

INTRODUCTION :

Several models of the growth and reproduction of bivalves are available in the literature. But most of them exhibit recurrent limits: i) simulations validated only on a short period of the year, generally during the growth period in spring and summer and ii) model specific from the site where they were developed. We propose here a generic model which could go beyond these limits for the Pacific oyster *Crassostrea gigas*, which is a species widely cultivated around the world. This new bioenergetic model for the growth and reproduction of *C. gigas* is based on the DEB theory (Kooijman, 2000) and its model (Figure 1), which has been successfully applied to other marine organisms (e.g. van der Veer *et al.*, 2001). Parameters of the model were adjusted previously according specific experiments and values available in the literature. We present on this poster the first simulations obtained with our generic model, for different ecosystems and with different food tracers (chlorophyll a and phytoplankton composition).

MATERIAL & METHODS:

The model presented here is fully detailed in Pouvreau *et al.* (2006). This model uses the Dynamic Energy Budget (DEB) theory developed by Kooijman (2000). It is a fully specified theory, based on mechanistic rules which are not species-specific. Fluxes of energy are described on the Figure 1. This model needs only 10 primary parameters for ectotherm animals, and we add 2 extra parameters to trigger automatically the spawning (Table 1). The data sets used to test the model come from independent and long-term growth experiments (> 5 months) performed along French coasts (Figure 2) on Pacific oysters under different conditions of food and environment.

Figure 2: localization of growth surveys



RESULTS:

The data sets from the five experiments used to test the model are presented on the Figure 3. The temporal variations of the forcing variables are illustrated on the five graphs on the left. The five graphs on the right show the comparison between observations and simulations of the flesh dry mass of oysters for each experiment. Comparison

of the model-predicted growth with observed growth in experimental conditions at Argenton laboratory gives a very good agreement ($R^2=0.98$, $n=14$, $p<0.0001$). Then, the model simulates not only oyster growth over a complete annual cycle, but also the gametogenesis and spawning periods in the four different natural field tested. Final masses are very well predicted by the model in the five experiments. Model analysis are detailed in Pouvreau *et al.* (2006).

DISCUSSION:

Over the last decade, modeling approaches have gained popularity in studies on shellfish energetics, especially in coastal management where carrying capacity and environmental changes are essential. Our study is the first application of this generic DEB model to the Pacific oyster. It highlights the good agreement between model-based simulations and real observations, even for very different types of environment. Such a concordance indicates that the DEB theory developed by Kooijman (2000) is an efficient tool for capturing the bioenergetics and physiology of molluscs, especially the Pacific oyster.

It also demonstrates that: (i) the accuracy on the measurements of the estimates used here for the forcing variables and DEB parameters was sufficient, (ii) the food sources selected in this study were highly decisive for growth and reproduction, and (iii) the reproductive processes had been clearly formulated to simulate accurately the spawning event, quantitatively and in a good timing.

The next step of our research will be to investigate the suitability of this model to simulate growth and reproduction in the field under environmental conditions more complex than those handled in this study.

CONCLUSION:

By demonstrating its rather good ability to mimic growth and reproduction under various conditions of environment, this generic DEB model appears to be generally suitable for simulation of bioenergetics of Pacific oyster in the field. It could also be applied on others shellfish.

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Figure 1: scheme of the DEB model

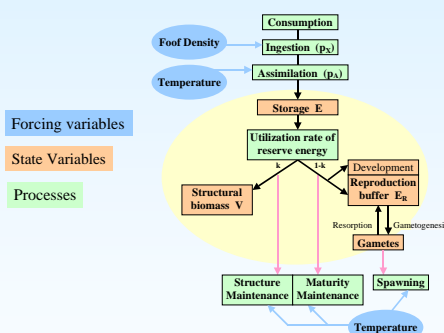


Table 1: Deb parameters values

| Parameters | Symbol | Dimension | Values * |
|---|-------------------|----------------------------------|------------------|
| Arrhenius temperature | T_A | K | 5800 |
| Half saturation coefficient | X_K | $\mu\text{g chlo a.l}^{-1}$ | 3-12 / 200 - 800 |
| Max. surf. area-specific ingestion rate | $\{p_{I_{max}}\}$ | $\text{J.cm}^{-2}.\text{d}^{-1}$ | 565 |
| Assimilation efficiency | ae | - | 0.75 |
| Volume-specific maintenance costs | $\{p_{M_{vol}}\}$ | $\text{J.cm}^{-3}.\text{d}^{-1}$ | 24 |
| Maximum storage density | $\{E_{R_{max}}\}$ | J.cm^{-3} | 2295 |
| Volume-specific costs for structure | $\{E_{G_{vol}}\}$ | J.cm^{-3} | 1900 |
| Structural volume at puberty | V_p | cm^3 | 0.4 - 0.8 |
| Fraction of $p_{C_{vol}}$ spent on maintenance + growth | κ | - | 0.45 |
| Fraction of reproduction energy fixed in eggs | κ_R | - | 0.7 |
| Thermic threshold to trigger spawning | T_{sp} | $^{\circ}\text{C}$ | -19.5 |
| Gonado-somatic threshold to trigger spawning | R_{GS} | % | -40 |

* Van der Veer *et al.* (2006), Pouvreau *et al.* (2006), Bourles (2004)

Figure 3: Data sets of the 5 growth experiments and the simulations associated.

