Links between gills genes expressions during moderate heat stress and resistance to acute hyperthermia using rainbow trout isogenic lines

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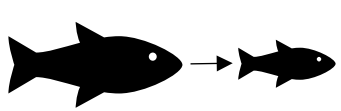
Introduction (1/2)

✓ Heat-waves : induce hyperthermia conditions in aquatic environment.

✓ Rainbow-trout : fish species sensitive to water quality.



Growth losses

pathogens sensitivity

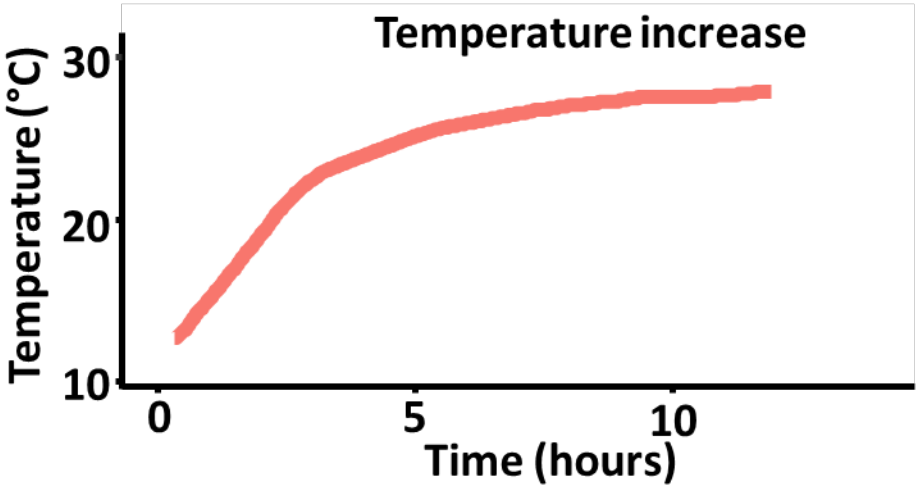
Increased mortality

✓ Limited technical solution for cooling raceways and cages

Introduction (2/2)

✓ A possible solution : selective breeding for acute hyperthermia resistance (Lagarde et al. 2023).

✓ Acute hyperthermia resistance phenotyping method :



Acute hyperthermia resistance : Degree-minutes between beginning of challenge and loss of equilibrium

✓ Severe procedure according to animal ethics committees

→1. Could gene expressions during moderate hyperthermia be used as less acute proxy to acute hyperthermia resistance?

✓ No consensus on physiological mechanisms : O2 limitation, protein denaturation, mitochondrial disfunction, … (Ern et al. 2023)

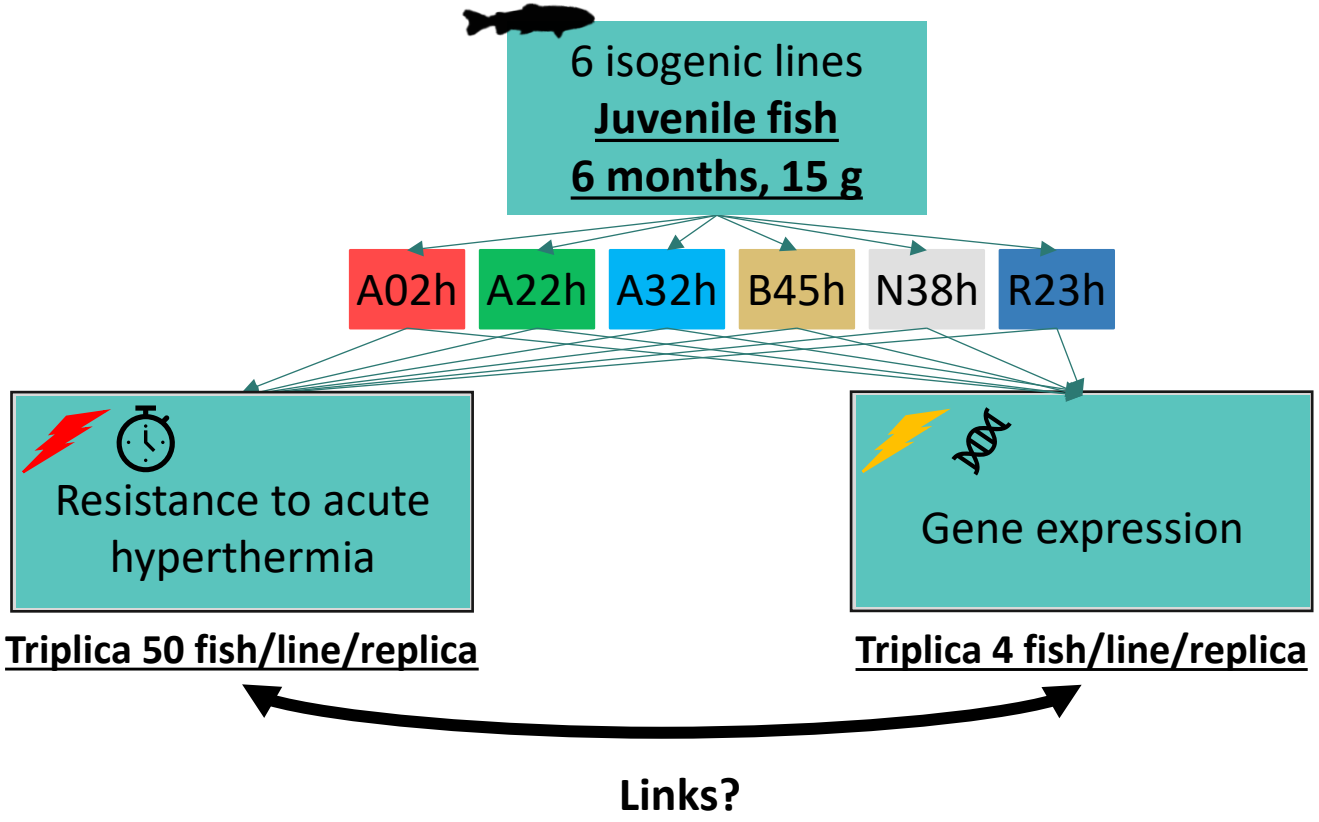
→2. Which physiological mechanisms are involved in acute hyperthermia resistance ?

Materials and Methods

Rainbow trout isogenic lines :

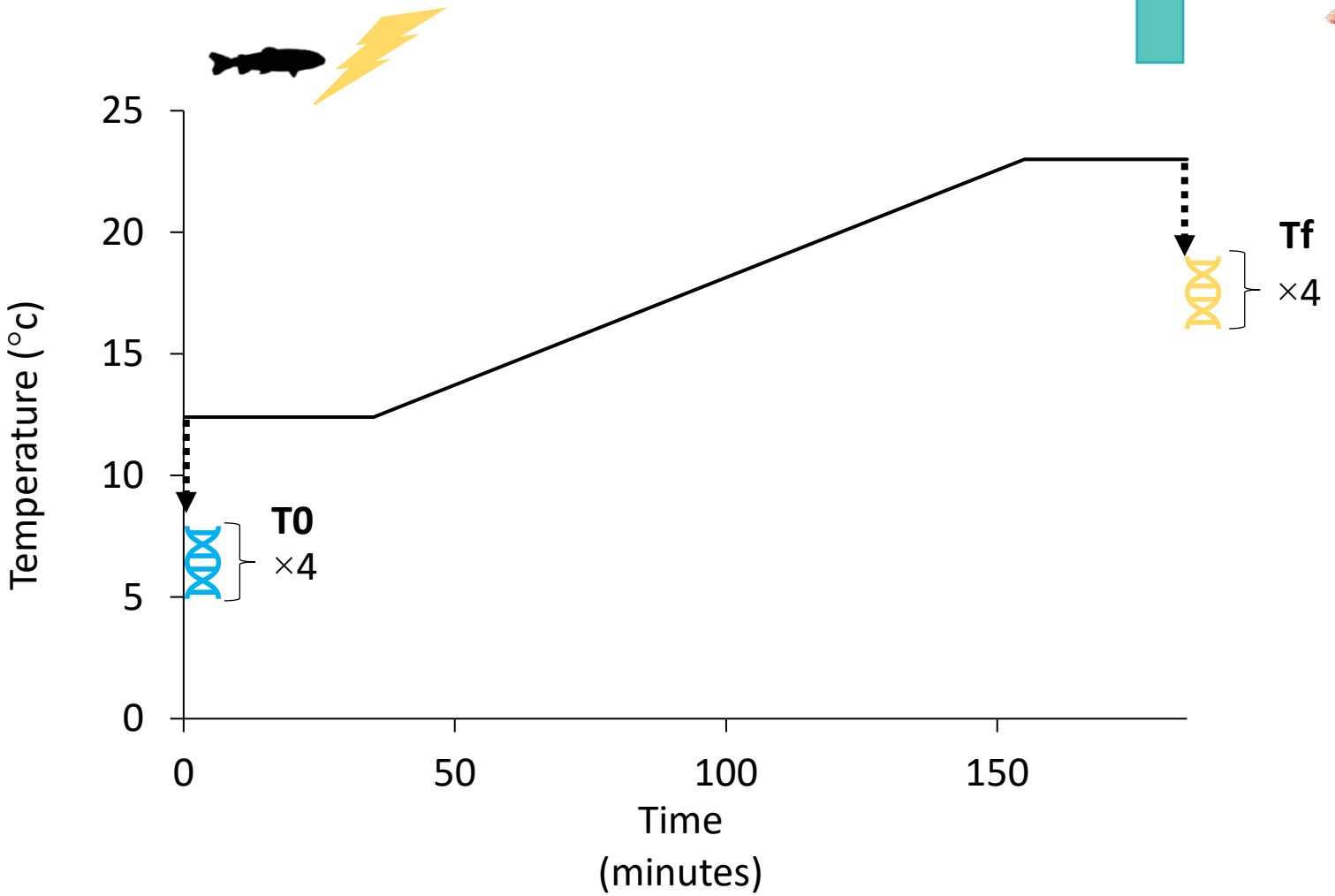
Fish of an isogenic line are genetically identical

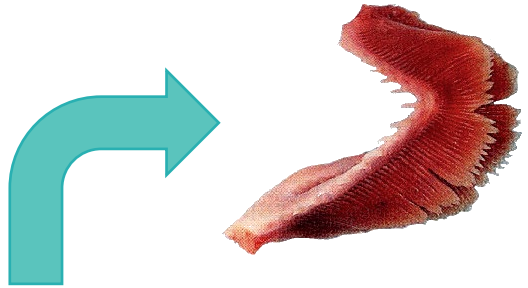
Isogenic lines can be replicated to the infinite

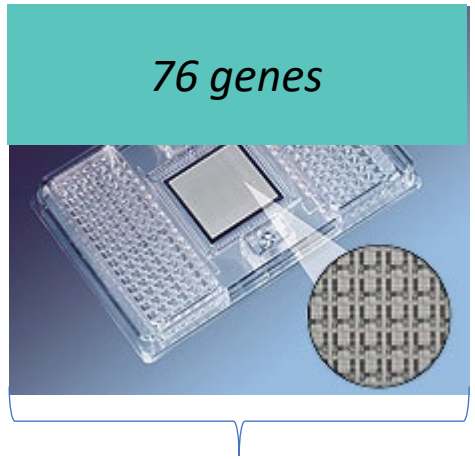


Materials and Methods

<u>Moderate</u> : lower exposition time, lower maximum temperature







4 genes found in GWAS (Lagarde et al. 2023)

dnajc7 *hsp70b* *phb* *cygb1*

→ Expression in T0
→ Differential expression T0/Tf

Materials and Methods

Mixed linear model :

$$y_{ijk} = \mu + (\beta + \vartheta_i)\, p_{ijk} + l_i + u_j + \varepsilon_{ijk}$$

Gene expression

Correction for body weight differences

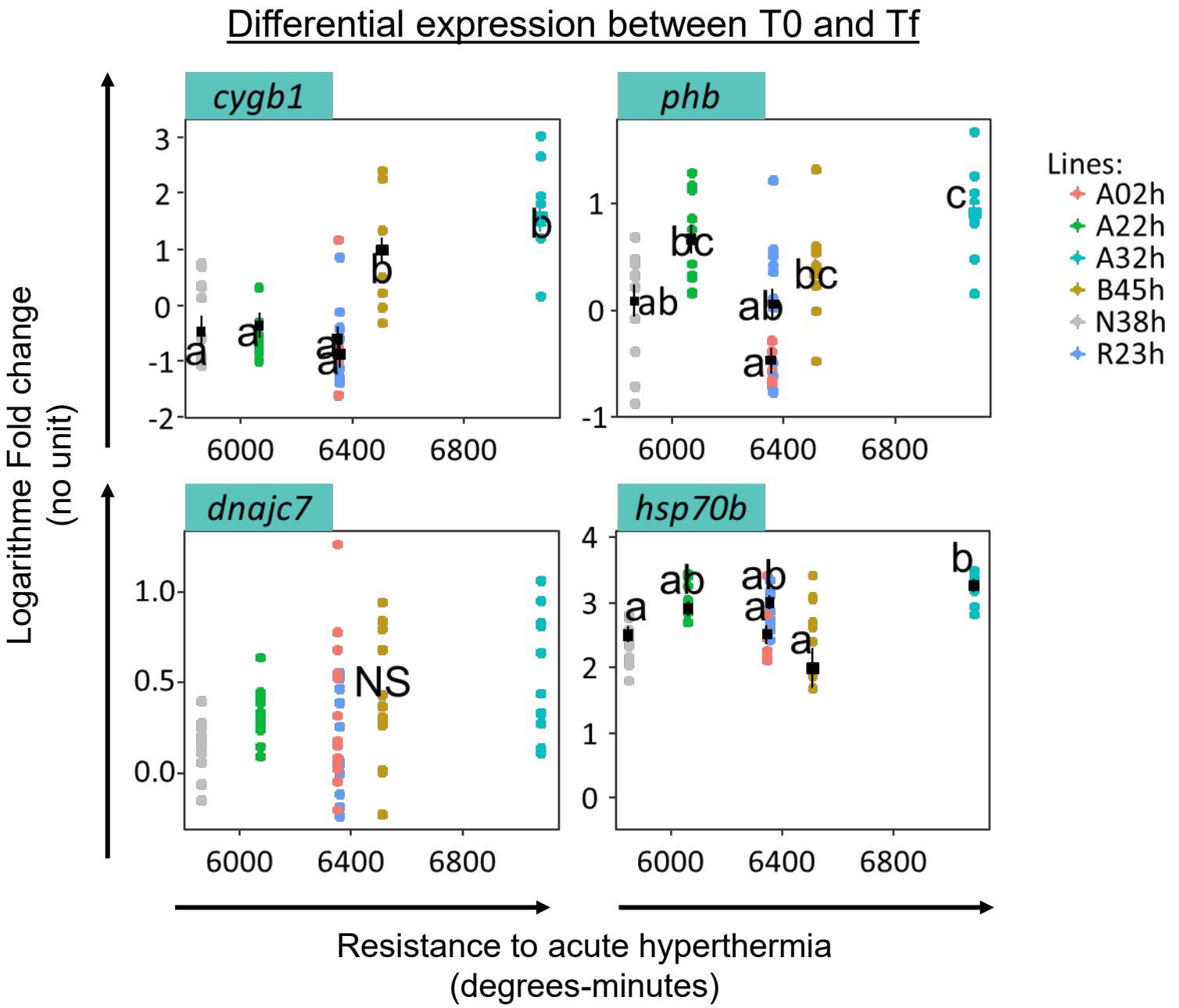
Isogenic lines

replica

$$y_{ijk} = \mu + (\beta + \vartheta_i)\, p_{ijk} + l_i + u_j + \varepsilon_{ijk}$$

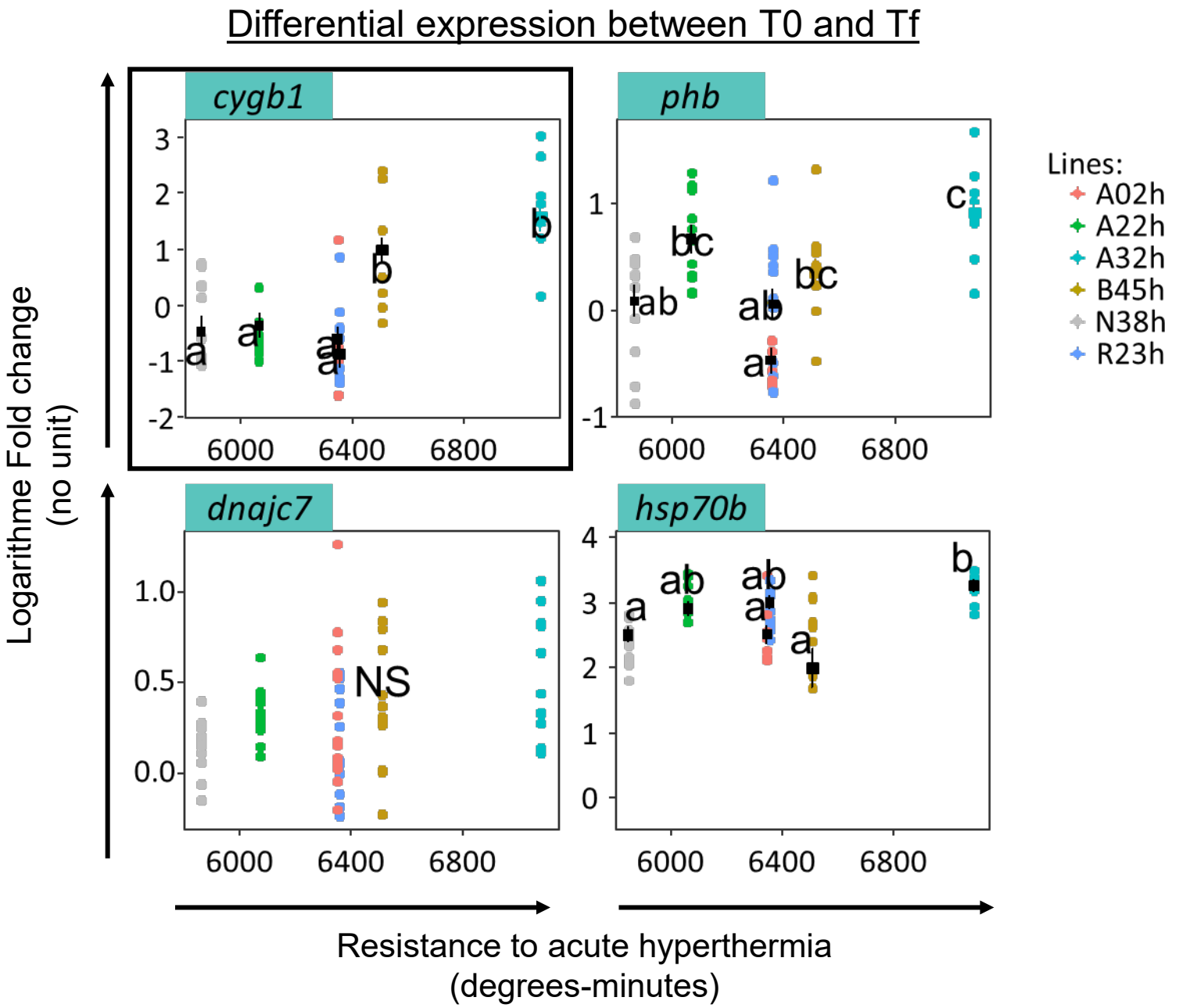
Acute hyperthermia resistance phenotype

Results and discussion



- No differences in genes expressions between lines in T0 (not shown)

Results and discussion



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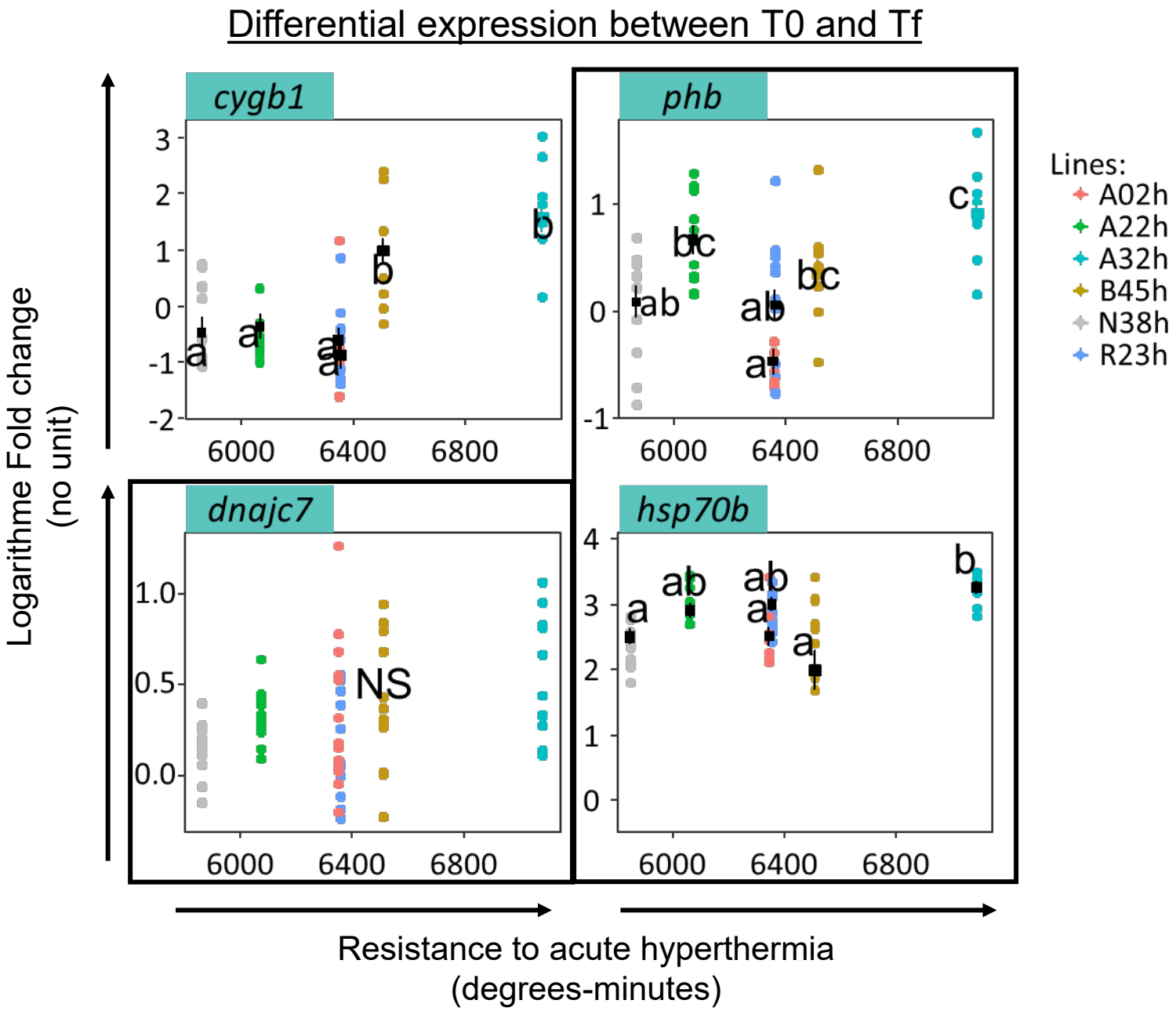
- Seems to confirm importance of cygb1 (involved in O2 transportation)

Results and discussion



- No differences in genes expressions between lines in T0 (not shown)
- Seems to confirm importance of cygb1 (involved in O2 transportation)
- No confirmation for dnajc7, phb, hsp70b

Conclusion

Main limit of the study : 6 isogenic lines → Risk of spurious correlations, need to confirm on more genotypes

Promising to find low-stress biomarkers of resistance to acute hyperthermia → More research is needed

Consistent with the theory that oxygen may be the limiting factor in certain hyperthermic stresses. → require functional validation

Data not shown : resistant lines underexpressed genes associated with homornal regulation of the stress response (*glucocorticoid receptors 1, glucocorticoid receptors 2)* → Sensitive lines are stressed earlier by hyperthermia than resistant lines (to be confirmed)

Thank you !

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