EFFECTS OF DOMESTICATION, SELECTION AND STRESS ON THE ENERGY BALANCE OF SEA BASS (*Dicentrarchus labrax*) IN AQUACULTURE

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CONTEXT & OBJECTIVES

The optimization of *D. labrax* aquaculture involves both **genetic criteria** for selecting traits of commercial interest, and **control criteria of fish welfare** for ensuring the long-term sustainability of commercial production systems.

Estimation of these criteria mainly relies on the analysis of **empirical growth curves**, obtained under different rearing conditions or for different genetic families. Such curves, however, do not enable to test explicitly and to quantify if any variation in feeding patterns (*e.g.* feed intake, conversion efficiency) can affect the fish growth performances

By using a bio-energetic growth model, **3 main questions** are addressed:

1. Any differences of the energy budget among different selected strains

WHY SELECTED FISH ARE BIGGER THAN NON SELECTED FISH?

Higher feed intake or better transformation of the ingested food?

2. Disruption of energy balance by chronic stress

Effect of stress on food intake and utilisation

3. Effect of the selection on the stress sensibility of fish

Measurement of the interaction between selection and stress factors

MATERIAL & METHODS

Estimation of assimilation and maintenance parameters by calibration of the DEB model on experimental data

Dynamic Energy Budget model

Kooijman 2000

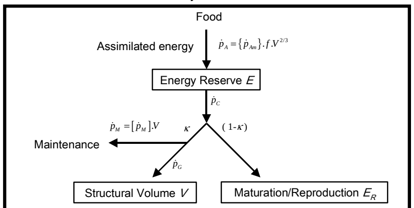

Fig.1 Schematic representation of the κ-rule DEB model. The assimilated energy ($\dot{p}_A$) enters the reserve compartment. A fixed fraction κ of the catabolic power ($\dot{p}_C$) is spent on maintenance ($\dot{p}_M$) and growth ($\dot{p}_G$) with priority for maintenance, the rest goes to maturity (for embryos and juveniles) or reproduction (for adults).

Assimilation: energy going through the digestive surface

Maintenance: energy needed to keep the fish alive (homeostasis, turn-over…)

Experimental data

4 strains of sea bass (Vandeputte et al. 2009)

- Wild fish
- Domesticated fish (1 cycle of reproduction in captivity)
- Fish from Massal selection (1 generation)
- Fish from PROSPER selection (1 generation)

Growth (50 fish per tank, 3 triplicates per strain) during 91 days; fish fed with self-feeder

Chronic stress after day 35

RESULTS

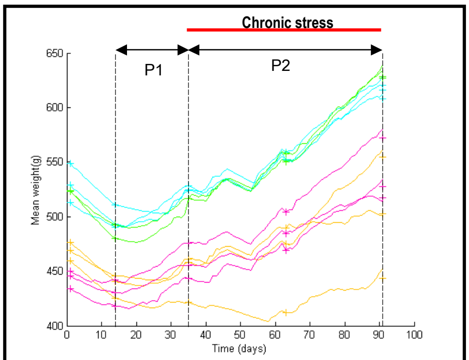

Fig.2 Calibration of the DEB model (straight line) on experimental data of growing sea bass (cross). One calibration is performed per tank and per period.

Assimilation $\{\dot{p}_{Am}\}$ **(J.cm^{-2})**

	Wild	Dom.	Massal	PRO.
P1	271 (106)	586 (70)	476 (191)	433 (22.3)
P2 Stress	542 (250)	698 (207)	704 (141)	724 (149)

Mean value of the maximum assimilation rate for each period and each strain (3 replicates, the standard deviation are in brackets)

***p*-value of the repeated measures ANOVA:**
- **Strain: 0.04**
- **Stress: <0.001**
- **Strain*Stress: 0.72**

Maintenance $[\dot{p}_M]$ **(J.cm^{-3})**

	Wild	Dom.	Massal	PRO.
P1	6.9 (6.2)	17.3 (4.5)	9.1 (9.0)	5.2 (5.9)
P2 Stress	23.2 (10.6)	22.6 (12.1)	23.6 (2.8)	16.2 (5.0)

Mean value of the metabolism rate for each period and each strain (3 replicates, the standard deviation are in brackets)

***p*-value of the repeated measures ANOVA:**
- **Strain: 0.44**
- **Stress: <0.001**
- **Strain*Stress: 0.06**

DISCUSSION & CONCLUSION

1. Differences in the energy budget among strains

-The strain has a significant effect on the assimilation, but not on the maintenance costs

$\{\dot{p}_{Am}\}_{Wild} << \{\dot{p}_{Am}\}_{Selected}$

$[\dot{p}_M]_{Wild} \cong [\dot{p}_M]_{Selected}$

Maintenance flux ($\dot{p}_M$) ≅ 15% of assimilation flux ($\dot{p}_A$) (for selected fish of 500g)

⇒The differences in growth among strains is mainly explained by differences in assimilation

⇒ Selecting the biggest fish results likely in selecting the fish that eats more

Further studies are needed to explain the "unusual" behaviour of domesticated strain, *i.e.* high assimilation and high maintenance.

2. Effect of a chronic stress on the fish energy balance

- A chronic stress results in increasing significantly the assimilation and maintenance rates

⇒ A chronic stress involves an increase of feeding which does not lead to an increase of growth

⇒ A chronic stress leads to a costly waste of feeding; this should be avoided for both economical and environmental reasons

In this study, an increase of metabolism is also blurred with a decrease of food digestibility

3. Effect of selection on stress sensibility?

- The increase of assimilation and metabolism caused by the chronic stress did not vary among strains

⇒ There is no difference in terms of sensibility to stress among selected and non-selected strains

⇒ Cultural practises and/or selection oriented upon stress resistance may help to decrease the effects of stress

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References.

Kooijman S.A.L.M., 2000. Dynamic energy and mass budgets in biological systems. Cambridge University Press, Cambridge, 424 p.

Vandeputte, M., Dupont-Nivet, M., Haffray, P., Chavanne, H., Cenadelli, S., Parati, K., Vidal, M.-O., Vergnet, A., Chatain, B., 2009. Response to domestication and selection for growth in European sea bass (*Dicentrarchus labrax*) in separate and mixed tanks. Aquaculture 286, 20-27.