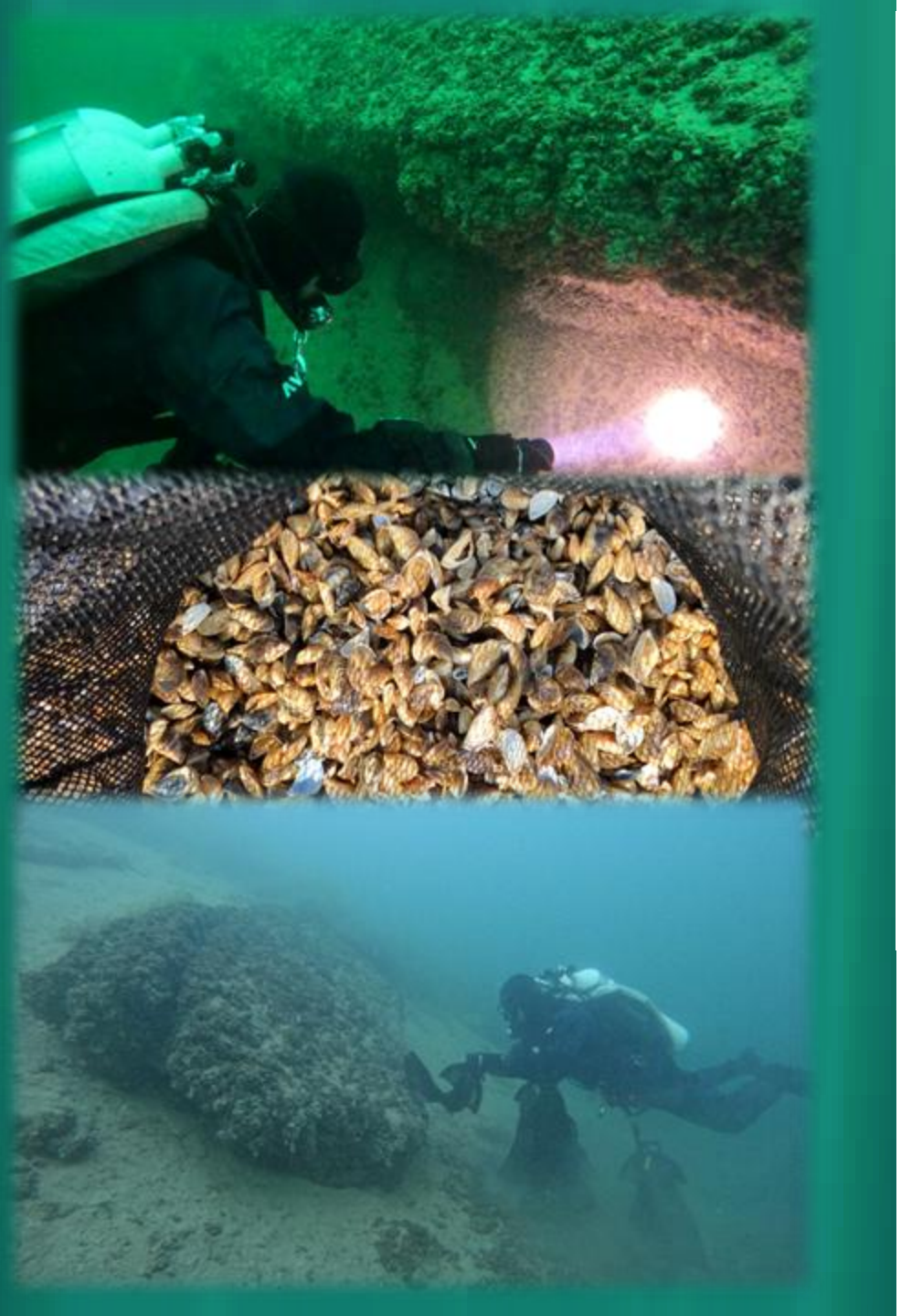


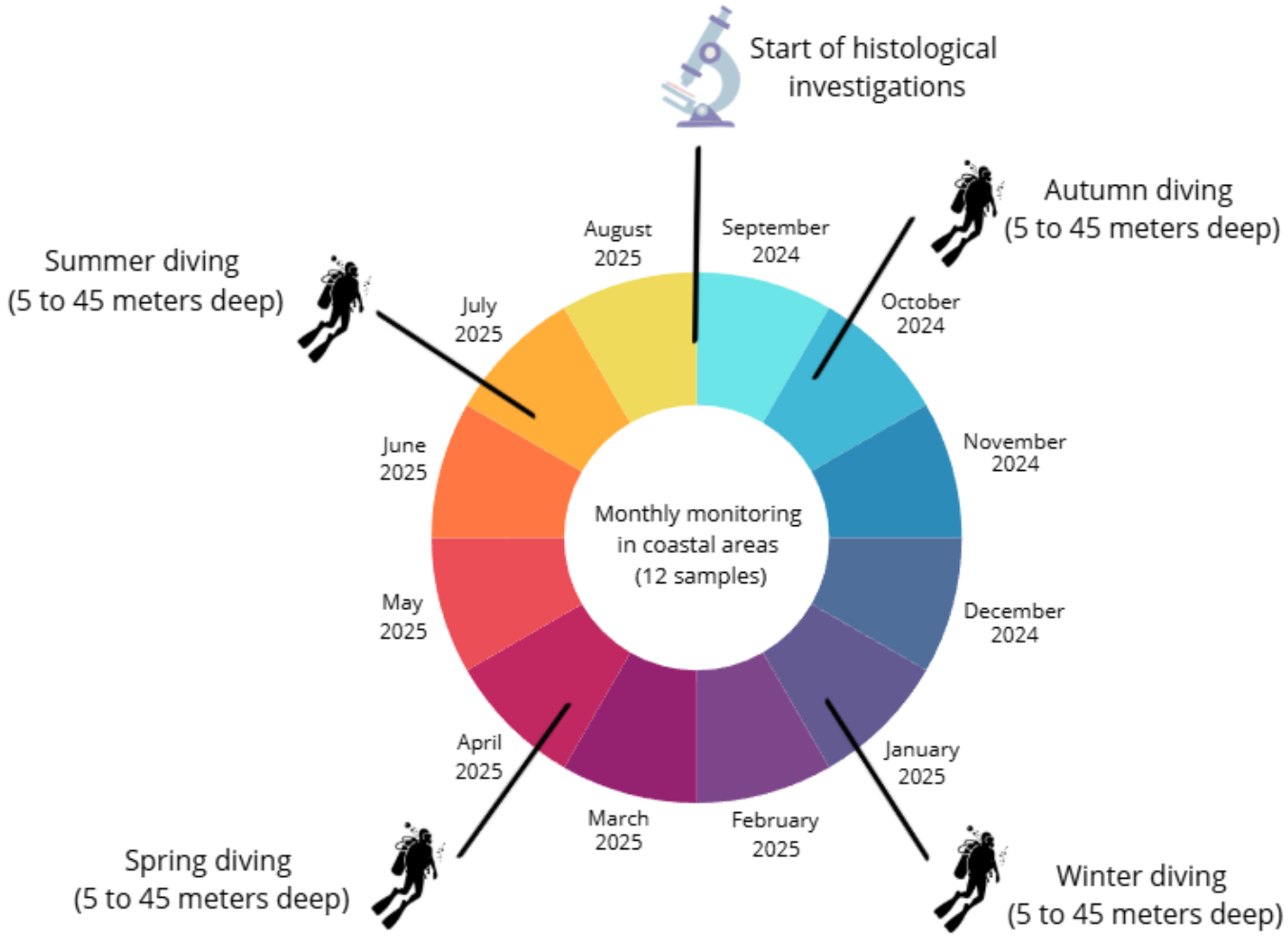
DEB modelling of the evolution of wet weight of gonads in *Argopecten purpuratus* scallops in Peru



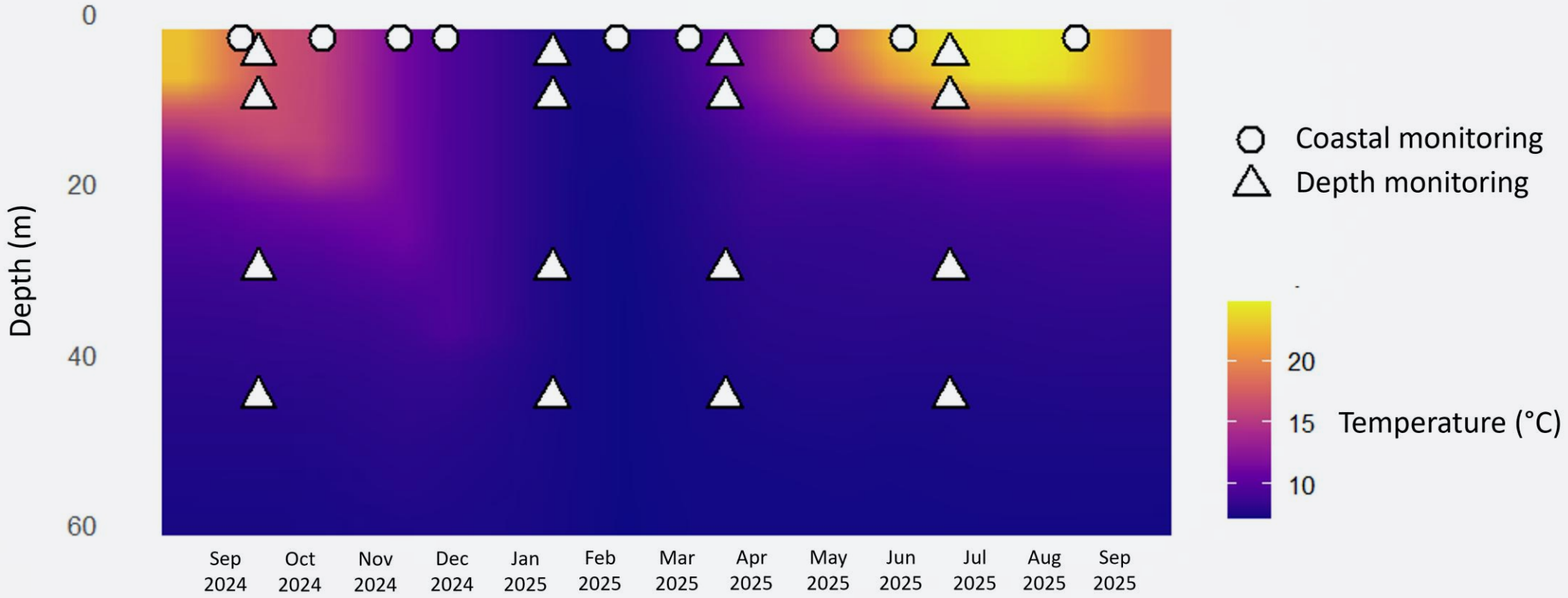
Blue dots = scallops cultivated in suspension
Red dots = scallops cultivated on the seabed
Black lines = DEB simulations

The steep drops in gonadal weight coincide with events where the energy stored in the gonads is released in the form of gametes.

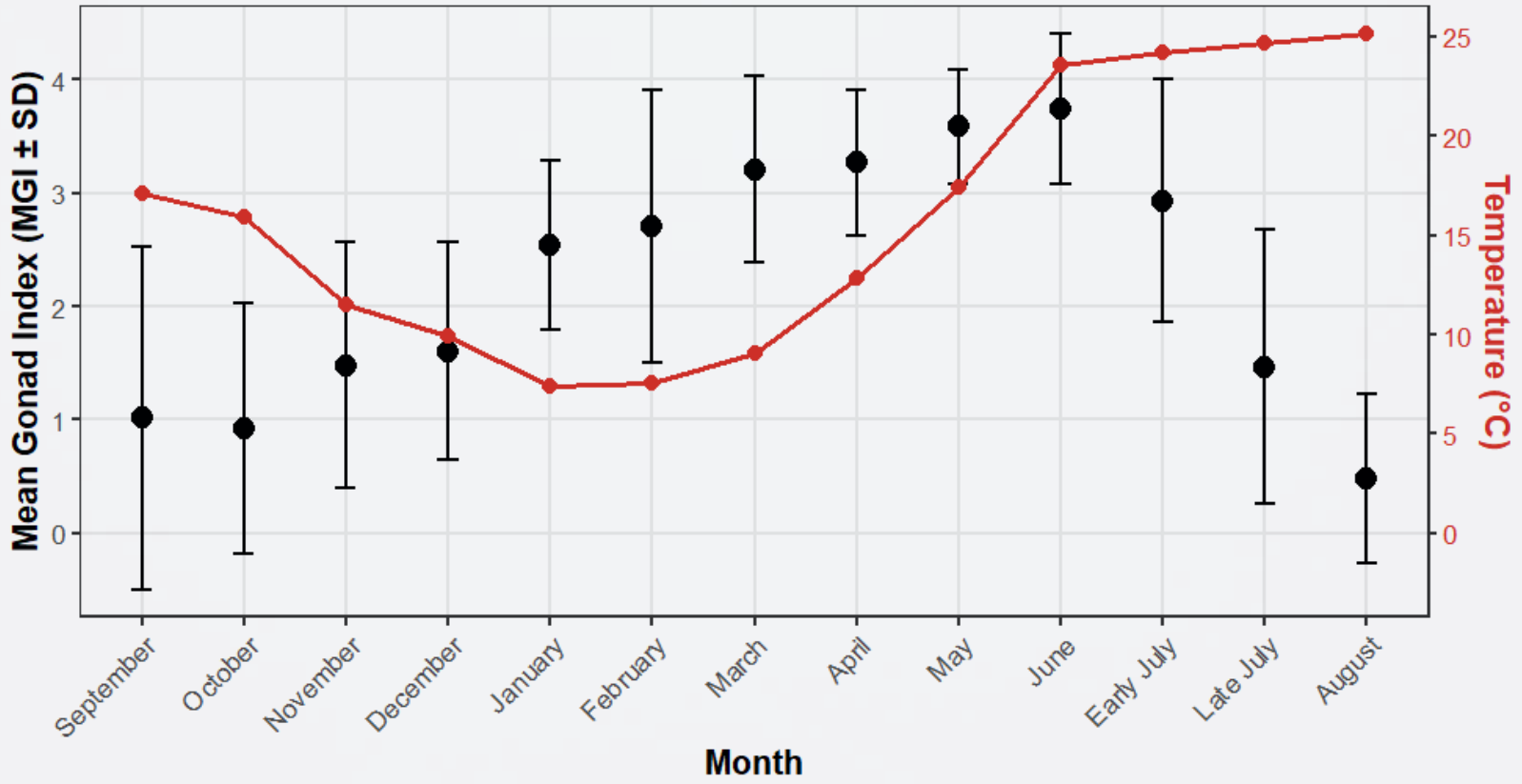




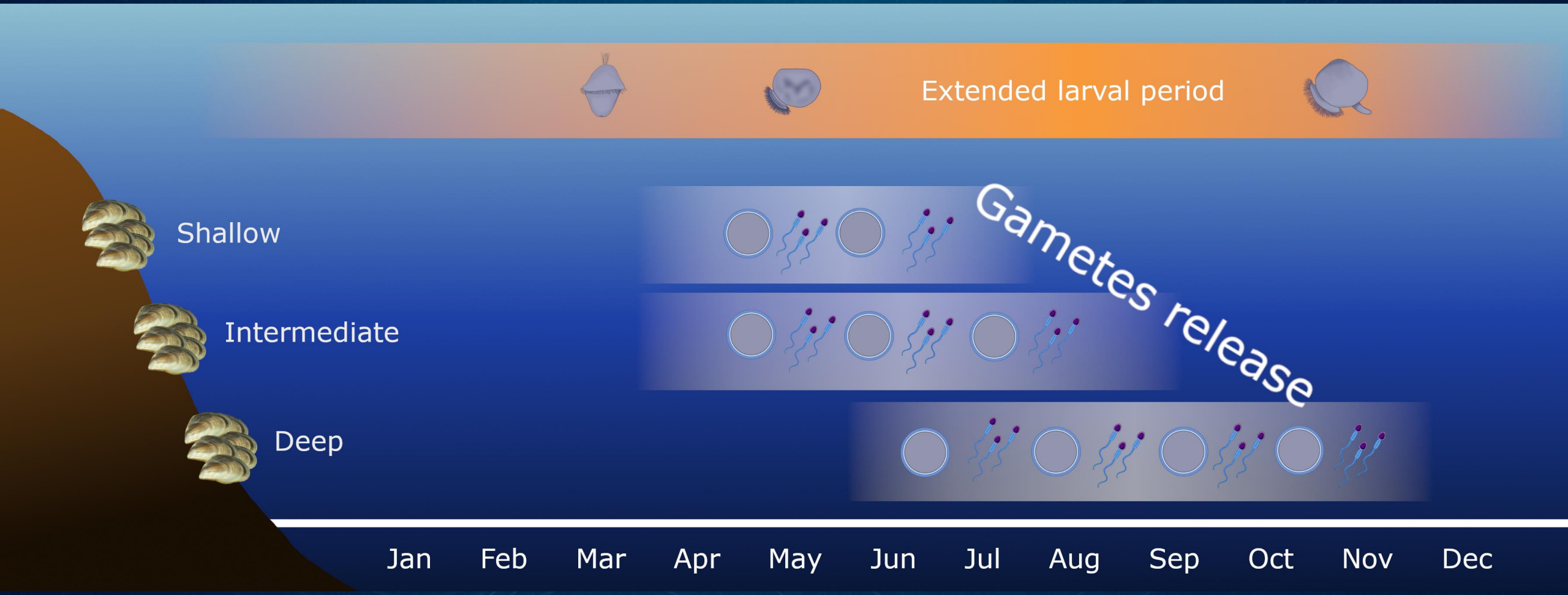
Histological study of quagga mussel reproduction in Lake Bourget from September 2024 to August 2025



Depth–time heatmap of water temperature (°C) from September 2024 to September 2025, based on the monitoring survey of the lake (Rimet et al. 2020). Symbols indicate discrete sampling events with circles represent littoral monitoring, and triangles represent depth monitoring at selected depths.



Seasonal variation of the Mean Gonad Index (MGI) and water temperature in the littoral population of *Dreissena bugensis* in Lake Bourget (September 2024–August 2025).

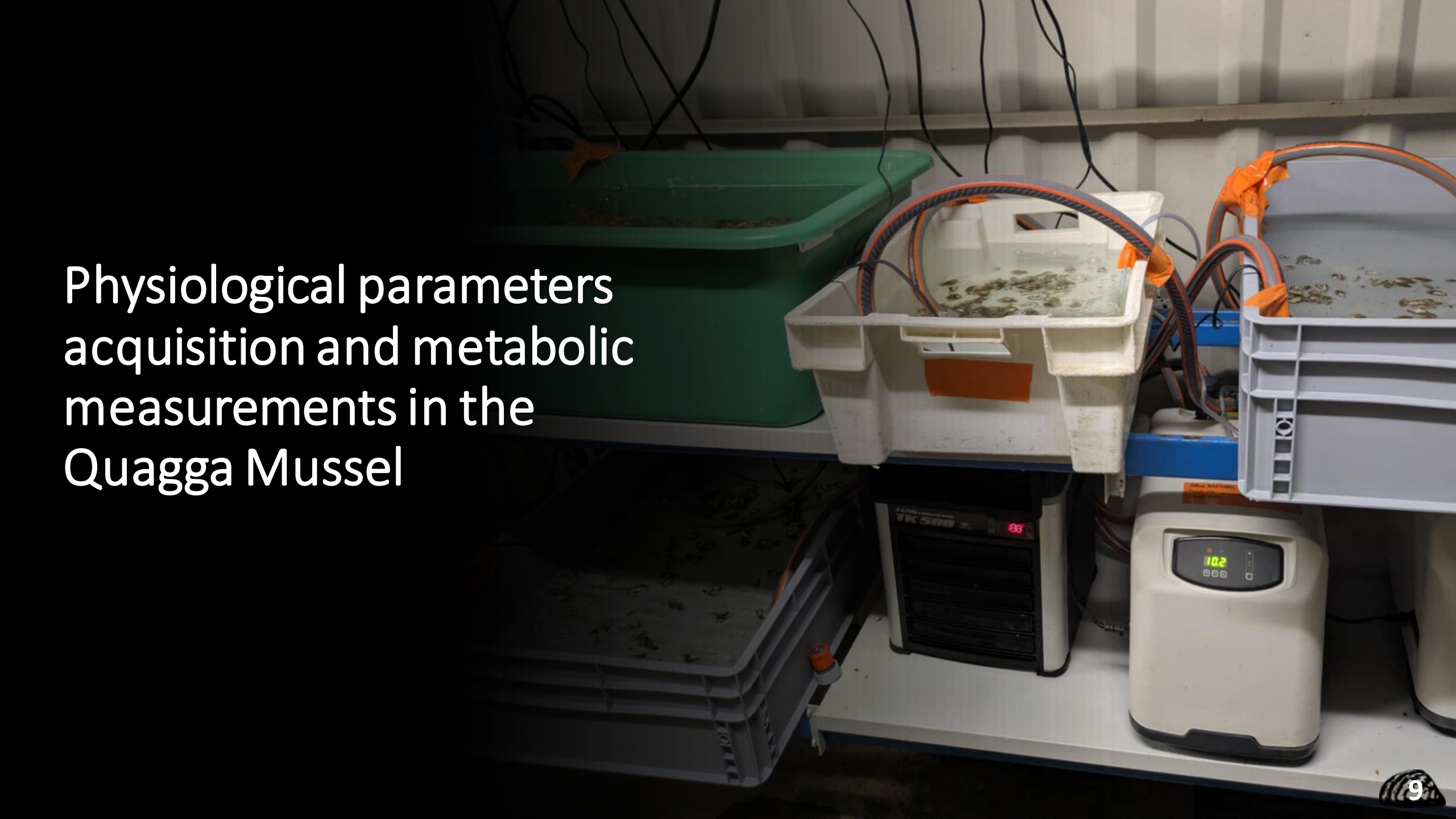

Extended larval period
Shallow
Intermediate
Deep
Gametes release
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Physiological parameter acquisition and metabolic measurements in the Quagga Mussel

1-Month Experimentation at INRAE CARRTEL

- Key parameters of the DEB model: Respiration, Filtration rate, Assimilation rate…
- Variables: Temperatures ranging from 6 to 27 °C, and fluctuating trophic ressources with several phytoplankton concentrations (functional response).
- AddMyPet: complete the dataset with available information on *Dreissena polymorpha*

Physiological parameters acquisition and metabolic measurements in the Quagga Mussel



Filtration experiment parameters

- **Clearance rate (F) :** filtration capacity determining particle capture efficiency (*attack rate, a*).

$$F = \frac{V}{t} \ln\left(\frac{C_i}{C_f}\right)$$

Measurement: change in algal concentration (Ci → Cf) over 2 h in a known volume (0,37L), corrected using controls without mussels. Cell concentrations measured using optical microscopy counting chambers and spectrophotometry.

- **Ingestion (I) :** food flux entering the organism (**energy input**).

$$I = F \times C_{mean} \qquad C_{mean} = \frac{C_i + C_f}{2}$$

Converted to **µg C·h^{-1}** using cell-to-carbon conversion factors **:** CN elemental analysis to determine carbon content of *Senedesumus acutus* (TCC 144).

- **Egestion (E) (faeces + pseudofaeces) :** fraction of culture rejected before assimilation expressed in µg C·h^{-1}.

Measurement: collection of biodeposits → filtration on GF/F filters → CN analysis.

- **Assimilation flux (p_a) :** energy available for maintenance, growth, and reproduction.

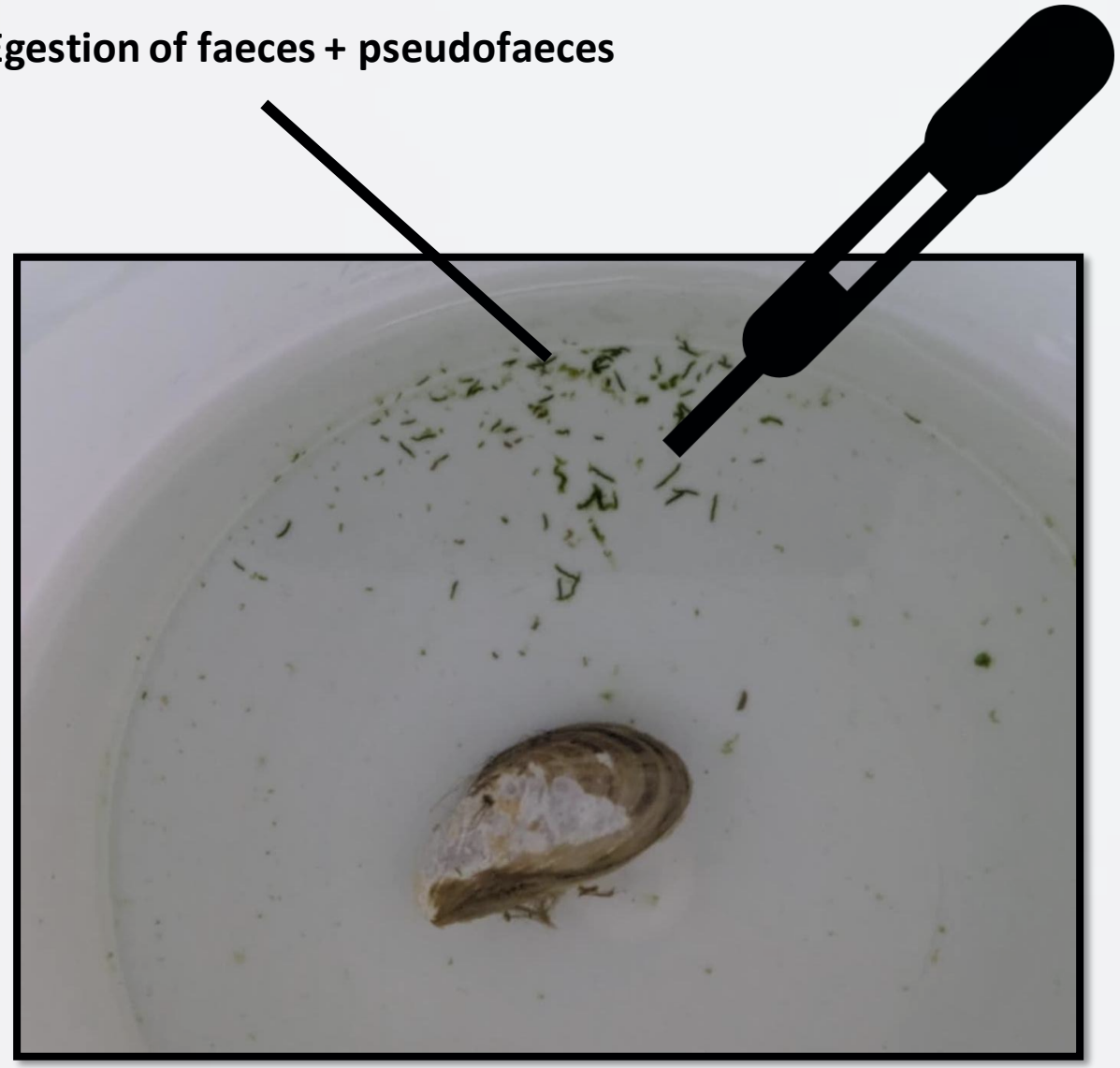
$$p_A = I - E$$

5 temperatures
6°C
11°C
16°C
21°C
26°C

3 replicates

Control without mussel

Increasing concentrations of microalgae (TCC141 *Scenedesmus acutus*)



Collection of biodeposits

→ filtration on GF/F filters

→ CN analysis

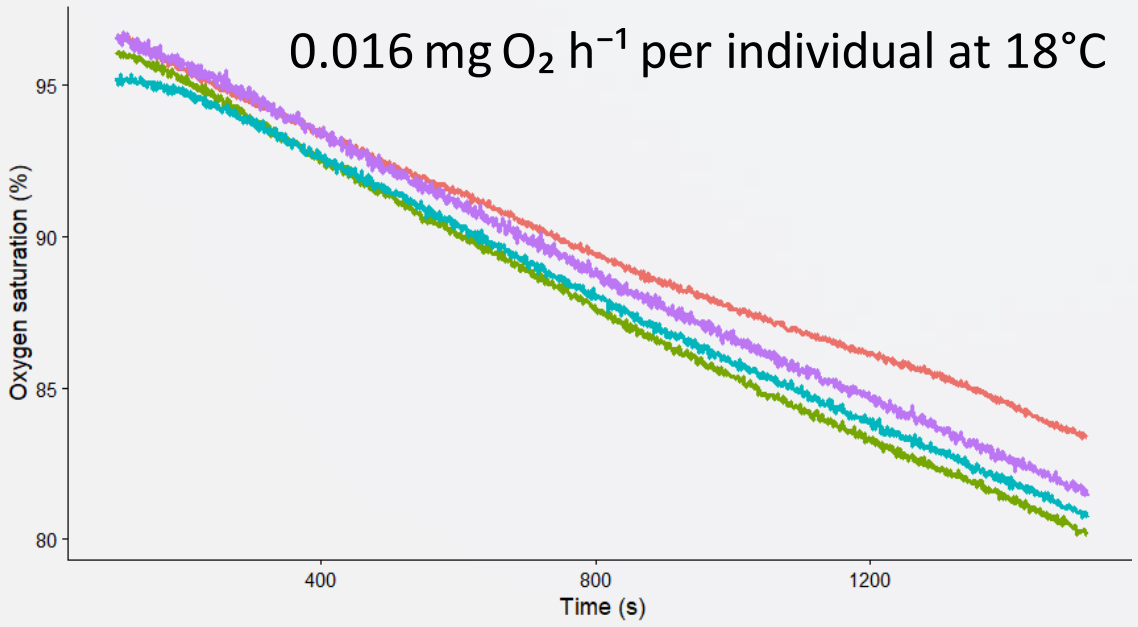
Faeces = Excrement expelled from the digestive system after food digestion.

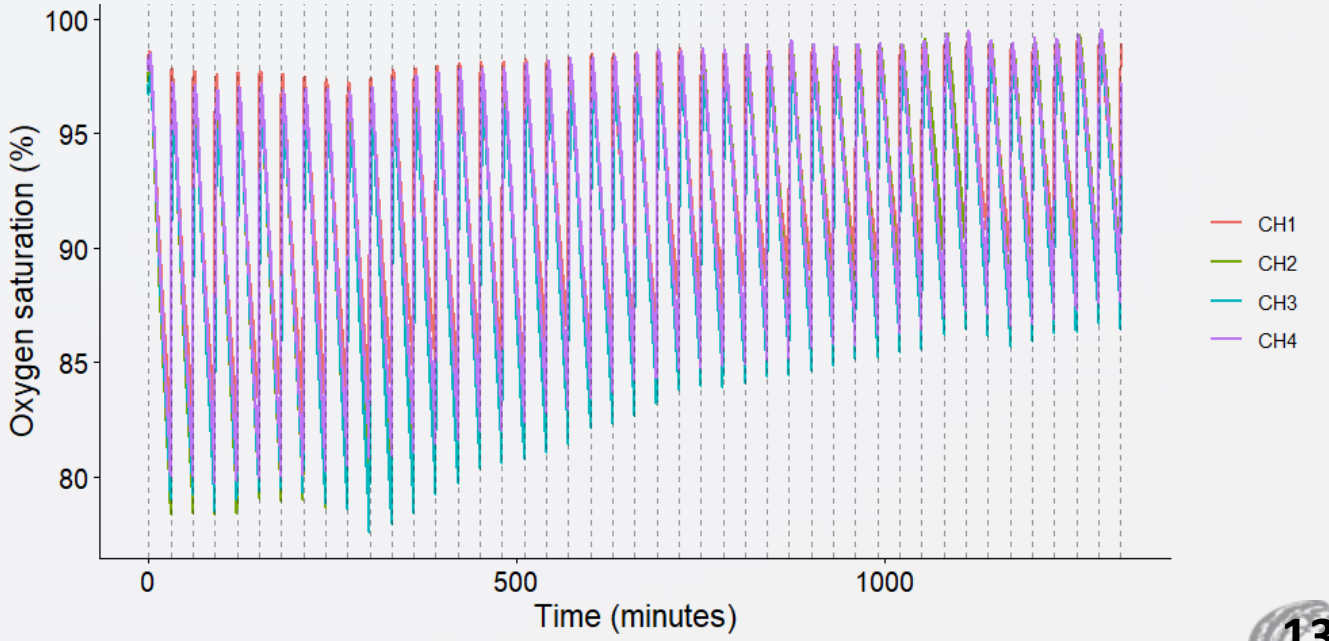
Pseudofaeces = Particles rejected by bivalves before ingestion; these are bound in mucus and expelled without being digested.

➢ **Respiration (O_2 consumption) :** estimation of **somatic maintenance costs** $[p_M]$ and temperature dependence.

Measurement: Loligo Systems metabolic chambers

- 8 temperatures (6, 9, 12, 15, 18, 21, 24, 27 °C)
- 12 individual replicates per temperature
- 30-minute respiration cycle (44 technical replicates)



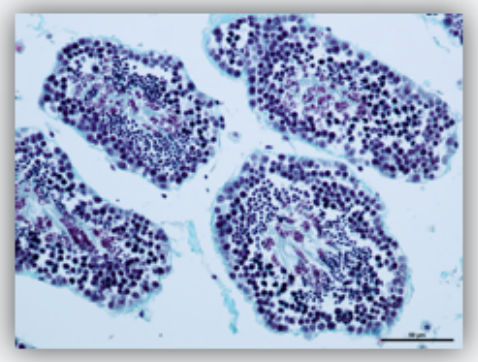


Physiological parameters
(filtration rate, assimilation, respiration)

Photogrammetry
In situ growth data

DEB
Dynamic Energy Budget

Environmental data
OLA (Observatory of Lakes)



Histological study
Validation of the model

Merci à

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Thank you for your attention