Effect of sex ratio and density mating on reproductive performances in *Tenebrio molitor*

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Context

New challenges for the world

- Need to minimize impact on natural resources
- Consuming insects: a promising alternative

Context

- Need to improve protein production in farm
- Female reproduction performance may be improved:

Physiology

Rearing techniques

Genetics

What is the effect of a sex ratio deviation and breeders' density on the female reproductive performance?

Materials and Methods

Experimental plan

Binocular loupe

Sexing

Adults pairing

1 – 6 Females

1 – 6 Males

Egg number

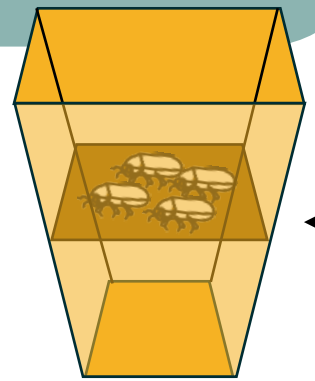
J+7 11 14 18 21

Measured phenotype :

Total eggs per female

Total eggs per individual

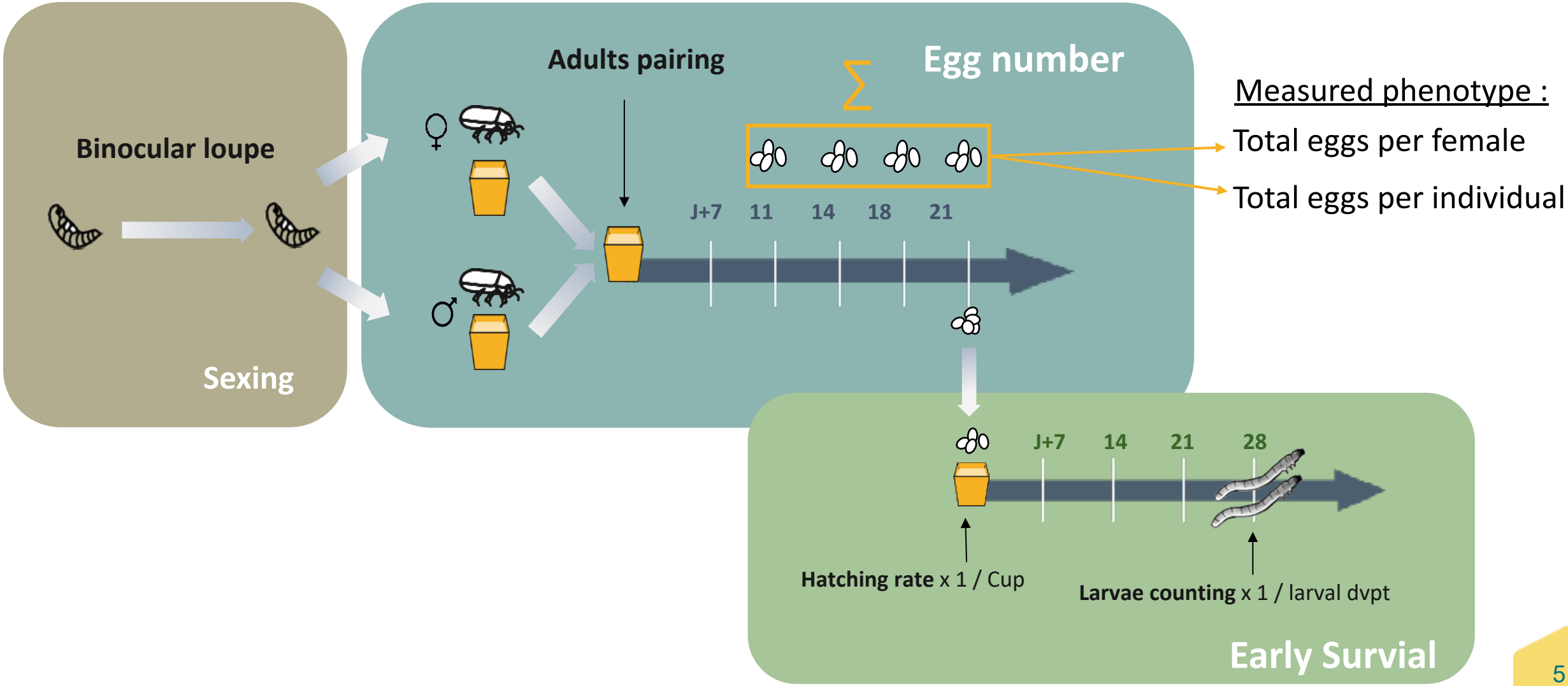
36 conditions
(3 replicates per condition)



Grid

Materials and Methods

Experimental plan



Statistical model

1. **Egg number** per individual or per female

2. **Early survival**

$$y_i = \mu + \alpha x_i + \beta z_i + e_i$$

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Fixed effect of sex ratio

Sex ratio = ♂ / ♀

R software 4.0.3

Statistical model

1. **Egg number** per individual or per female

2. **Early survival**

$$y_i = \mu + \alpha x_i + \beta z_i + e_i$$

Fixed effect of individual number (1) or egg number (2)

Fixed effect of sex ratio

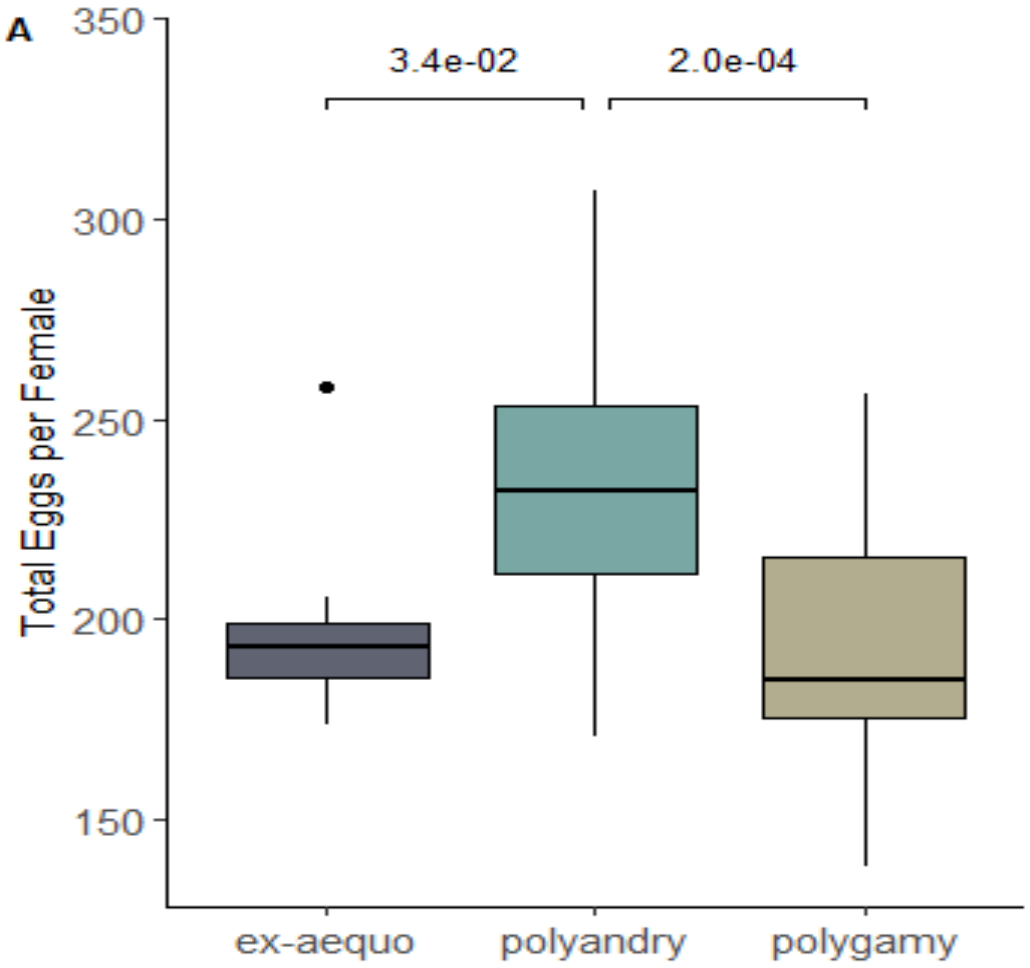
Residuals

Sex ratio = ♂ / ♀

R software 4.0.3

Results

Egg number per female



Trait	Term	Estimate	Prob > |t|
Egg number per female	Intercept	209.542 ± 13.845	***
	Sex-ratio	14.725 ± 3.642	***
	Individual number	-2.720 ± 1.529	NS

Polyandry ♀ < ♂

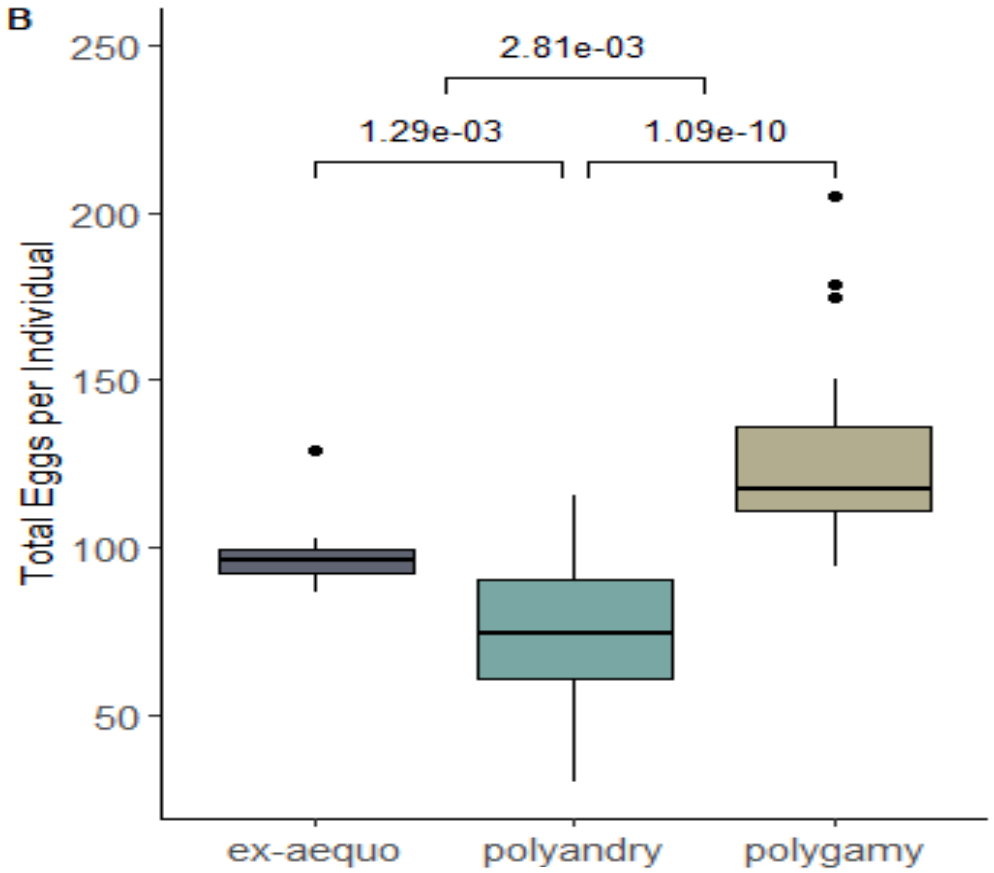
- Significant positive effect of sex ratio
- No adults density effect

What about the egg number per individual ?

Worden & Parker, 2001; Slatyer et al., 2012; Colares et al., 2015; Carrillo et al., 2012; Kong et al., 2021

Results

Egg number per individual



Trait	Term	Estimate	Prob > |t|
Egg number per individual	Intercept	129.547 ± 4.460	***
	Sex-ratio	-21.329 ± 2.306	***

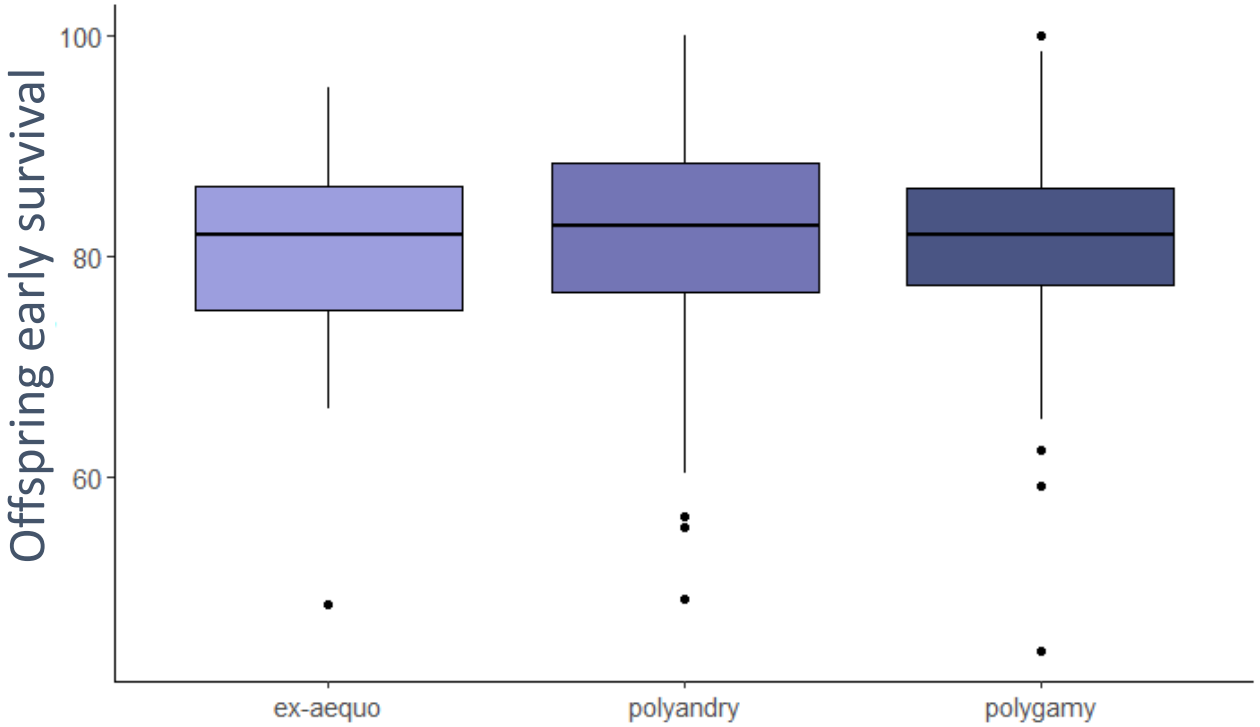
Polygamy ♀ > ♂

- Significant negative effect of sex ratio
- No adults density effect

Sex ratio, influenced the offspring early survival ?

Results

Early survival : Hatching + survival



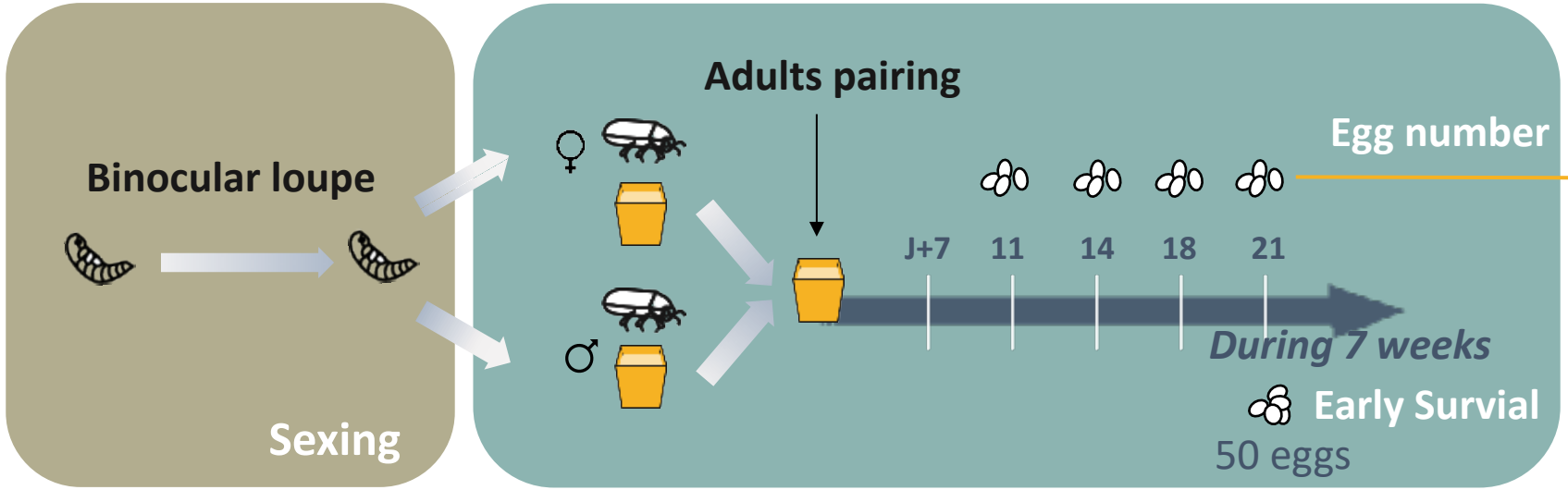
Trait	Term	Estimate	Prob > |t|
Early survival	Intercept	87.37275 ± 3.25041	***
	Sex-ratio	0.21721 ± 0.95178	NS
	Egg number	-0.04140 ± 0.01504	**

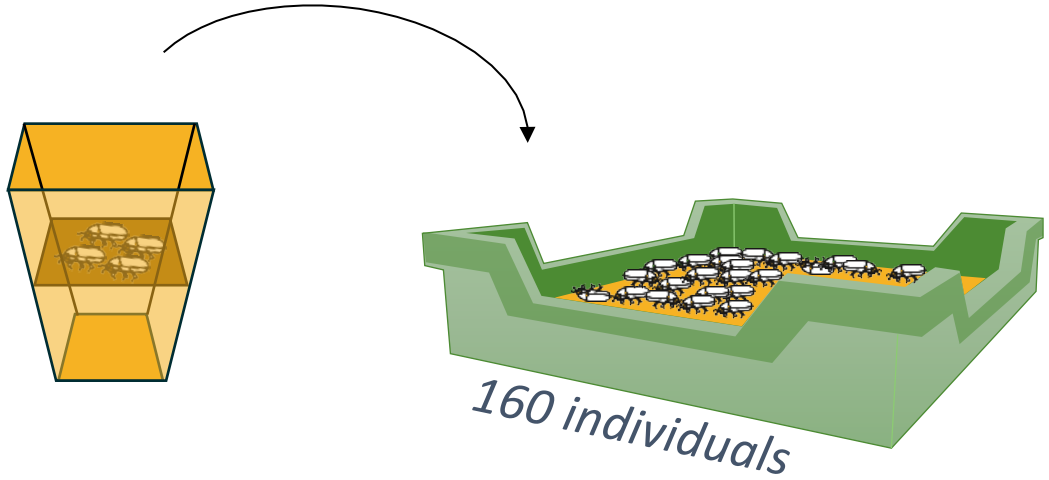
- No sex ratio effect
- Low but significant effect of initial egg number

Soffan et al., 2012; Bayoumy & Michaud, 2014; Tregenza & Wedell, 1998; Slatyer et al., 2012; Carrillo et al., 2012; Fedorka & Mousseau, 2002; Ivy & Sakaluk, 2005; Liu et al., 2010 ; Caesar & Forsman, 2009

Materials and Methods

And in a larger scale ?





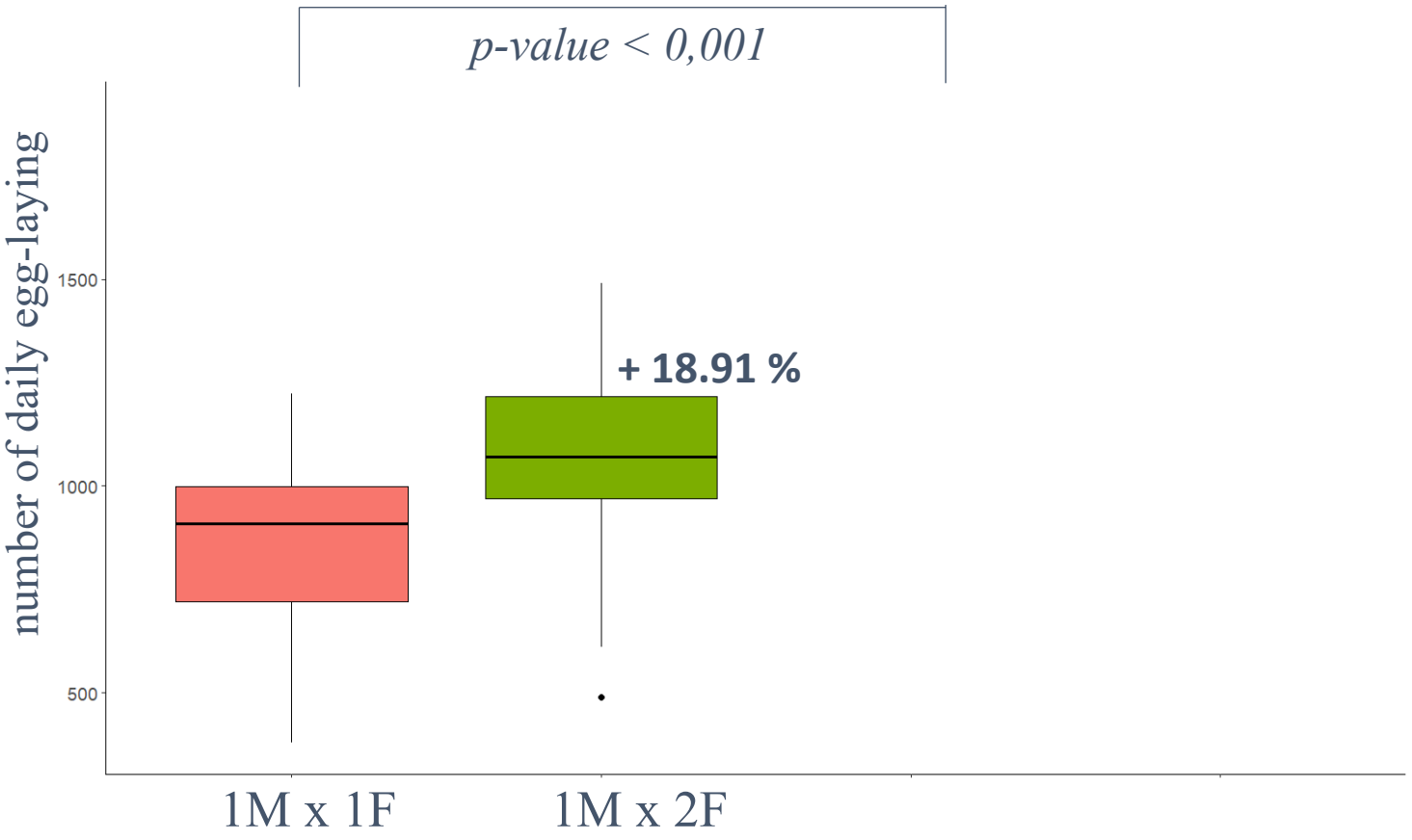
4 sex ratio were tested :

- 1 Male x 1 Female
- 1 Male x 2 Females *(+33% of females)*
- 1 Male x 3 Females *(+50% of females)*
- 1 Male x 4 Females *(+60% of females)*

And in a larger scale ?

Results based on 7 weeks of laying

Sex-ratio deviation effect on daily egg-laying



And in a larger scale ?

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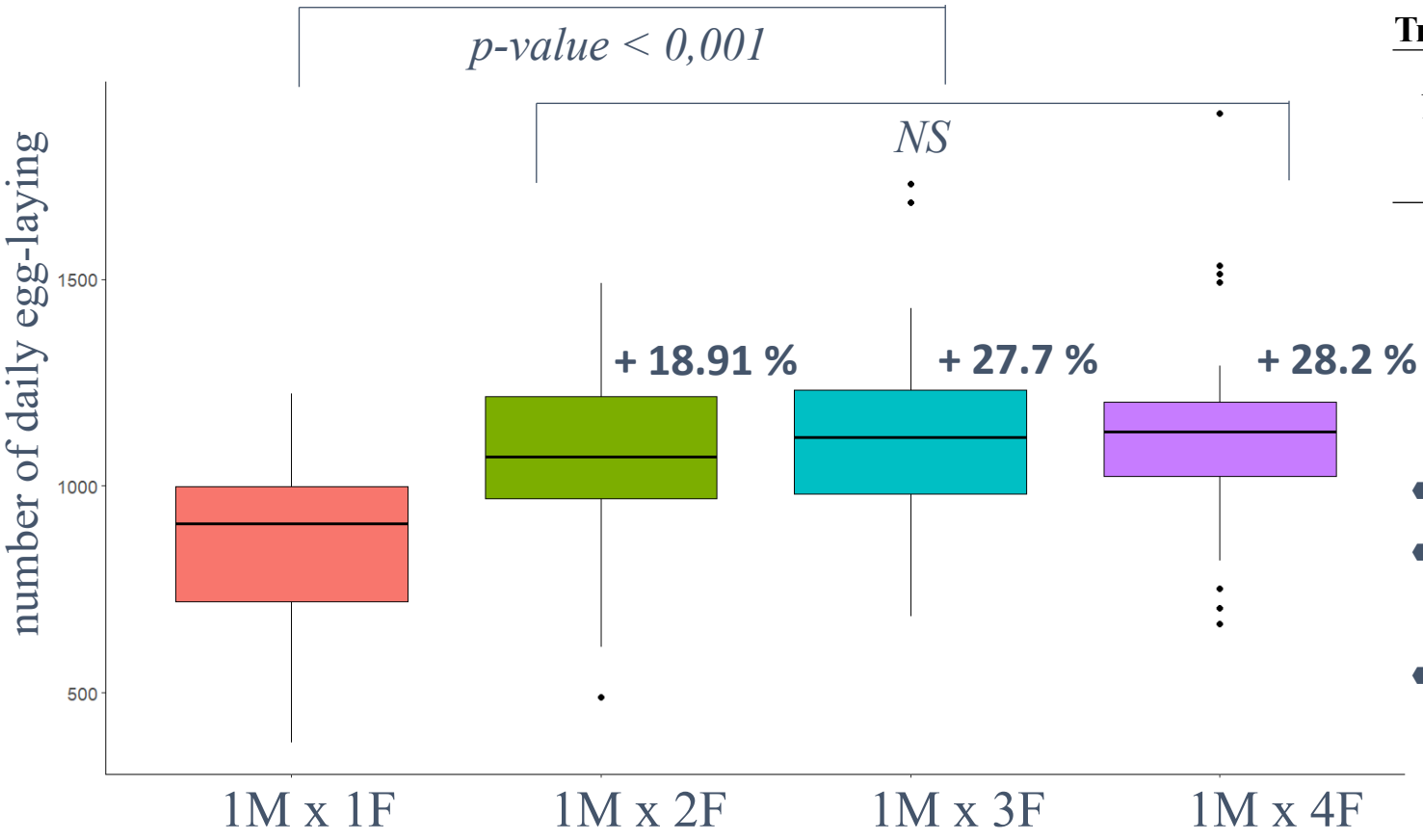
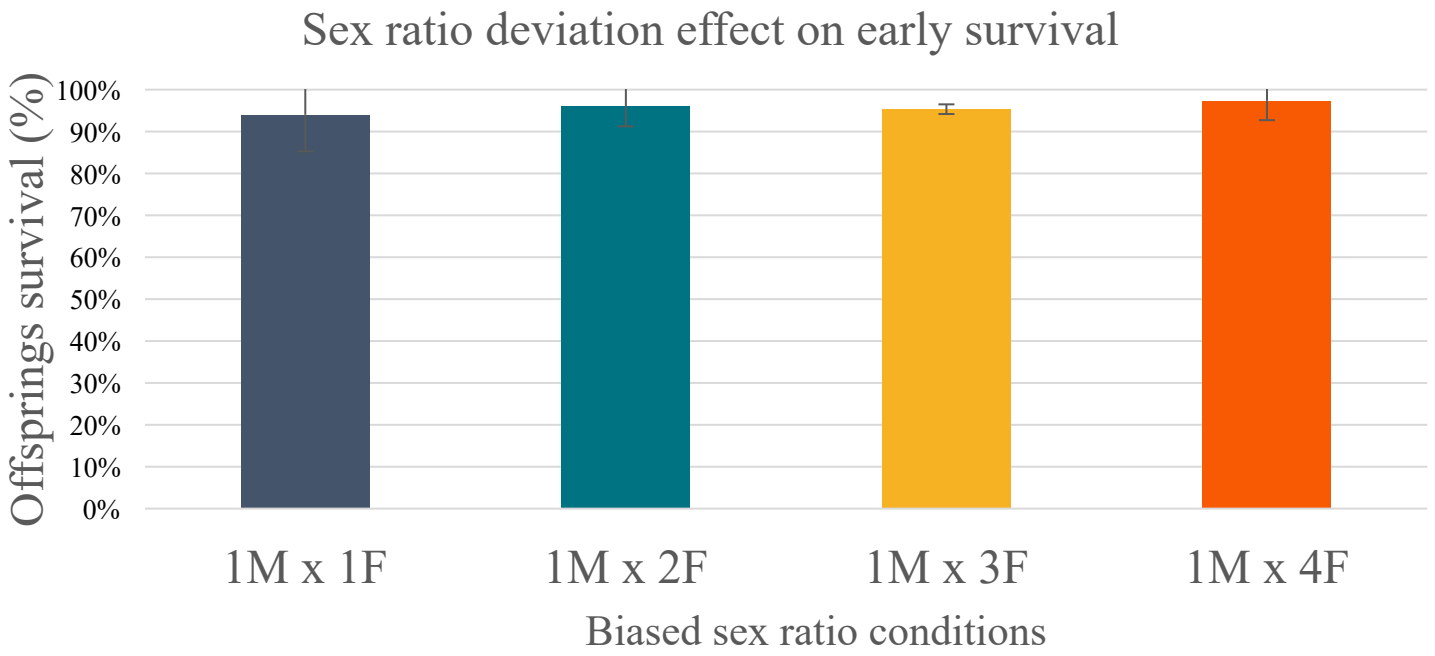


Trait	Term	Estimate	Prob > |t|
Number of daily egg-laying	Intercept	1248.71 ± 74.33	***
	Sex-ratio	-368.59 ± 79.83	***
	Replicates	-2.31 ± 28.03	NS

- No replicates effect
- **Polygamy condition increases** the number of daily egg-laying
- No significant differences between the three polygamy conditions

Results

And in a larger scale ?



Trait	Term	Estimate	Prob > |t|
Early survival	Intercept	1.03 ± 0.04	***
	Sex-ratio	-0.03 ± 0.04	*NS*
	Replicates	-0.03 ± 0.02	*NS*

- No effect of sex ratio on early survival

Conclusion

- **Polyandry** leads to an **increase in the individual female reproductive performance**.
- However, regarding the egg number for a constant size of breeding stock (*i.e., individual number*), the **polygamy condition is advantageous**.
- Whatever the biased sex ratio used (polyandry or polygamy), **no effect of sex ratio was observed on egg quality (hatching rate and early offspring survival)**.
- **Next step:** Experimentation in an industrial scale (~10,000 individuals)

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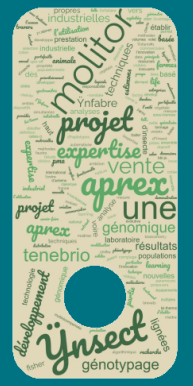
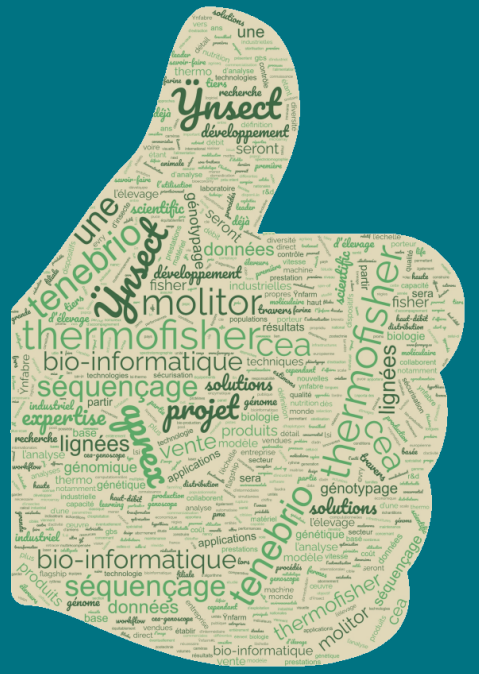
Thank you!







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