



Aqualande

## Impact of non-genetic maternal effect on juvenile growth in rainbow trout *Oncorhynchus mykiss*

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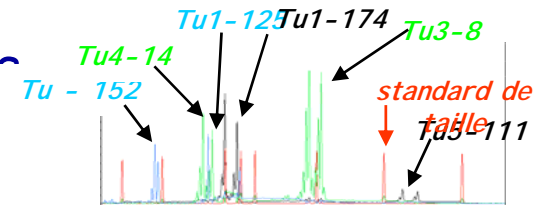
# Non-genetic maternal effect?

- All non-genetic sources of variation induced by the mother :
  - Mother age and size
  - Mother sexual maturation process
  - Mother investment in the egg production (RGS, relative fecundity)
  - Egg quality or composition
  - Number of viable progeny per mother
  - Egg size
  - Date at hatching
  - ...

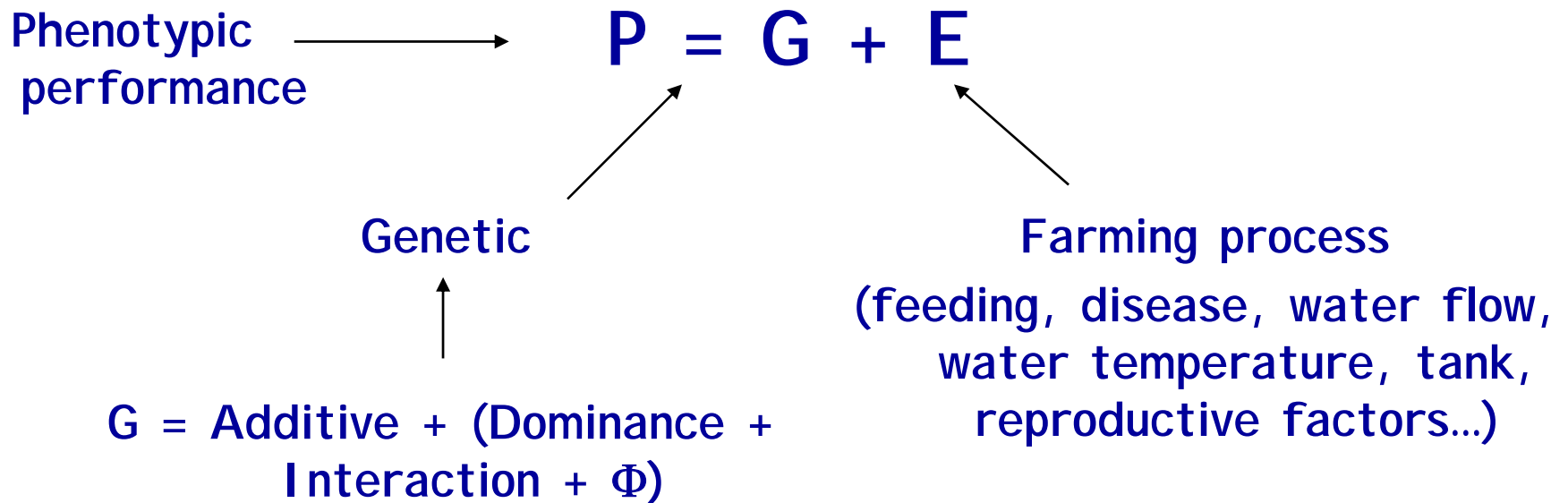


# Why to evaluate non-genetic maternal effect to optimize breeding programs ?

- Traditional selection programs  $\Rightarrow$  200-600 family units :
  - High investment and running costs
  - Significant "tank" effect including non-genetic maternal effect
- DNA fingerprint  $\rightarrow$  All family mixing in one tank
  - $\downarrow$  investment and running costs
  - $\downarrow$  "tank" effect
  - Impact of non-genetic maternal effect on the selection efficacy ?



# How non-genetic maternal effect can reduce genetic progress ?



# Selection efficacy

Heritability of the trait  
[0 to 1]

Gain per  
generation  
of selection

$$G = h^2 * i * \sigma_p$$

Phenotypic  
variation of  
the trait

Selection intensity



# Objectives of the project

- Quantify non-genetic maternal effect by the estimation of the growth heritability when rainbow trout eggs are pooled together since hatching → “NORM” group
- Evaluate the relative efficiency of an alternative strategy trying to minimize non-genetic maternal effect based on the managing of the between dams egg size difference (Chevassus et al., 2004) → “MIN” group



# Protocole

136 dams (Gonazon) \* 100 XX neomales (Storfish)

800 families  
10 factorials (8 dams \* 10 sires)

600 families  
(- 2 dams / factorial)

« MIN » group  
• 2500 eggs / dam  
• 12 tanks of 5 dams according to egg size

10 g, 250 juveniles / tank  
and pooling in 1 tank  
(3000 juveniles)

« NORM » group  
Pool of 200 eyed eggs /  
dams (12 000 eggs)

60 g :  
• Body weight + body  
length  
• DNA collection

Genotyping  
and genetic  
data  
treatment



# Data treatment : Animal model

- 1 equation / individual to solve

Performance of one individual →  $y_{ij} = \text{mean} + c_i + \text{dam} + a_{ij} + e_i$

Annotations:

- Random effect (points to  $a_{ij}$ )
- Breeding value of a candidate ( $= \frac{1}{2} Vg \text{ sire} + \frac{1}{2} Vg \text{ dam} + \text{meiosis}$ ) (points to  $a_{ij}$ )
- Known fixed effect (points to  $c_i$ )
- Unknown effect (residual variance) (points to  $e_i$ )

- Research of the maximum of likelihood using VCE software by successive iterations (REML) :

- Heritability :  $h^2$
- Genetic correlation between traits :  $r_g$
- Candidates BLUP breeding value (Best Linear Unbiased Predictor)





# DNA parentage assignment



- LABOGENA laboratory (ISO 17025)
- 12 microsatellites markers : OMM1013, OMM1050, OMM1117, OMM1313, OMM1354, OMM5013, OMM5043, OMM5098, OMM5126, omy7inra, omy77 et ots1BML
- Parentage assignment of 3020 individuals :
  - "MIN" group : n = 2020, 99,5 % assignation, 49 triploids
  - "NORM" group : n = 1000, 100 % assignation
  - 99,70 % assignation



# Reproductive dam performances



	Mean $\pm$ SD	Minimum	Maximum	n
Females (*) body weight (g)	5416.4 $\pm$ 539.2	4000	6600	60
Total egg number	7835.7 $\pm$ 970.9	6559	12106	60
Mean egg weight (g)	76.9 $\pm$ 6.9	54.1	89.2	60
Relative fecundity (egg/kg)	1458.4 $\pm$ 240.8	1132	2201	60
Gonado-somatic index (%)	11.1 $\pm$ 1.3	9.0	15.3	60
% eyed eggs	81.4 $\pm$ 10.8	47.1	94.6	60

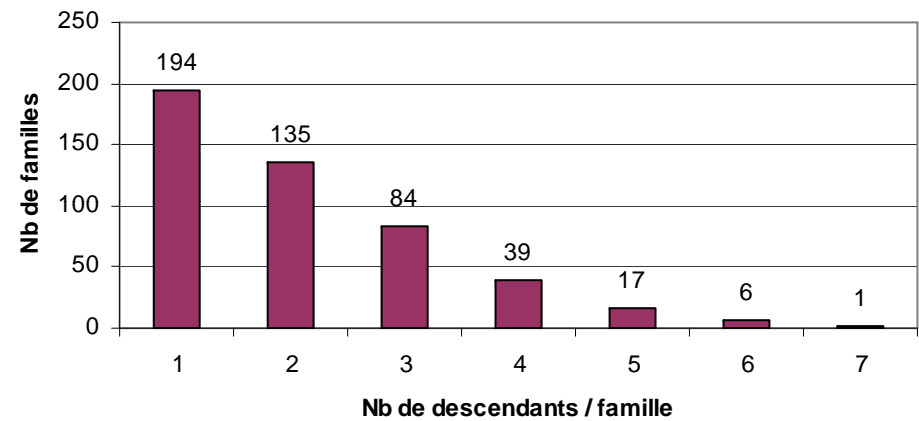
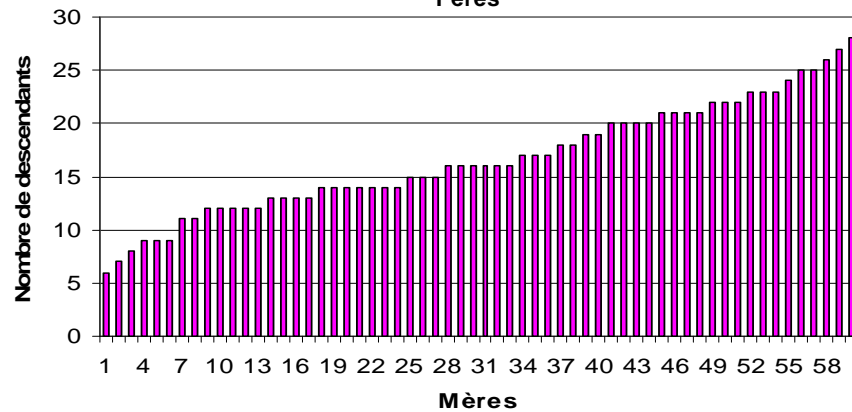
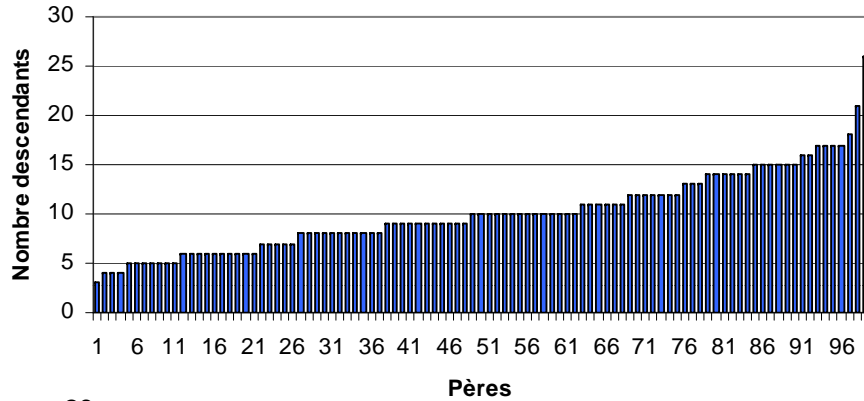
(\*) 2 years old females selected since 4 generations



# Genetic composition of the "NORM" Group



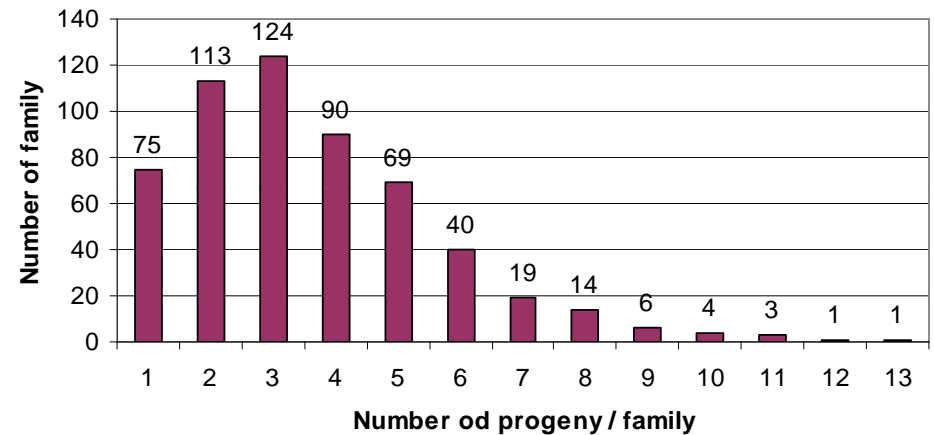
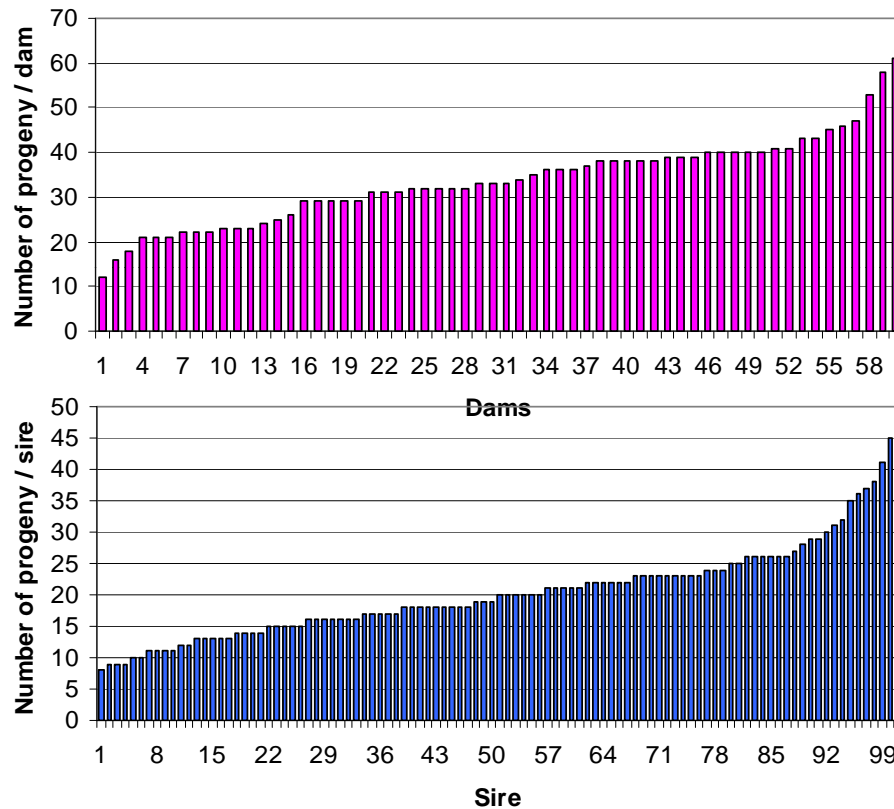
- 476 family / 600 ; 99 sires et 60 dams represented



# Genetic composition of the "MIN" Group



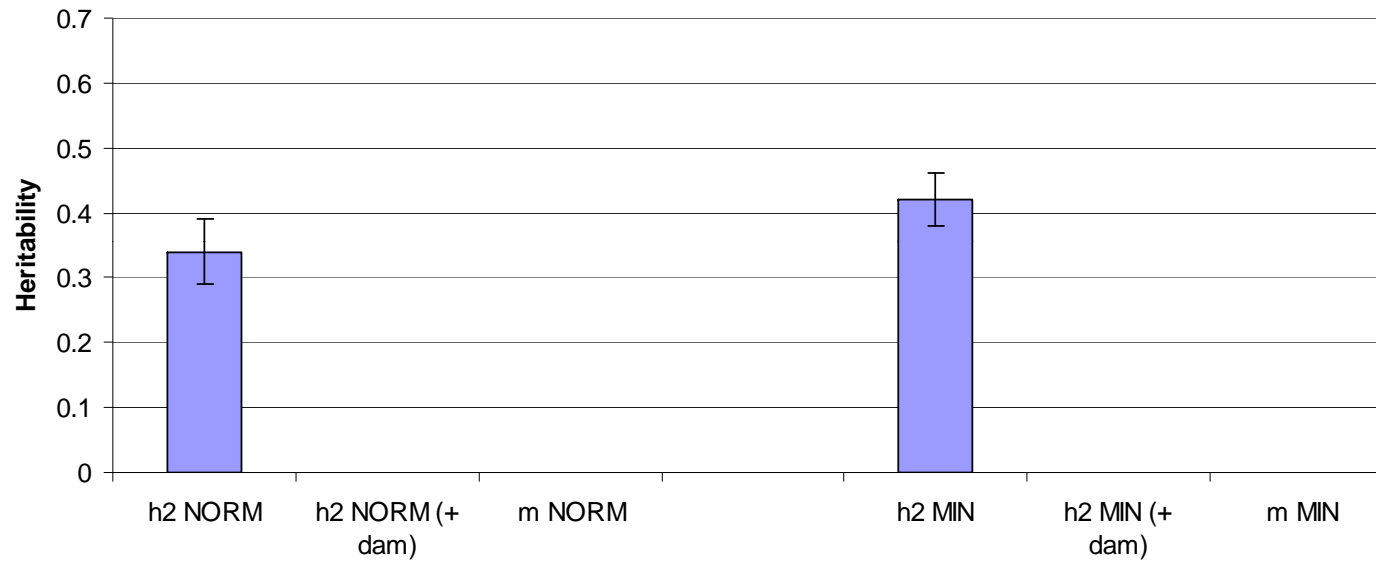
- 559 family / 600 (93,1 %) ; 100 sires ans 60 dams represented



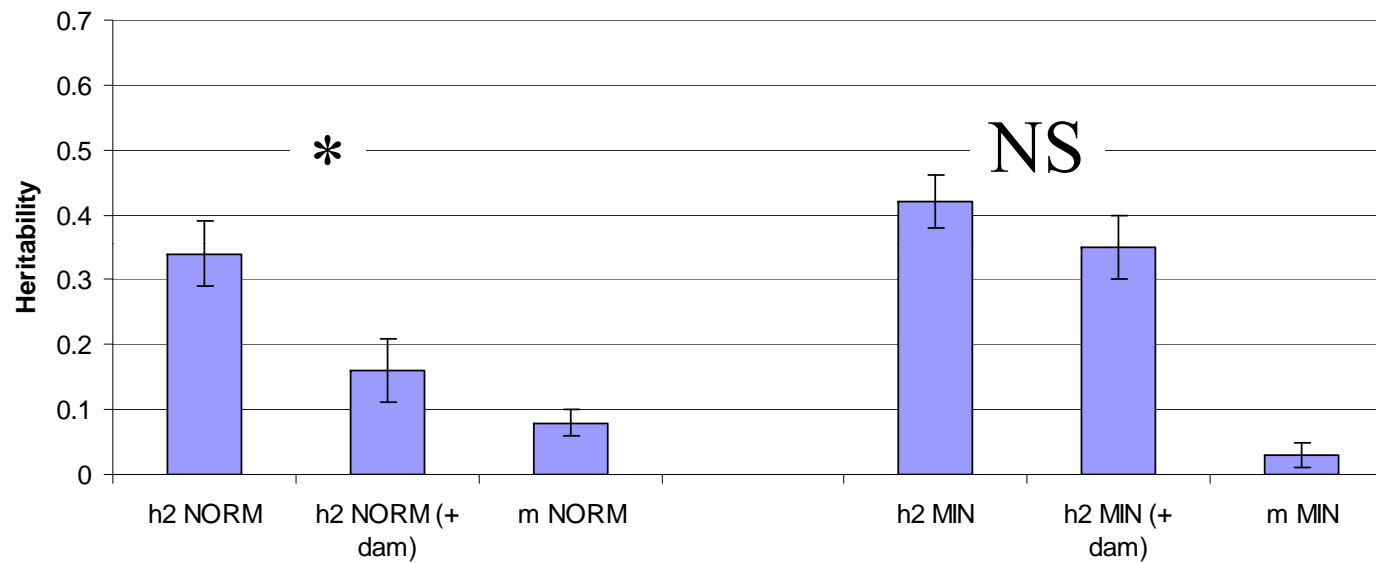
- No difference between groups
  - Sires ( $\chi^2 = 118.3$ ; 99 d.f.;  $p > 0.008$ )
  - Dams ( $\chi^2 = 74.4$ ; 59 d.F.;  $p > 0.08$ )



# Heritability of body weight



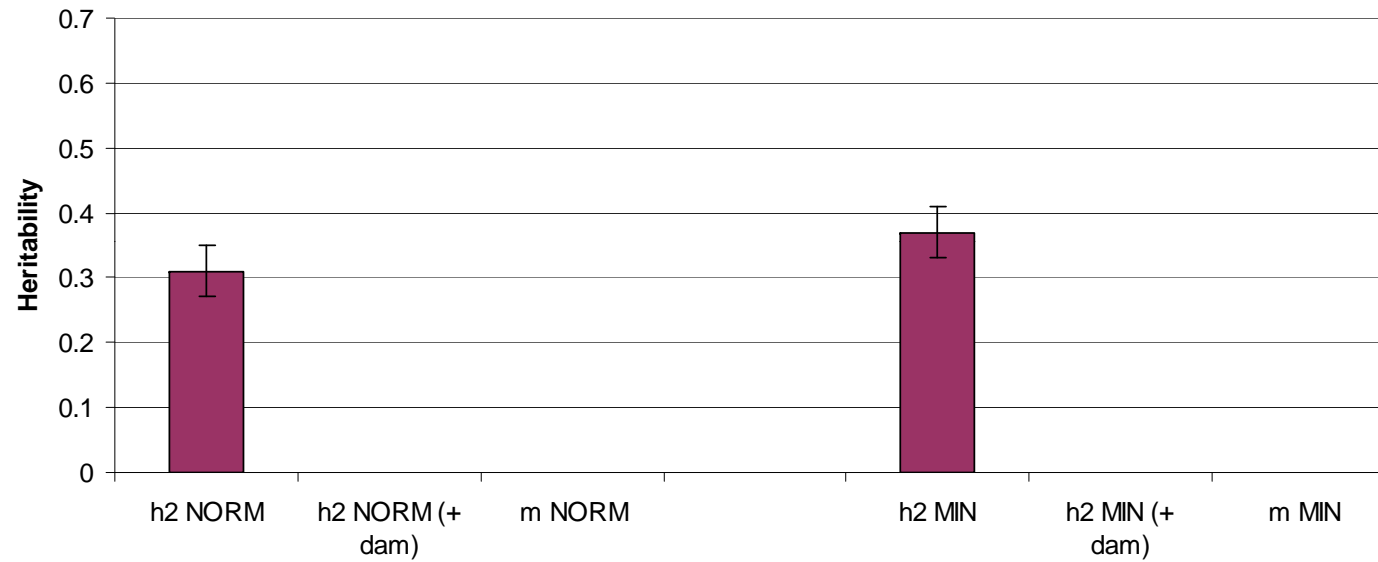
# Heritability of body weight



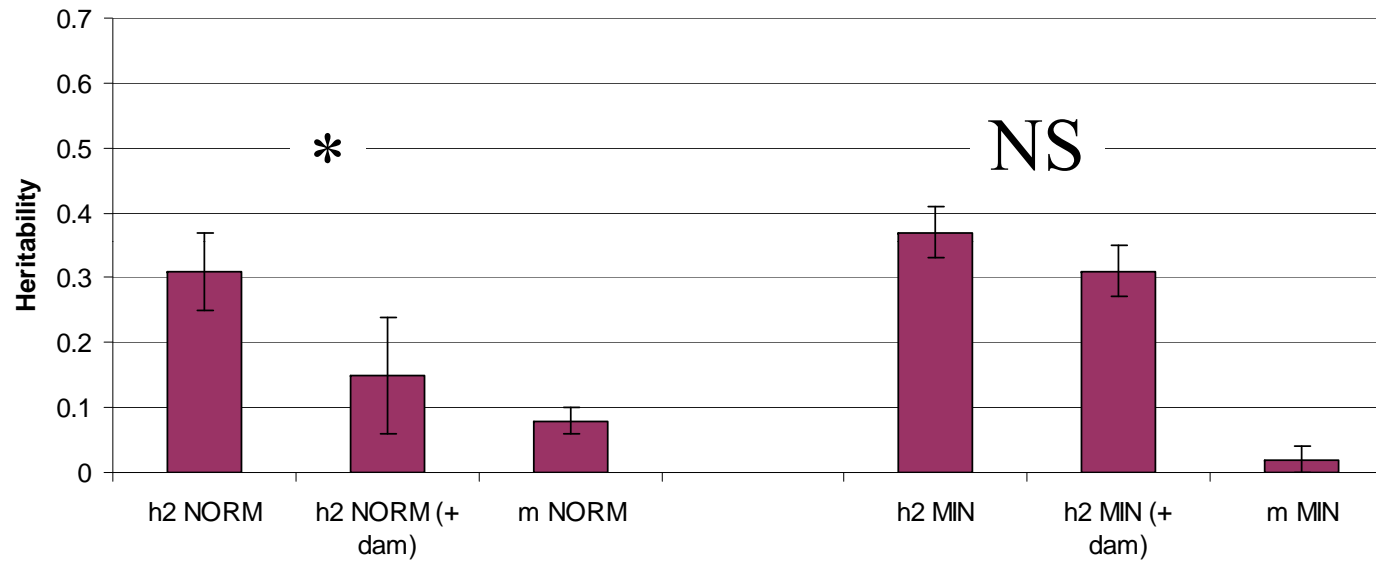
Large non-genetic maternal effect in the “NORM” group



# Heritability of body length



# Heritability of body length

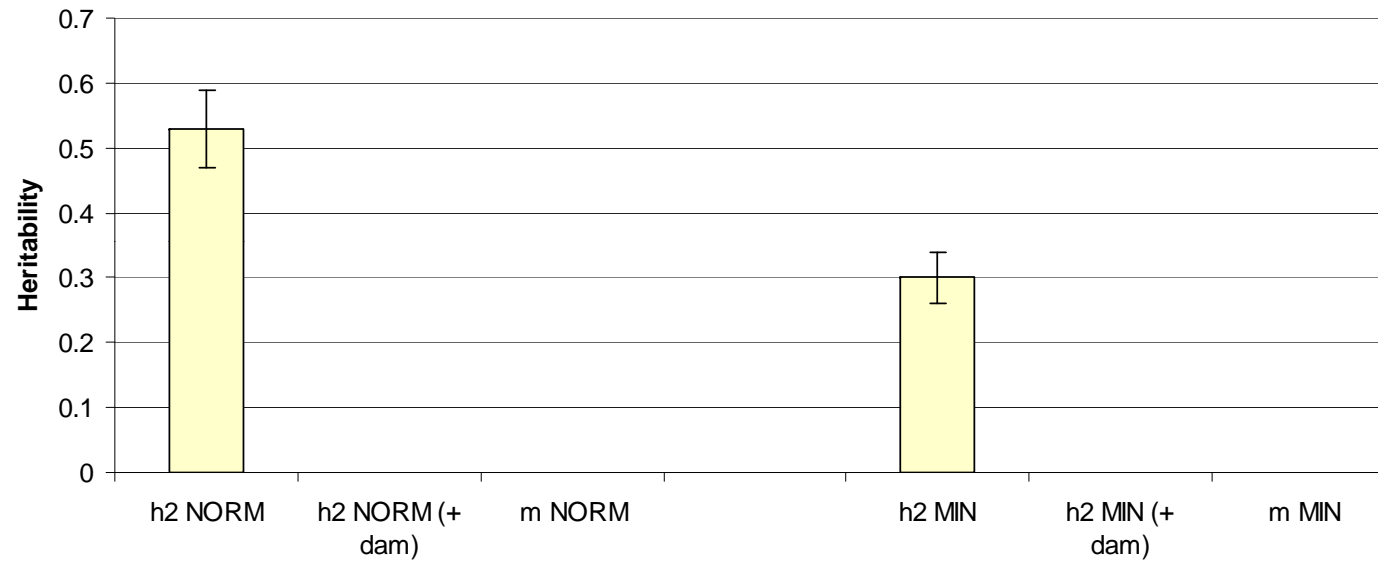


Large non-genetic maternal effect in the "NORM" group

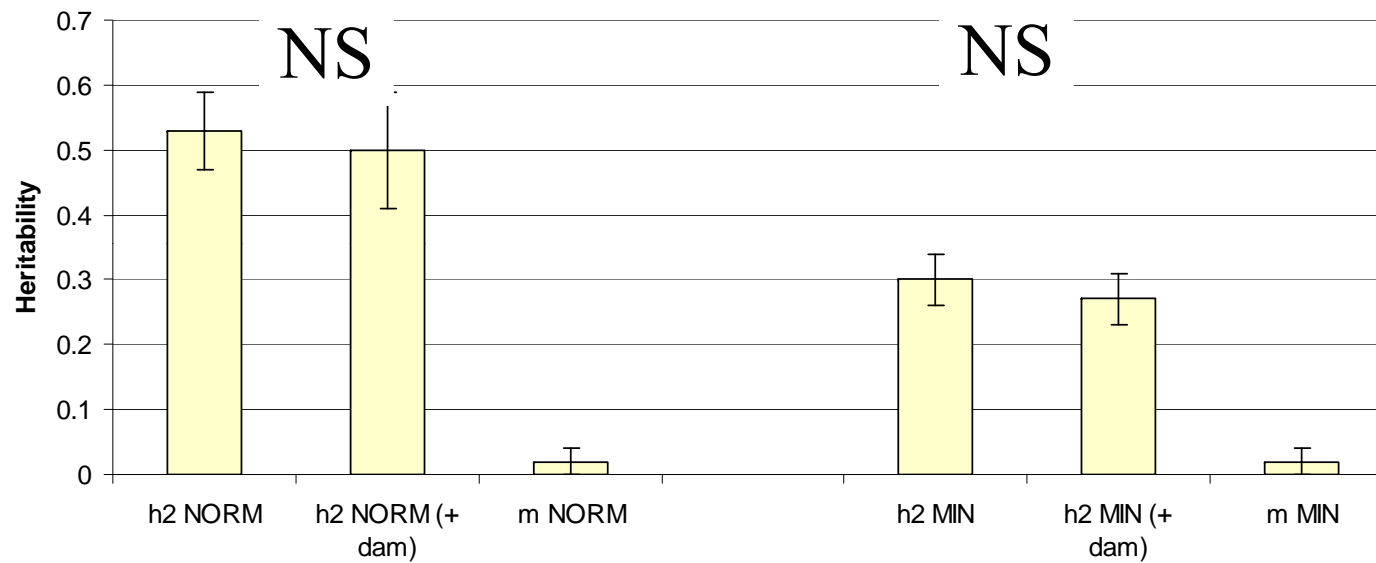




# Heritability of condition coefficient K



# Heritability of condition coefficient K



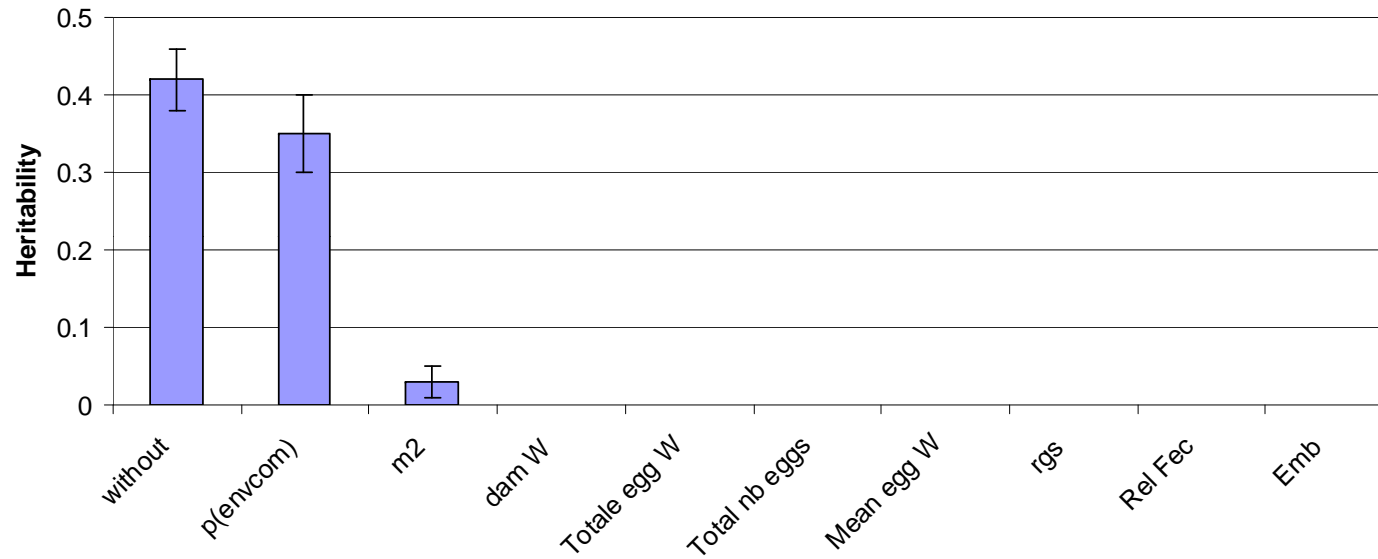
Lack of non-genetic maternal effect in both groups



# Non-genetic maternal effects ?



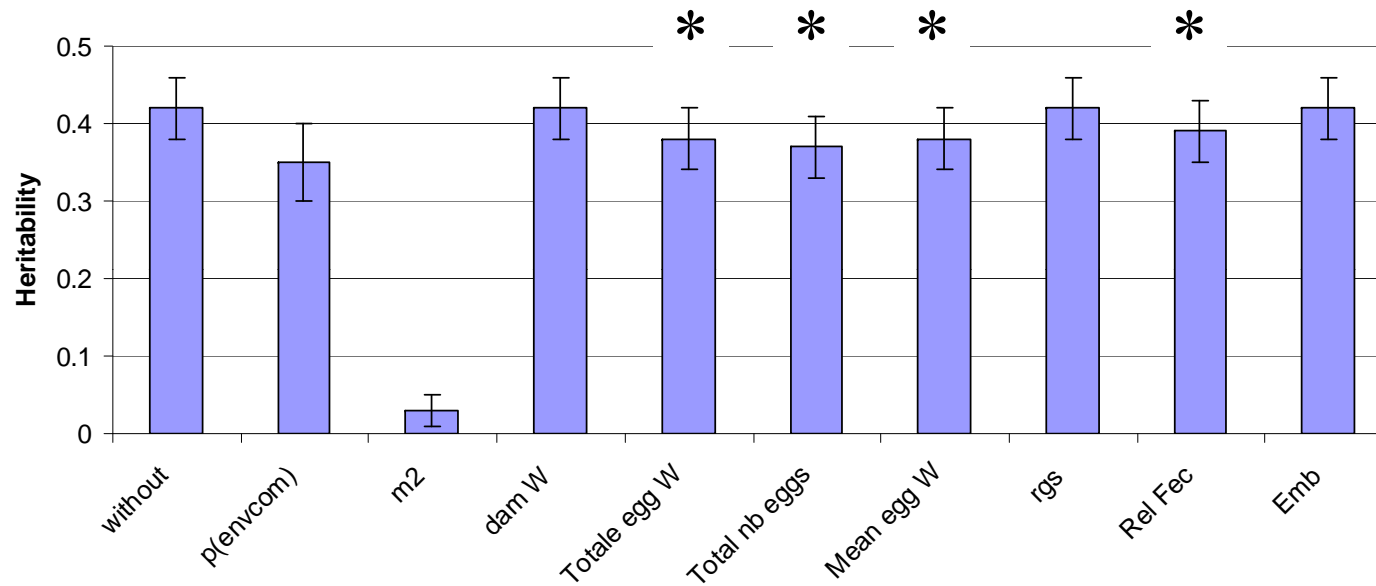
« MIN » group



# Non-genetic maternal effects ?



« MIN » group



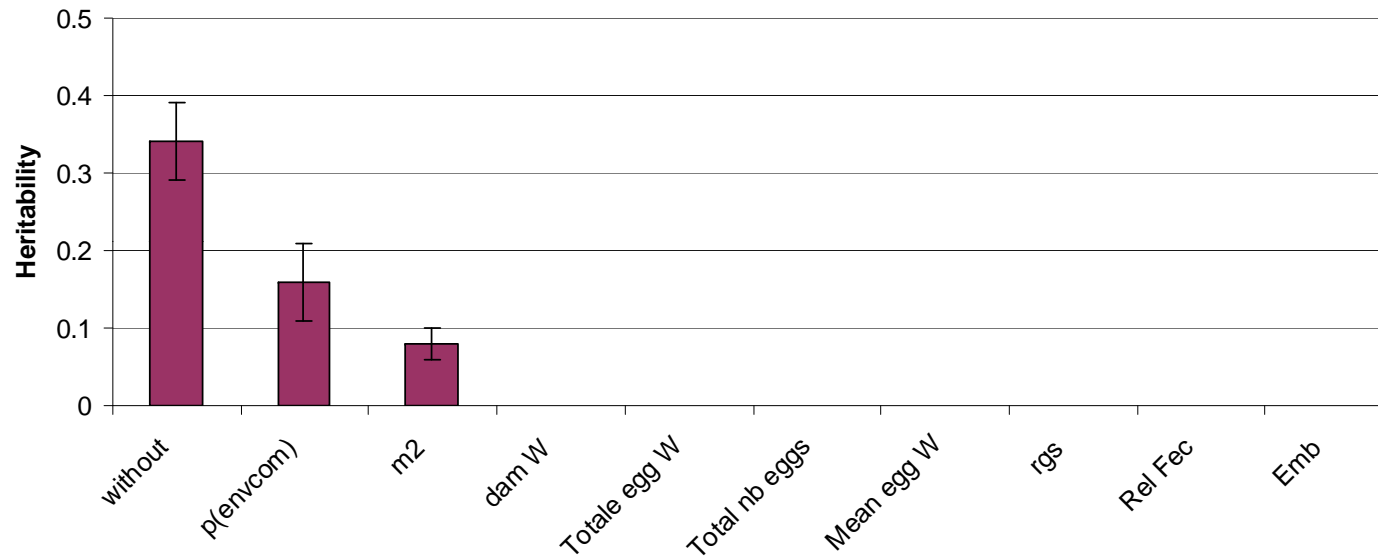
Different traits interacted but not substantially



# Non-genetic maternal effects ?



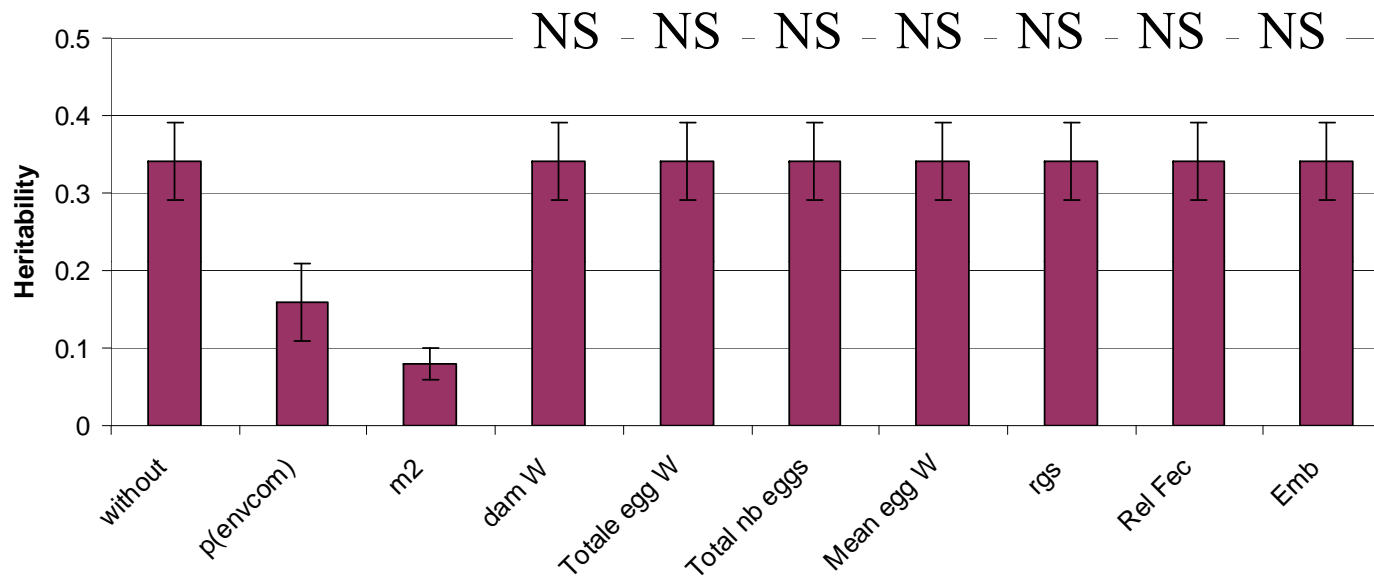
« NORM » group



# Non-genetic maternal effects ?



« NORM » group



None of the maternal effect measured interact !



# Phenotypic correlations between reproductive traits



	Dam W	Total number egg	Total egg W	Mean egg W	Rel Fec	RGS	Emb
Dam W		<i>0.09</i>	<b>0.44</b>	<i>0.10</i>	<b>- 0.70</b>	<i>- 0.22</i>	<i>- 0.14</i>
Total number egg			<b>- 0.28</b>	<b>- 0.90</b>	<b>0.77</b>	<i>- 0.23</i>	<i>- 0.16</i>
Total egg W				<b>0.38</b>	<b>- 0.47</b>	<b>0.77</b>	<i>- 0.13</i>
Mean egg W					<b>- 0.71</b>	<b>0.33</b>	<i>0.04</i>
Rel Fec						<i>- 0.01</i>	<i>- 0.03</i>
RGS							<i>- 0.03</i>

Different correlations between mother reproductive phenotypic traits



# Genetic correlation within groups

## « NORM » group

	P	L	K
P	$0.16 \pm 0.04$	0.9	$0.50 \pm 0.12$
L	0.95	$0.14 \pm 0.04$	$0.18 \pm 0.13$
K	0.48	0.25	$0.53 \pm 0.06$

## « MIN » group

	P	L	K
P	$0.42 \pm 0.04$	$0.96 \pm 0.01$	$0.50 \pm 0.06$
L	0.95	$0.37 \pm 0.04$	$0.26 \pm 0.08$
K	0.48	0.25	$0.30 \pm 0.04$

- High genetic correlation between weight and length
- Positive correlation between weight and K
- Lower correlation between length and K





# Conclusions....



- 99.7 % of parentage assignment with 100 sires and 60 dams
- Spontaneous production of triploids (< 1 %)
- 93,7 % of the family  $\Leftrightarrow$  Interest of factorial mating design
- Same value of heritability with « NORM » selection ( $h^2 = 0.16$ ) than with family selection in tanks (Pante et al., 1998)
- Doubling of genetic gain ( $h^2 = 0.42$  vs 0.16) when proper management of non-genetic maternal effect !
- What is non-genetic maternal effect in "NORM" group (Herbinger et al., 1998) ?
- $h^2$  for other traits (flesh quality, processing traits) ?





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Thank you for your attention

