

Modelling growth and reproduction of *Crassostrea gigas* in different contrasted ecosystems by use of Dynamic Energy Budgets (DEB): generic validation of the oyster-DEB model

Introduction

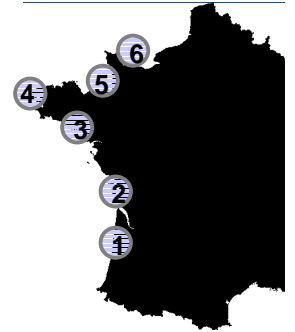
Oyster (*Crassostrea gigas*) farming is the main aquaculture activity in France and the first shellfish production in Europe with an annual production of ~130 000 tons. The growth performances of *C. gigas* exhibit an important variability among culture sites along the French Atlantic coast.

Many studies have been carried out to understand the effects of environmental factors on oyster growth and physiology, by using bioenergetics growth models. Most of these models, however, are site-specific (e.g. Barillé *et al.* 1997) and cannot be successfully applied to other culture sites without re-estimating parameters or re-formulating some processes. In that context, our study aims to develop a generic growth model, *i.e.* a model that can be applied in various contrasted environments with a constant set of parameters.

Material & methods

We use the DEB model designed for the Pacific oyster *C. gigas* (Pouvreau *et al.*, 2006; Bourlès *et al.*, 2009) based on the DEB theory (Kooijman, 2000). The resulting oyster-DEB model is built on 10 main DEB parameters with some extra parameters to consider specific bioenergetics of *C. gigas*. Only one DEB parameter, *i.e.* the half-saturation coefficient X_K which depends on food quality and quantity (e.g. inorganic matter, phytoplankton composition) and therefore on ecosystems, is calibrated for each site in order to evaluate the generality and/or the limits of the model.

In collaboration with Ifremer coastal laboratories, we test the oyster-DEB model to simulate *C. gigas* growth on different cohorts (spat and adults) in major shellfish culture sites in France and for different years: 1) Arcachon (1993-1994); 2) Marennes-Oléron (2007); 3) Quiberon (1999, 2000, 2001); 4) Rade de Brest (2008); 5) Baie du Mont-Saint-Michel (2003); 6) Baie des Veys (2002). These different ecosystems offer a wide range of values for the two model forcing variables: water temperature (range: 6-24°C) and phytoplankton enumeration (annual average: 110-700.10³ cell.L⁻¹). The validation data (dry flesh mass of *C. gigas*) come from different growth surveys of Ifremer.



Results & discussion

- The oyster-DEB model simulates accurately over time the oyster growth dynamics of both spat and adult stages of *C. gigas* in the different and contrasted culture sites. The model is able to capture: i) the active spring growth, ii) the timing and amplitude of spawning events and iii) the lean periods (*i.e.* loss of dry flesh mass) in autumn and winter.

- The half-saturation coefficient X_K is the only model parameter which varies among sites and over years. It reflects the **variability in the food composition** for oysters, e.g. both quantitative and qualitative effects of the inorganic material and of the phytoplankton species on the feeding response of *C. gigas*.

Conclusion

With **one single set of parameters** (except for X_K), this is the **first bio-energetic growth model** for *C. gigas* which is robust enough and **generic** to simulate accurately the oyster growth in **different ecosystems**.

References

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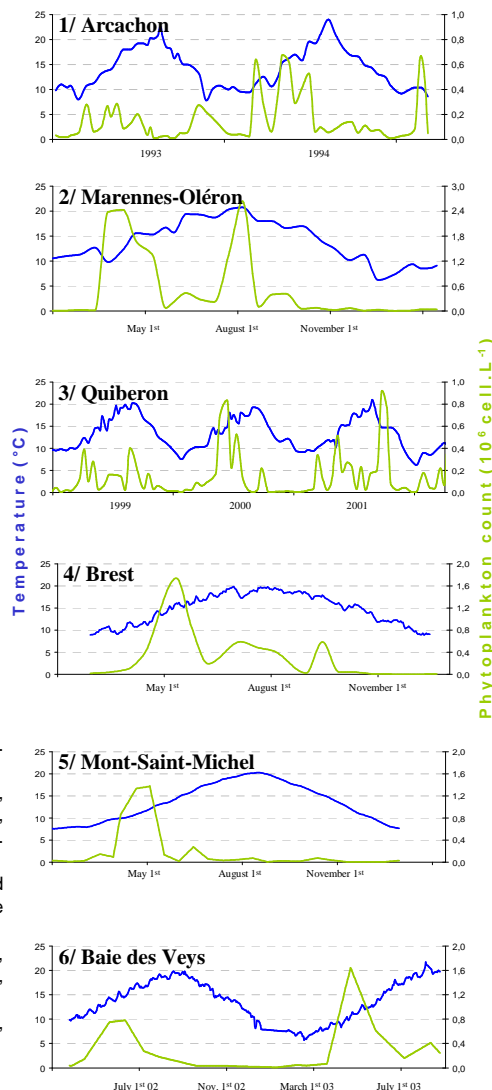
Acknowledgments

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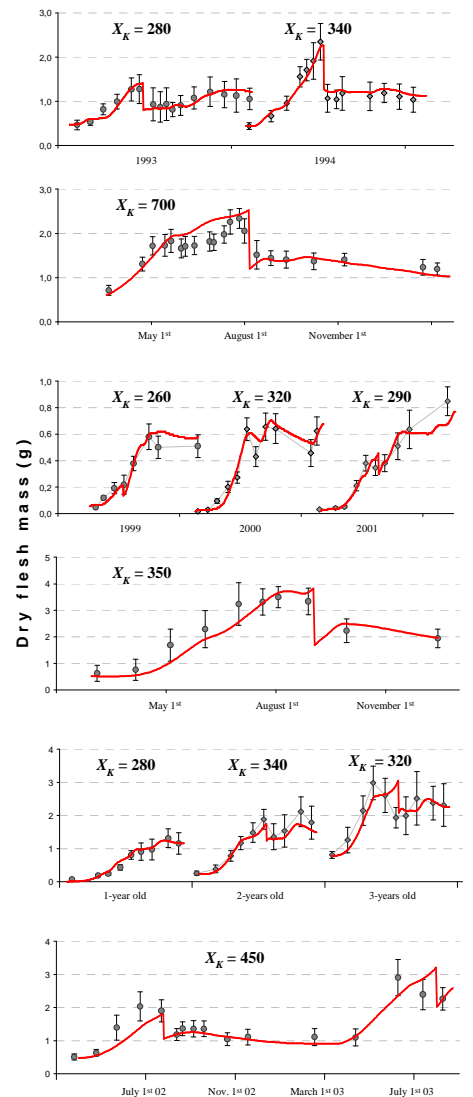
Forcing variables:

Temperature and Phytoplankton enumerations



Application of the oyster-DEB model

Observed (dots) vs Simulated (red line) growth



[X_K is expressed in phytoplankton cells per liter (10⁶cells.L⁻¹)]