# Studying the trophic ecology of the Pacific oyster (*Crassostrea gigas*) at a large spatial scale by coupling isotopes and DEB modeling

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## Introduction

Biological performances (growth & reproduction) of interdidal bivalves mainly rely on environmental factors such as water temperature and food sources. However, both quantity and quality of bivalves food sources are not easy to determine because of complex features in interdidal ecosystems. This is particulary critical for *Crossostrea gigas* culture in France when explaining the variability of growth performances of oysters among culture sites at a large spatial scale. Is necessary in this context, insights for new operational tools to characterise trophic features of coastal ecosystems are needed.
The aim of the present study is to couple natural isotopic tracers (carbon & nitrogen) and Dynamic Energy Budget theory (Kooijman, 2000) to describe quantitatively and mechanistically bioenergetic processes and isotope dynamics in oyster tissus under varying environmental conditions (temperature, food sources).

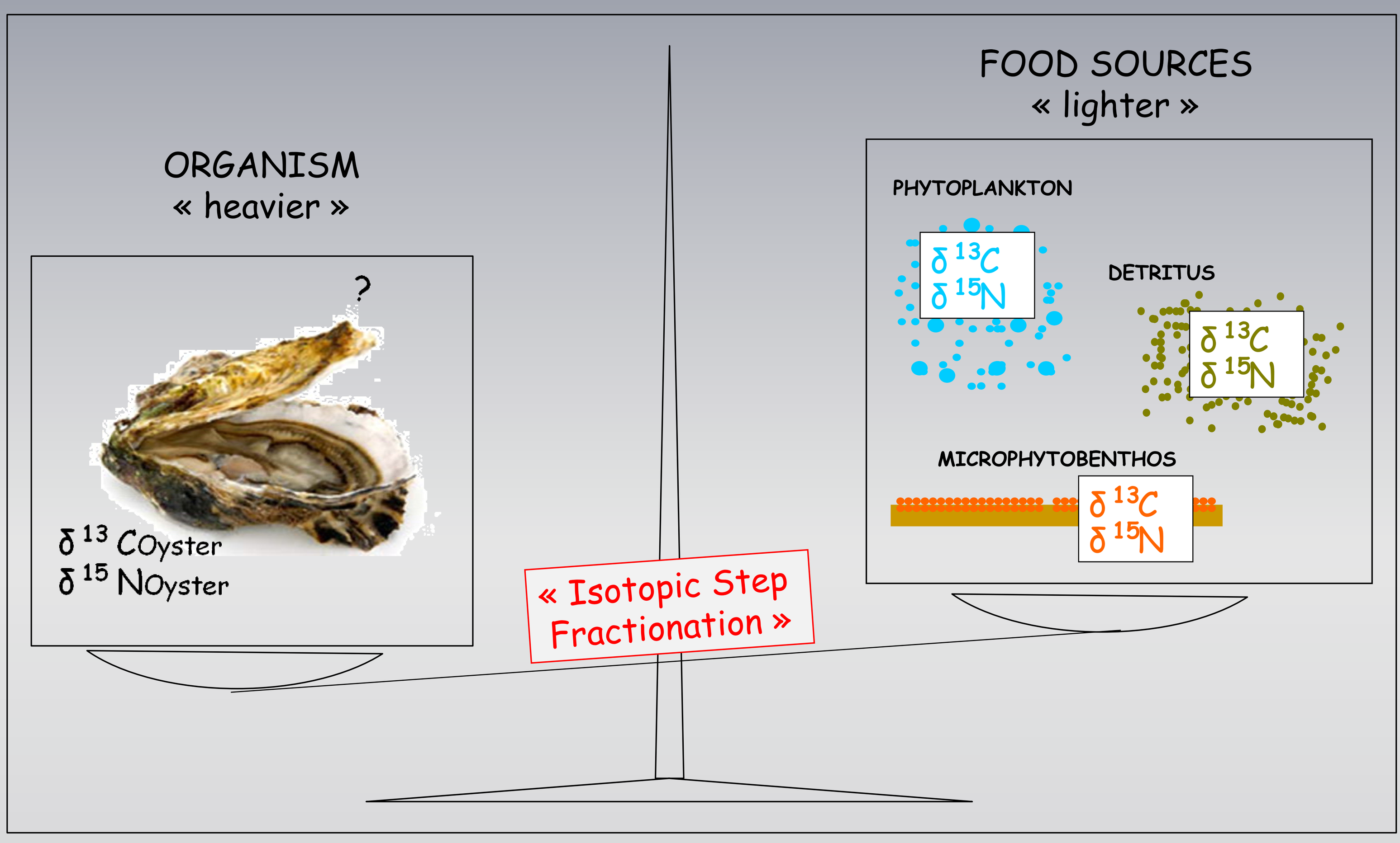


Fig 2: Scheme of isotopic step fractionation from food sources to organism

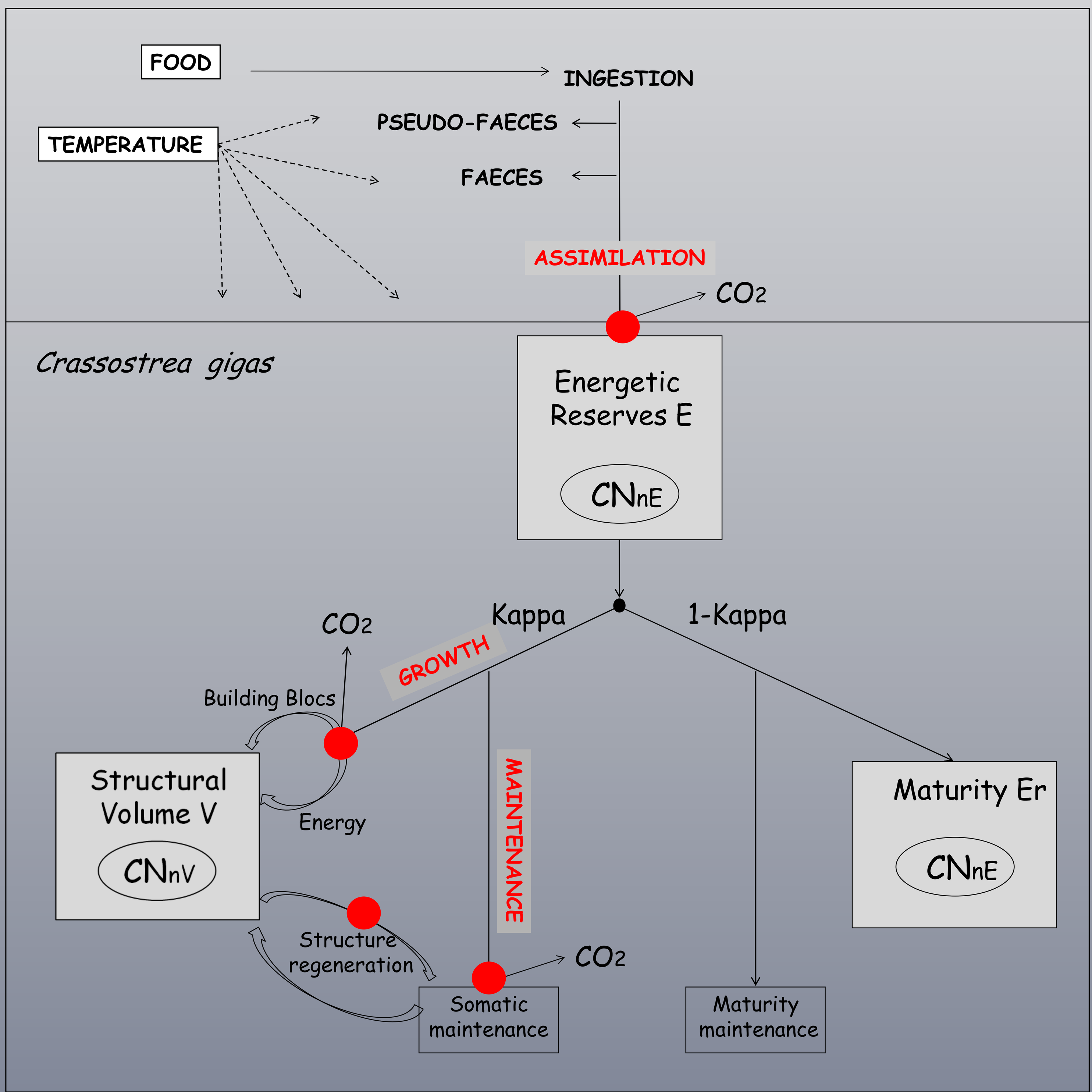


Fig 3: Scheme of the DEB growth model for the Pacific oyster (*Crassostrea gigas*). State variables with their own generalized compound (circle) are in grey and forcing variable are in white. Red dot stand for reactions where fractionation can occur.

## Perspectives

The aim of this PhD project is to better understand allocation and fate of matter/elements fluxes in organisms. Final aim is to use the model on natural field with an inverse method approach. The result will be used to *i)* reconstruct originally trophic conditions of observed isotope signatures and *ii)* to determine biological indicators (e.g. nutrition level, food sources, availability of reserves, maintenance, growth rate) for Oyster production to compare culturing sites. Model predictions will be tested using monitor data for oyster spat in the Bays of Brest (Brittany) and Vey (Normandy).

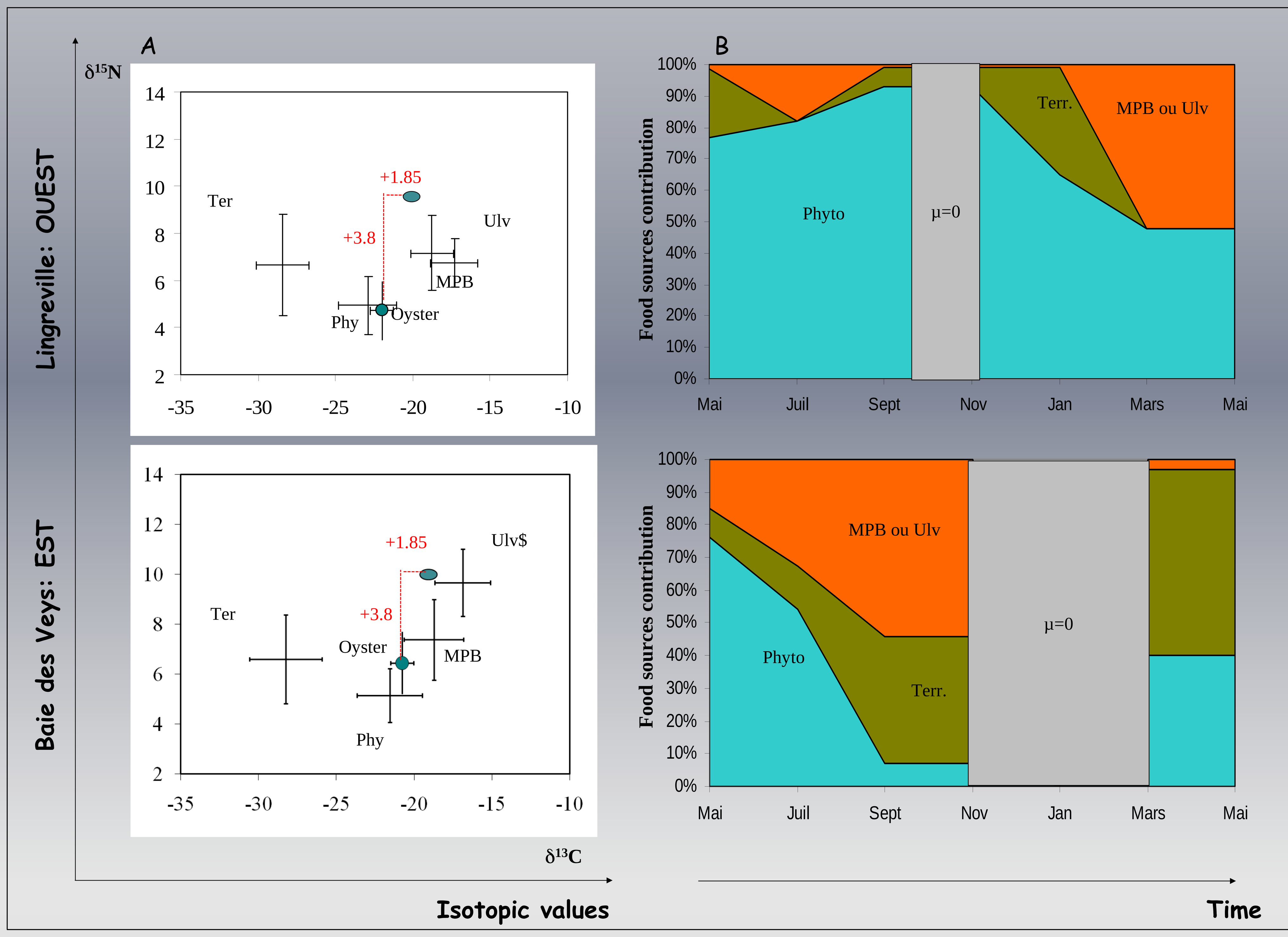


Fig 1: Mean annual isotopic signature of oyster and the four food sources sampled (A) in two contrasting ecosystems. « Ter » stand for terrestrial matter, « Phy » for phytoplancton, « MPB » for microphybenthos and « Ulv » for macroalgae (*Ulva sp.*). Estimated contribution of each food sources in *Crassostre gigas* diet over one year in the same contrasted environment (B). « μ » stand for the no growth period (Marin Leal & *al.* 2008 ; Dubois S. et *al.* 2007)

## Methods

### 1- Isotopes: food sources and organism

Potential food sources available for *Crassostrea gigas* and bivalves in general have important spatial and time variability (Fig.1) and it is, thus, difficult to characterize and quantify their contribution to the bivalves diet. Figure 1 (A) show that each source has its own isotopic signature which can slightly vary between ecosystems. It also shows that isotope ratios of organism tissues closely resemble those of their diet but with slight enrichment of heavier isotopes, since lighter ones are preferentliay used in metabolism. This enrichment classically called, trophic-step fractionation, can vary with temperature, diet, species, metabolism,…
At the same time, availability (%) of these sources over sites and year seems to be much more variable, as it has been shown by the statiscal model proposed by Marin Leal & *al.* (2008).

### 2- Conceptual aspect

A) In the context of Dynamic Energy Budget theory, reserves (E) and structural (V) mass, can be considered as « generalised compound », rich mixture of compounds, molecules,… that do not change in chemical composition. This concept rests fully on the strong homeostasis assumption. It is then possible to define a typical « reserve compound » and « structural compound » in the basis of C-mole notation such as $CN_{nE}$ and $CN_{nV}$ respectively. The isotope dynamics in oyster tissues will be based on the mass dynamics as specified by DEB theory (Kooijman, 2009).

B) DEB theory assumes a set of three transformation in organism in which fractionation can occur (•): assimilation, growth and dissipation (maintenance processes).
- Flux of matter from reserves to structure will be « split in two »: one part will be used for building blocs construction, (anabolism) the other one will be used to « fixe » building blocs
- Maintenance processes (turn over of structure) use a part of « structure blocs » and reserves to regenerate structure.

### 3- Experimental aspect

An experiment in controlled mesocosms will be done in the Experimental Station of Argenton (France, Brittany). This experimental approach will consist of testing different factors & scenario as, constant food conditions (composition and quantity, e.g algae paste) , sudden diet changes (composition, quality and quantity), starvation, constant and variable temperature, … in order to validate the model assumptions

### References

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