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Effects of genetic drift and selection at larval stage resulting from hatchery practices in the Pacific oyster (*Crassostrea gigas*)

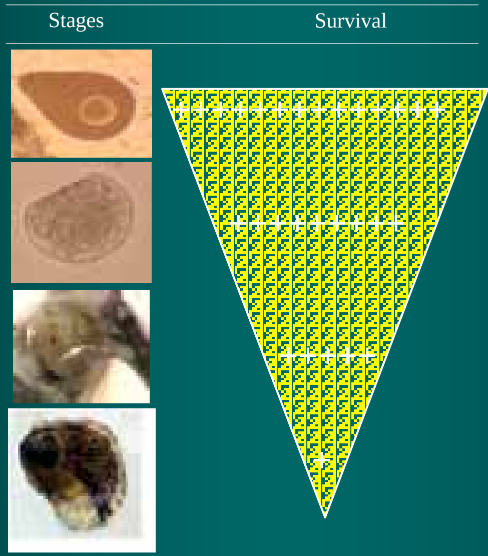
N. Taris, C. Sauvage, B. Ernande*, F. Batista[#] & P. Boudry

Laboratoire de Génétique et Pathologie, Ifremer, La Tremblade, France
*Laboratoire Ressources Halieutiques, Ifremer, Port-en-Bessin, France
[#] INIAP/IPIMAR, Olhão, + ICBAS, Universidade do Porto, Portugal

Crassostrea gigas life cycle

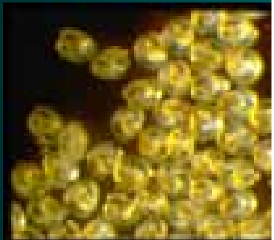
The "elm-oyster model"

Williams 1975



High fecundity and high mortality at early stages

Which consequences of such a life history strategy for hatchery-based aquaculture production ?

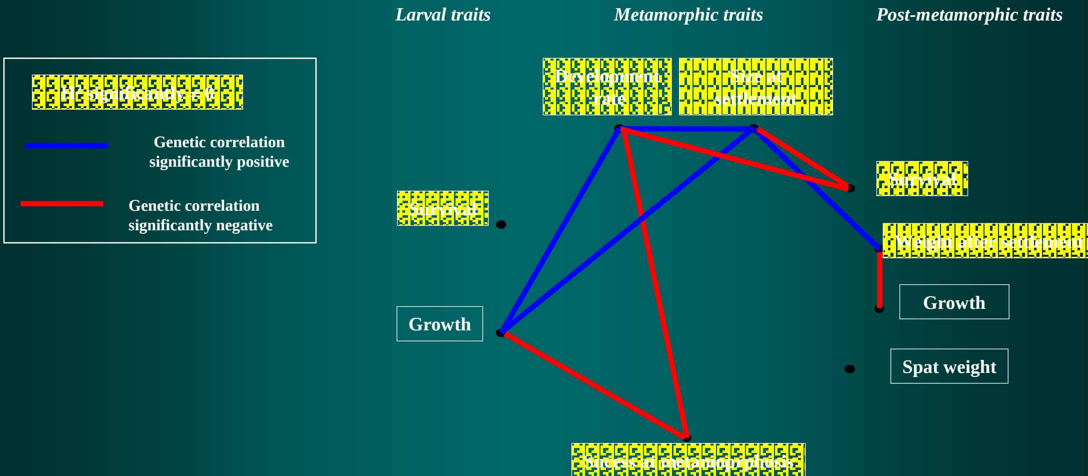


☺ Few genitors needed for massive production of juveniles
☺ Culling (*i.e.* size selection)

☹ Low effective population size (Hedgecock *et al*., 1992)
☹ Risks of rapid loss of genetic variability and inbreeding in closed populations

Can specific rearing practices (culling) and/or environmental conditions (high temperature) lead to a specific genetic adaptation in *C. gigas* larvae ?

Genetic variability of early life traits in *C. gigas*

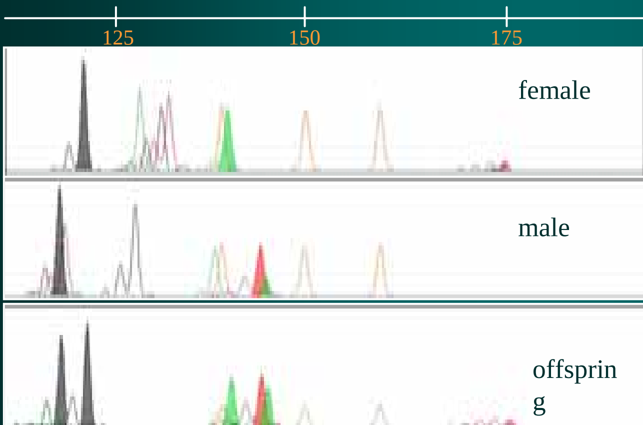


(Ernande *et al*., Journal of Evolutionary Biology 2003

Technical constrains often lead to limit the number of families and to rear them in a single environment

Mixed-family approach

- More families
- More homogeneous rearing conditions among families
- Different environments (G x E ?)

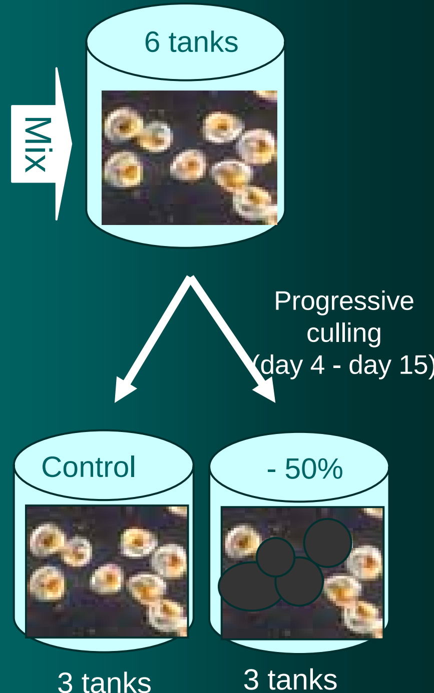


Set of PCR-multiplexed markers allowing efficient parental assignment of larvae

(Taris *et al*., Aquaculture Research 2005)

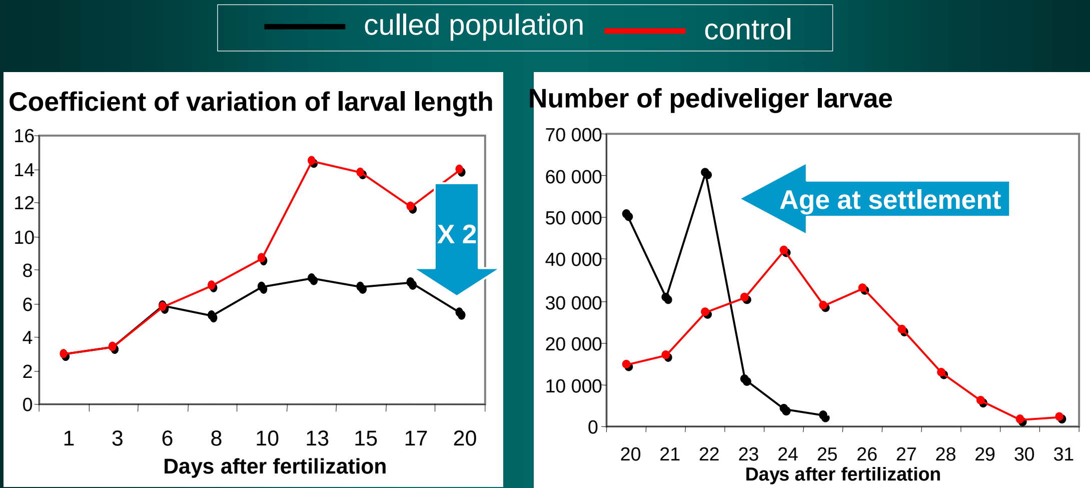
1. Effect of culling

Full factorial cross with
equal gametic contribution
within each sex



Which phenotypic and genetic consequences ?

1.1 Phenotypic effect of culling 50% of the (smallest) larvae

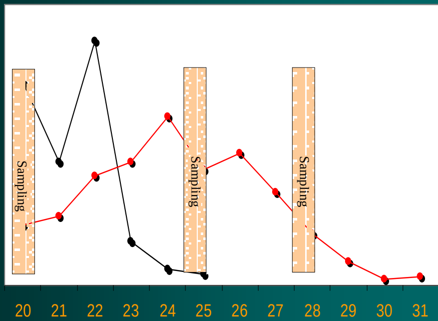


Limited effect on <u>yield</u>:

-30 % of ready-to-settle larvae (higher survival of fast growing larvae)

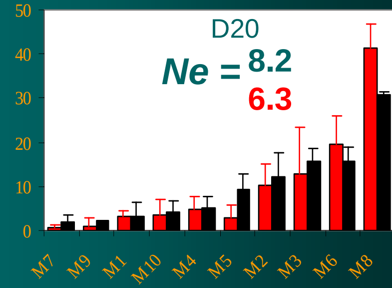
-15 % of spat (higher settlement success of fast growing larvae)

1.2 Genetic effect of culling

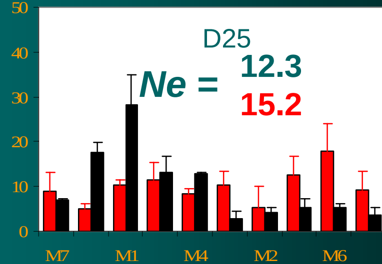


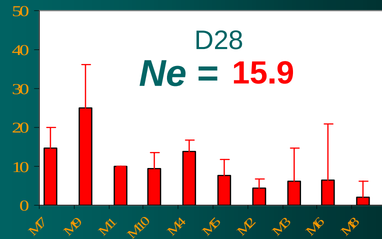
The effect of culling on genetic diversity is mediated through its effects on the timing of settlement

(Taris *et al*., JEMBE 2006)



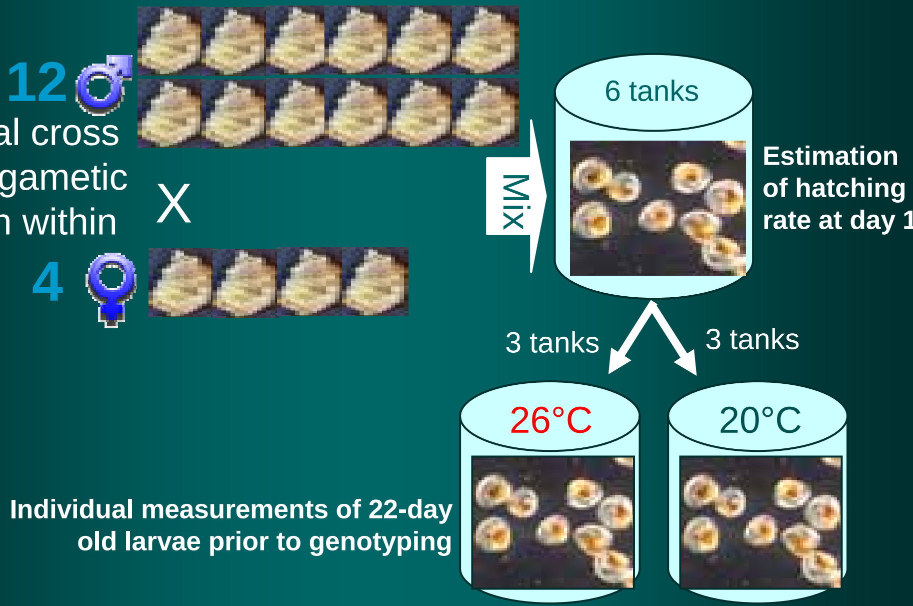
males





2. Effect of temperature

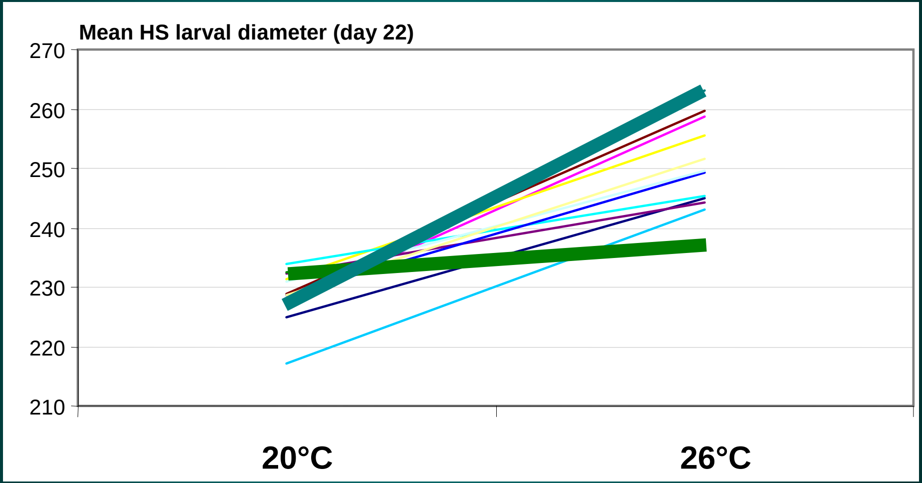
Full factorial cross with equal gametic contribution within each sex



“Early” and “late” settlement cohorts

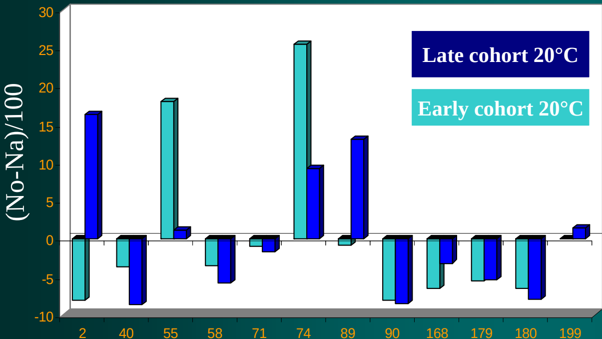
Which phenotypic and genetic consequences ?

2.1. « G x E » interaction on larval growth

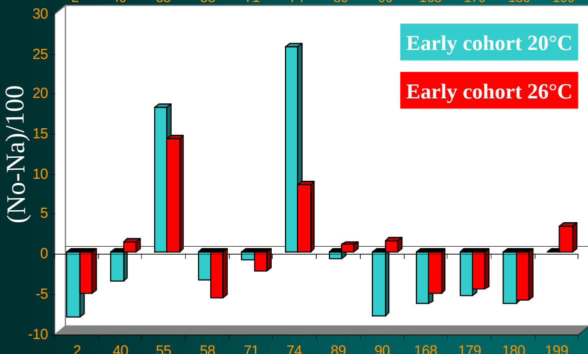


h²(ns) 0,007 ± 0,007 <<< 0,117 ± 0,019

2.2. Paternal contributions in spat (day 80)



Significantly different contributions between early and late cohorts reared at 20°C (26°C: similar result)

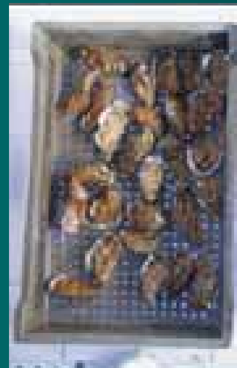


Significantly different contributions between early cohorts reared at 20°C and 26°C (late cohorts: similar result)

Temperature significantly affects the genetic composition of the population and its growth (G x E)

3. Comparison of "domesticated" and "wild" larvae

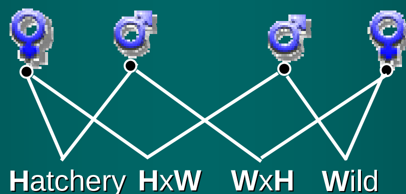
Oysters from a commercial hatchery broodstock following 7 generations of closed hatchery matings with high culling and high temperature



Oysters from a French natural bed

Microsatellite markers :

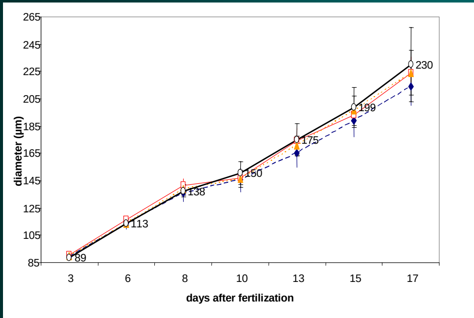
Mean nb. Of allele / locus	10	<	34
Observed heterozygosity	0.66	<	0.86
Expected heterozygosity	0.77	<	0.96



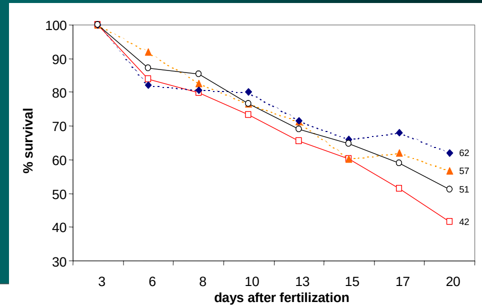
<u>Larval rearing</u>:
24°C
no culling
3 replicated tanks / progeny

3.1. Larval growth, survival and settlement

Growth (ns)

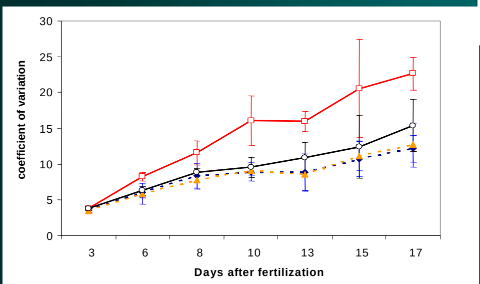


Survival **

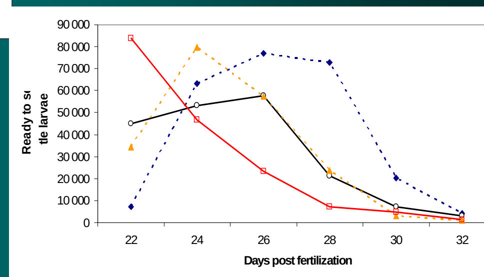


Hatchery
H x W
W x H
Wild

Variance in Growth *



Timing to settlement *



Settlement success : Hatchery > HxW > Wild > WxH

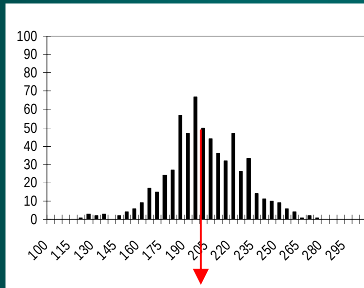
(%) 90,7 78,1 72,3

68,7

3.4. Within progeny variation for larval size

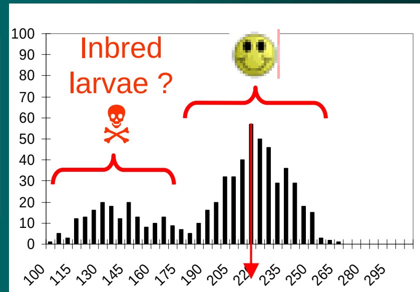
Distribution of larval length at Day 15

Wild progeny



205 µm

Hatchery progeny



225 µm **

Pairwise relatedness in the broodstocks

0,012 ± 0,001 → x 6 → 0,068 ± 0,005

High genetic load (Launey and Hedgecock, Genetics 2001)

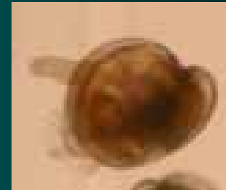
Response to selection due to culling ?

h^2 = 0.16 (*Dégremont, 2003*)
S = 20µm (*Taris et al., 2006*)

→

Δ µ ~20µm over 7 generations
+ earlier settlement
+ higher settlement success

4. Conclusions



Methodology

- As individual tagging is impossible at early life stages, marker-based parentage analysis of mixed families represents an efficient way to study the genetics of larval traits in oysters.

Unintentional selection at larval stage in hatcheries

- Significant differences are observed between families, confirming the existence of genetic variation for several traits.
- Temperature influences the expression of genetic variability for growth and survival. It therefore is likely to increase the genetic effect of culling.
- Intensive rearing practices can lead to the selection of faster growing larvae and higher settlement rates, despite inbreed depression.

Acknowledgments:

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Conseil Général de Charente Maritime

Oyster ponds along the Seudre estuary, *Marennes-Oléron* Bay, France