Genetic basis of reproduction in diploid and triploid Pacific oysters, *Crassostrea gigas*

Julien Normand, Bruno Ernande & Pierre Boudry

Genetic improvement of *C. gigas* through triploidization:

- **Better growth** (Nell, 2002) **and survival** (Degrémont, 2003)

Enhanced yield

- **Reduced (but variable) gonad development** (Normand et al., in press)

Enhanced marketability during the diploid reproductive period & limited propagation in the wild

→ **Growing commercial success**

Genetic basis of variability for reproductive effort in *C. gigas*

- Genetic basis found for reproductive effort in diploid oysters (Ernande et al., 2004)

… but

- *Is there a genetic basis for the variability of reproductive effort in triploid individuals ?*
- *Are reproductive effort in diploid and triploid genetically correlated ?*

How to obtain a triploid individual ?

2n breeders

n gamet

n gamet

2n offspring

2n breeder

n gamet

2n gamet

3n offspring

How to obtain a triploid individual ?

2n breeders

n gamet

n gamet

2n offspring

2n male

2n female

n gam

Chemical induction

2n gamet

3n offspring

How to obtain a triploid individual ?

2n breeders

n gamet

n gamet

2n offspring

2n female

4n male

n gamet

2n gamet

3n offspring

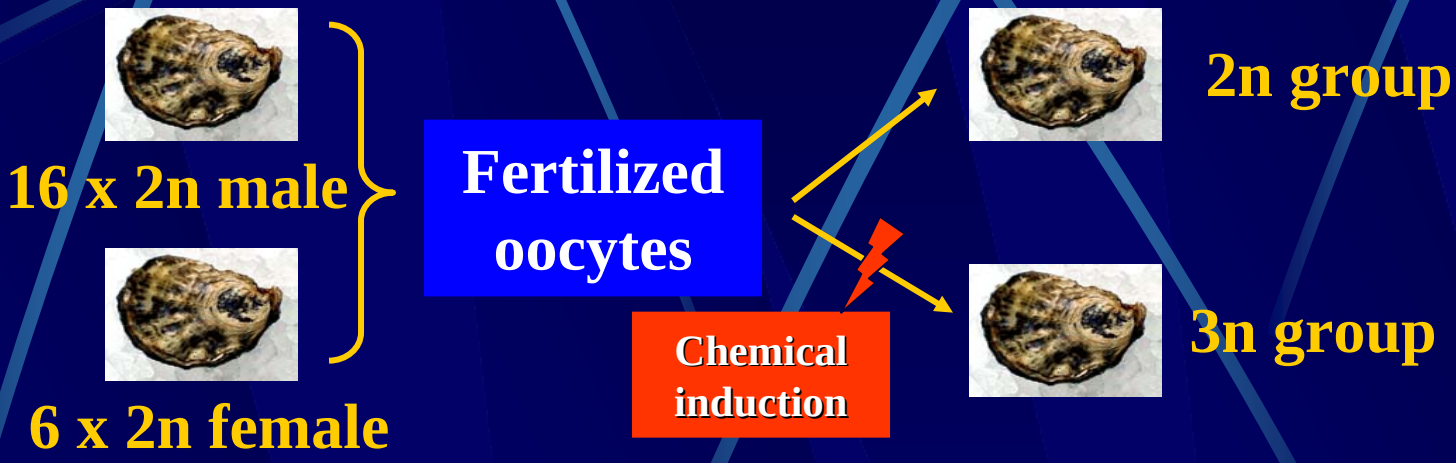
Effects of triploidy on phenotypic values

Phenotypic traits could be affected by triploidy, respectively or not to breeders genetic values and environment

Triploid oysters are not diploid (partially) sterile oysters!

Relation between phenotypic values in diploid and triploid relatives must be tested…

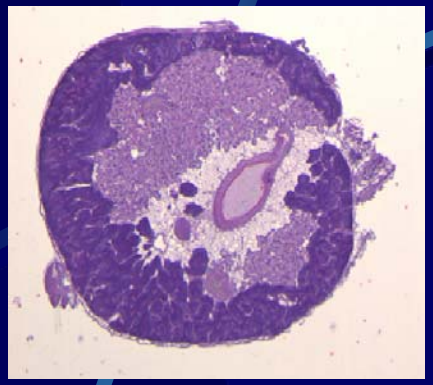
Experimental design: Mixed families approach

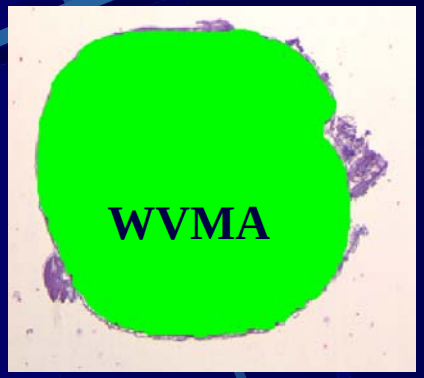


Sampling at 6 months, N= 300 / ploidy :

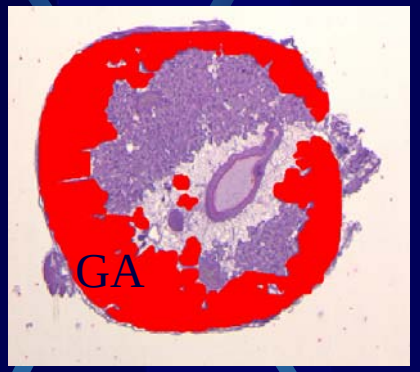
- gonadal occupation
- parentage assignation using molecular markers

Material and methods





Whole Visceral Mass Area



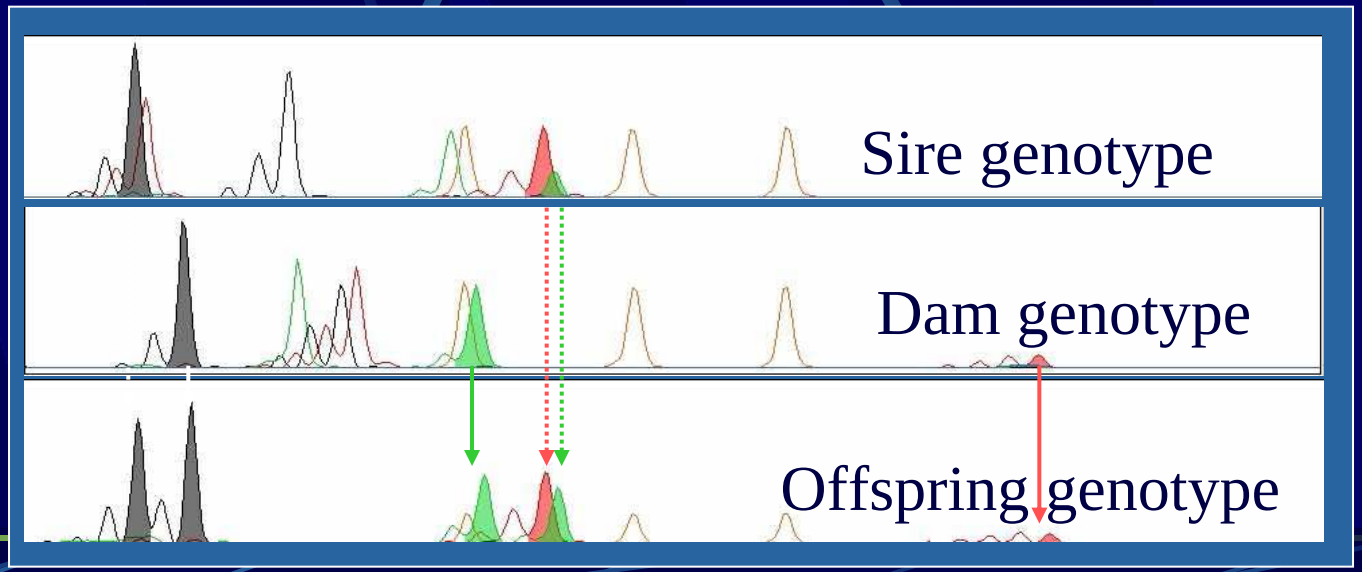
Gonad Area

Gonadal Occupation

GO = GA x 100 / WVMA

Parentage analysis

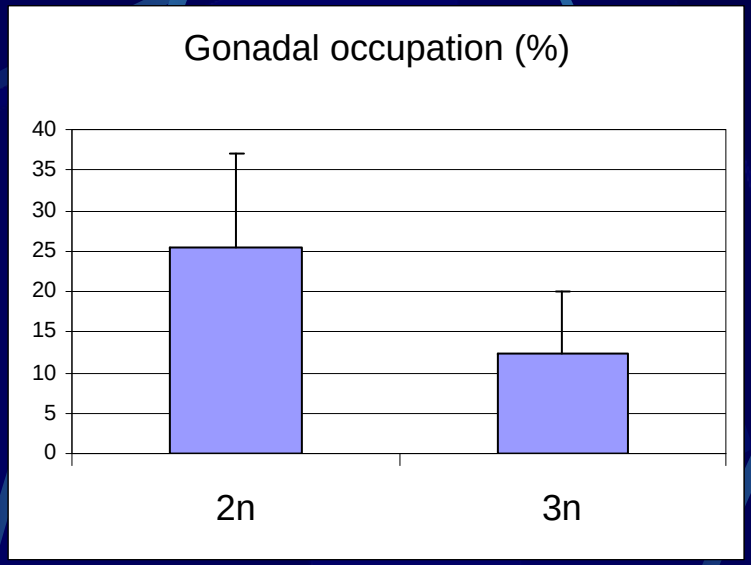
(multiplexed microsatelittes loci)



Analysis of variance*:*

is there an effect of the ploidy on the phenotypic value of the offspring ?

Ploidy effect on gonadal occupation



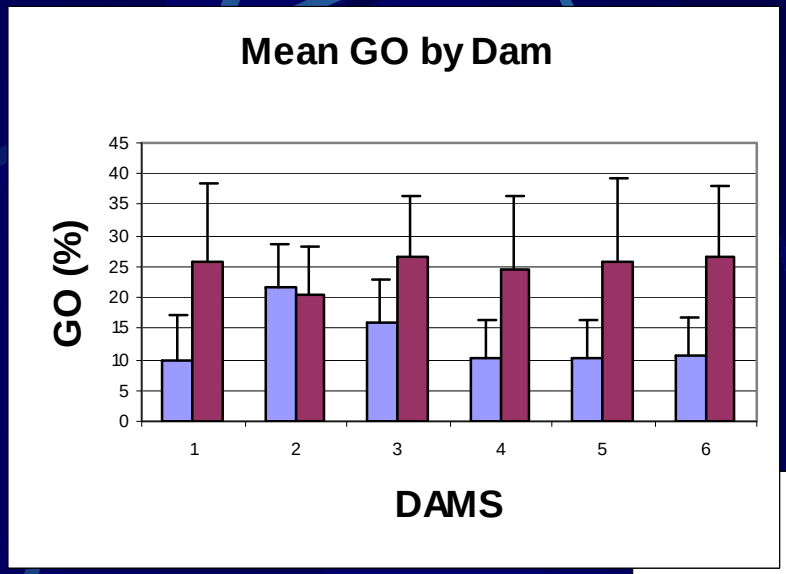
Highly significant effect of ploidy on gonadal occupation

	Descriptive Statistiques				ANOVA	
	Mean		Variance			
Trait	**2n**	**3n**	**2n**	**3n**	**Mean Squar**	**Significance**
Gonadal occupation (%)	25,64	12,32	127,75	62,26	321,26	**0,0001**

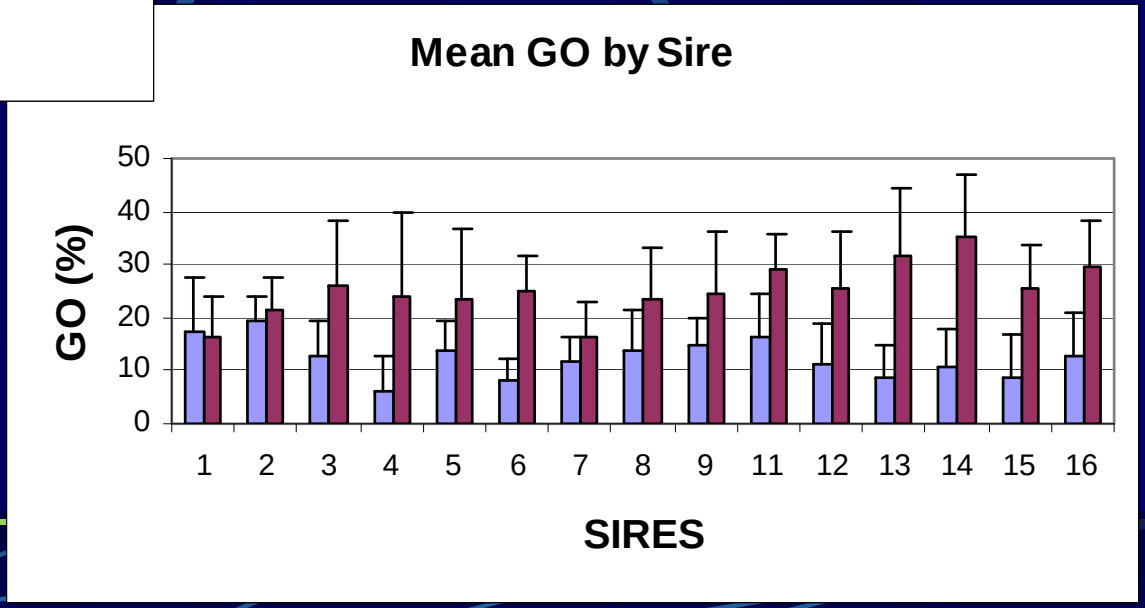
Within group analysis of variance*:*

is there an effect of the breeder (genetic value) on the phenotypic value of the offspring ?

Breeders effect on Gonadal Occ.



Some differencies in offspring gonadal occupation grouped by breeder



Breeders effect on Gonadal Occ.

Model: GO = Sire + Dam + Sire x Dam

Regression: Variance parameter estimates and significance by group					
Group	**Cov. Par.**	**Estimate**	**% of total variance explained**	**Standard error**	**Pr (test Z)**
3nc	Sire	0,162	11,7	0,091	**0,037**
	Dam	0,348	25,2	0,24	**0,074**
	Sire x Dam	0,044	3,2	0,059	0,227
	Residual	0,827	59,9	0,088	0,0001
2n	Sire	0,152	11,0	0,095	**0,055**
	Dam	0		non-est.	non-est.
	Sire x Dam	non-est.		non-est.	non-est.
	Residual	1,235	89,0	0,116	0,0001
	h^2=	0,44			

Dams and Sires effects both significative at 10%

Breeders effect on Gonadal Occ.

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	h^2=	**0,44**			

Genetic determinism for reproductive effort appears to be high

Breeders effect on Gonadal Occ.

Dams effect explains a greater part of total variance than Sire effect:

(i) Due to the combination of maternal and genetic effects

(ii) In 3n group, unbalanced contribution of maternal genome

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	h^2=	0,44			

Inter group analysis of variance*:*

is there a significative interaction between ploidy effect and breeder (genetic value) effect?

Interaction between ploidy effect and breeder's values

Model: GO = Ploidy x Sire + Ploidy x Dam + Ploidy x Sire(Dam)

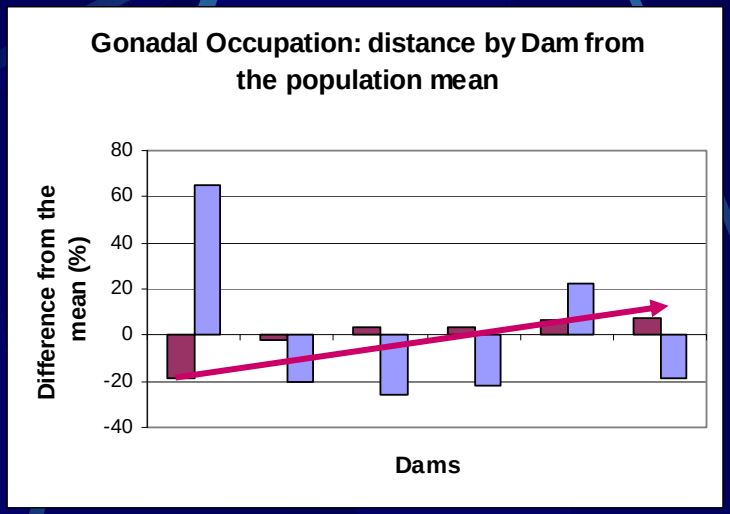
Regression: Covariance parameter estimates and significance			
Cov. Par.	**Estimate**	**Standard error**	**Pr (test Z)**
Ploidy x Sire	0.059	0.024	**0.006**
Ploidy x Dam	0.059	0.032	**0.032**
Ploidy x Sire(Dam)	0.02	0.019	0.147
Residual	0.328	0.025	0.0001

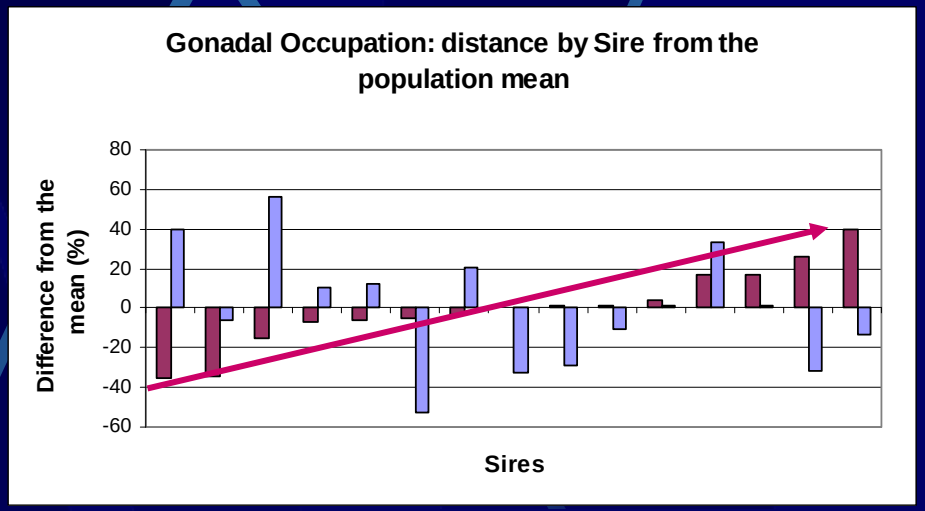
Significative interaction between ploidy group and breeder value

Analysis of genetic covariance :

is this interaction modified the rank order of the families between 2n and 3n group ?

Results: Genetic covariation of 2n and 3n values





Rank order of the families appears not to be conserved between 2n and 3n groups

2n

3n

Results: Genetic covariation of 2n and 3n values

Bivariate regression: Covariance parameter estimates and significance

Subject (group)	Cov. Par.	Estimate	Standard error	Pr (test Z)
Sire	GO 2n / GO 3n	-0,008	0,021	**0,69**
Dam	GO 2n / GO 3n	-0,009	0,014	**0,51**
Dam(Sire)	GO 2n / GO 3n	0	0,018	1

Model: GO = Ploidy

Grouped by Sire /

Grouped by Dam /

Grouped by Dam(Sire)

No genetic covariance between 2n & 3n for Gonadal Occupation

Genetic basis of reproduction in diploid and triploid Pacific oysters, *Crassostrea gigas*

- Genetic determinism on reproductive effort appears to be significative for both 2n & 3n oysters
- Ploidy induction modified the rank of breeders genetic value

…genes mainly controlling the reproductive effort for diploid are probably not the same than for triploids

Need of functional physiology studies to undestand differences between 2n and 3n