The impact of hydrological events on morphology of brown trout juvenile

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Director - **Matthias VIGNON** UPPA

- **Aitor LARRAÑAGA** UPV

Climate change & hydrological events

Change in global hydrology and precipitation

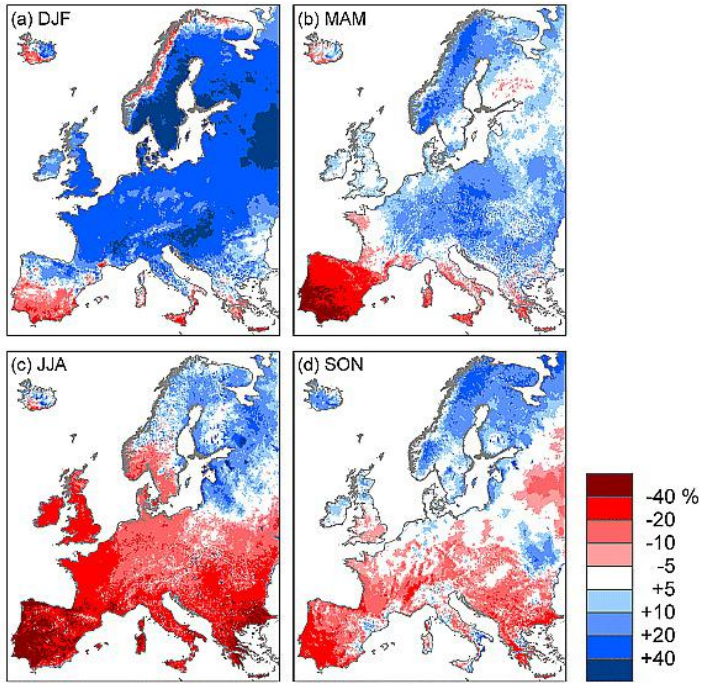


FIGURE : Change in average seasonal precipitation predicted under global climate change scenario **: (a) winter, (b) spring, (c) summer, and (d) autumn**. *(Dankers & Feyen, 2008)*

Climate change & hydrological events

Change in global hydrology and precipitation = Frequency and intensity of hydrological events (Blöschl *et al.* 2015)

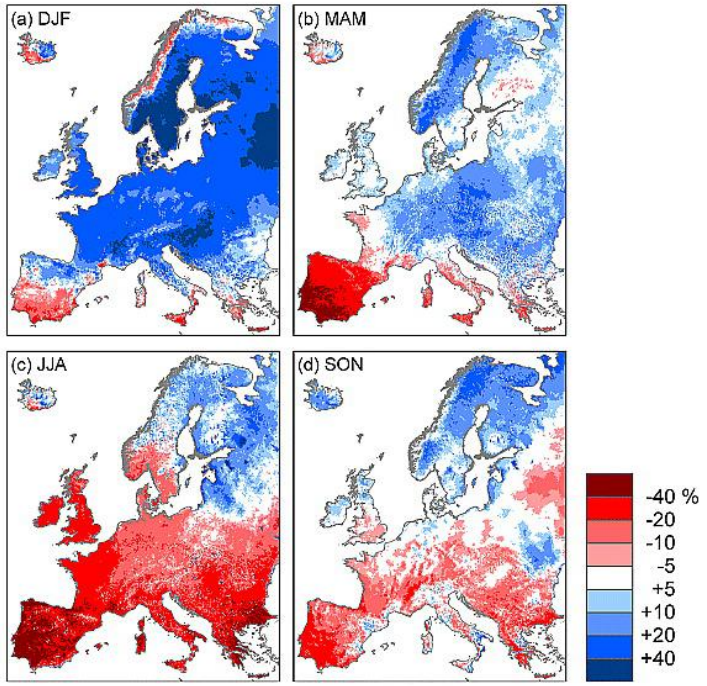
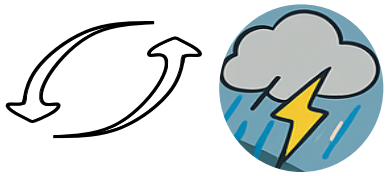


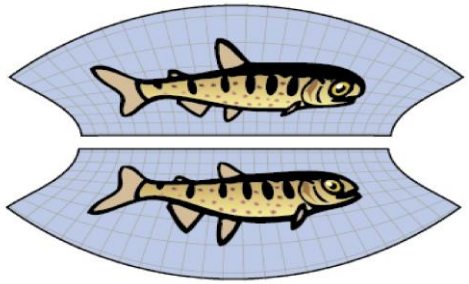
FIGURE : Change in average seasonal precipitation predicted under global climate change scenario **: (a) winter, (b) spring, (c) summer, and (d) autumn**. *(Dankers & Feyen, 2008)*

Hydrological events & Development

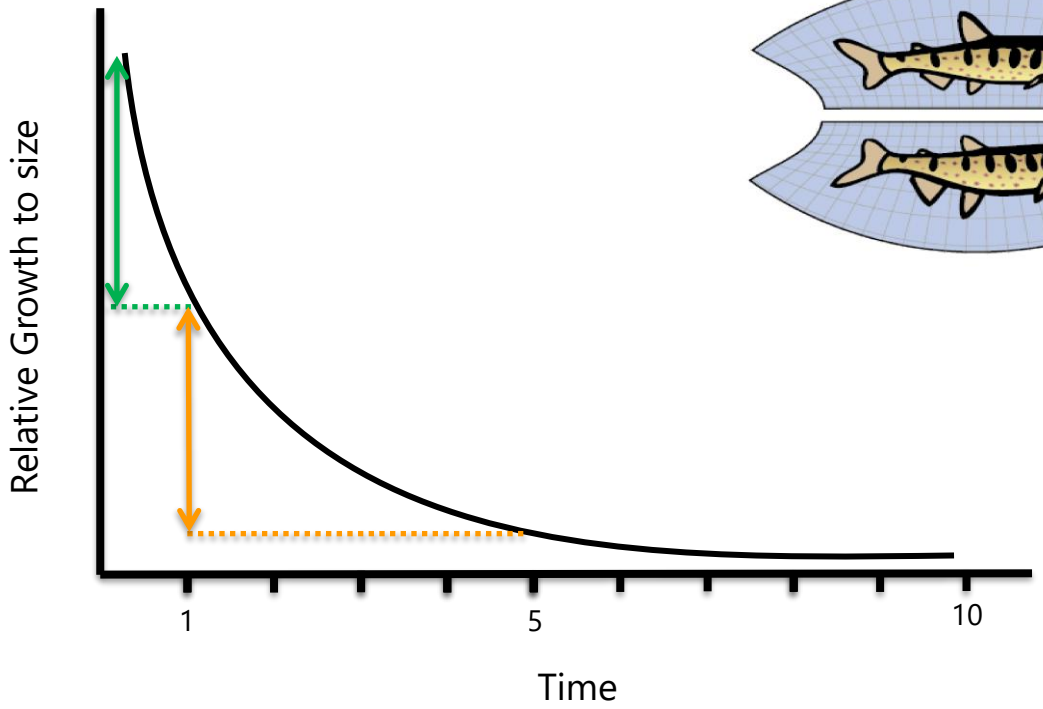


Change in global hydrology and precipitation **=**

Frequency and intensity of hydrological events (Blöschl *et al.* 2015)



Alter regulatory developmental mecanisms conducting to rapid morphological shift



Hydrological events & Development

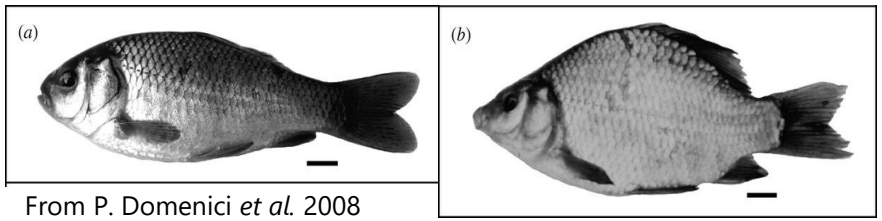
Change in global hydrology and precipitation =

Frequency and intensity of hydrological events (Blöschl *et al.* 2015)

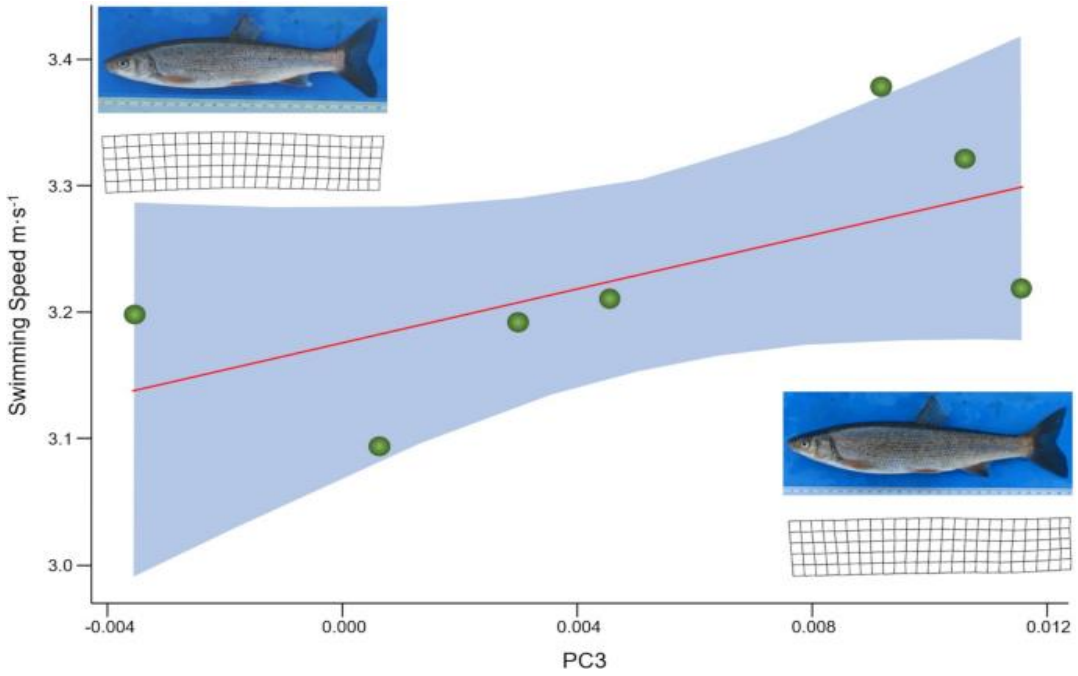
Alter regulatory developmental mecanisms conducting to rapid morphological shift

Long-lasting effect on fish shape and life due to morpho-fonctionnal constraint

Hydrological events & Functional morphology



From P. Domenici *et al.* 2008



From Sanchez-Gonzalez *et al.* 2021

Frequency and intensity of hydrological events (Blöschl *et al.* 2015)

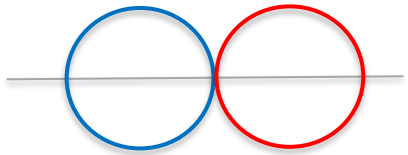
Alter regulatory developmental mecanisms conducting to rapid morphological shift

Long-lasting effect on fish shape and life due to morpho-fonctionnal constraint

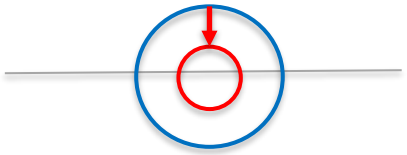
Question

What could be the impact of hydrological events on fish morphology ?

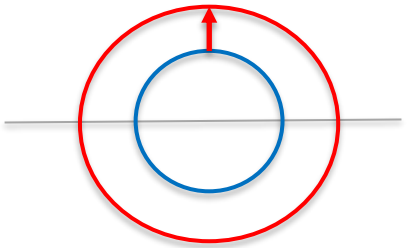
No change



Mean change

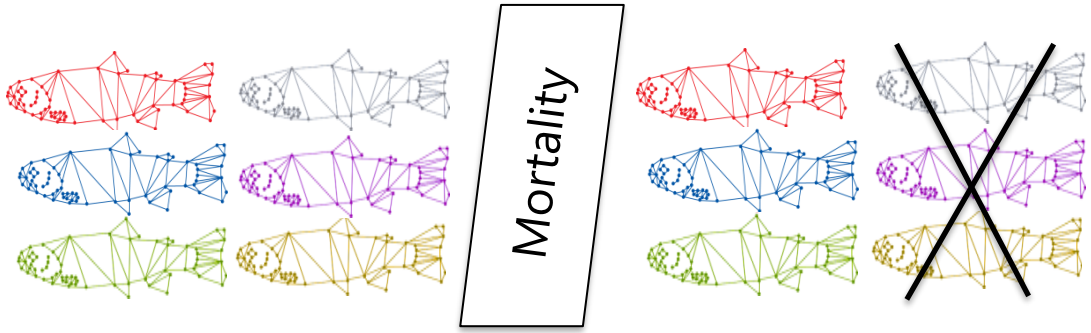


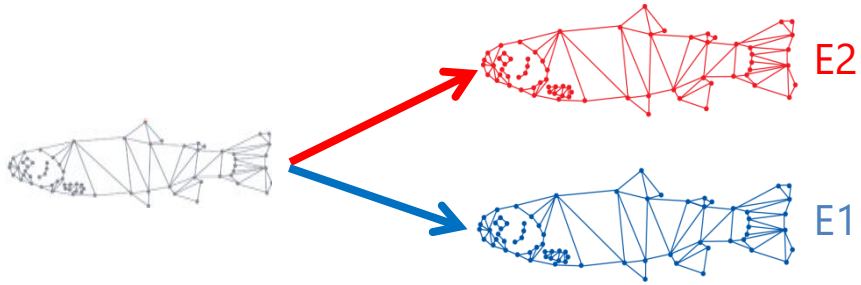
Variability decrease



Variability increase

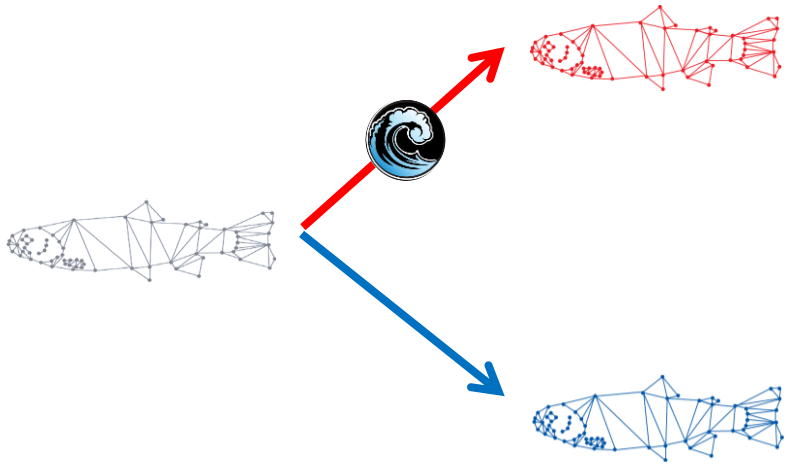
Which mecanisms are involved ?



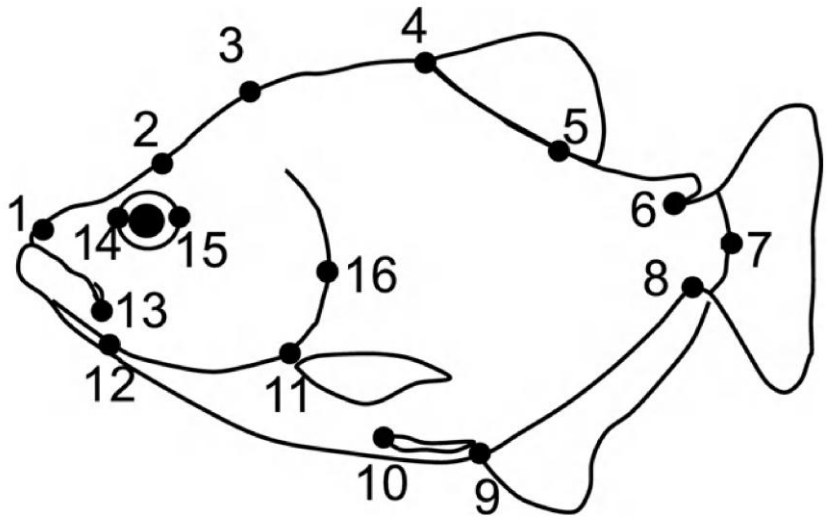


Experimental approach

Parts I – Simulation of hydrological events in semi-natural condition

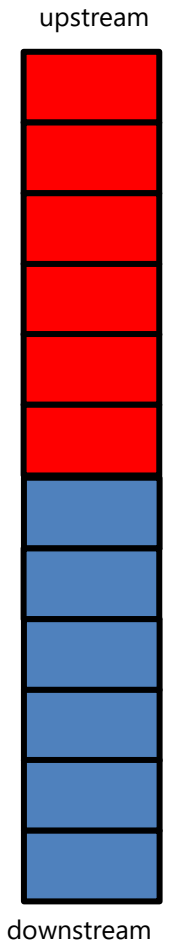


Parts II - Morphometrics analysis

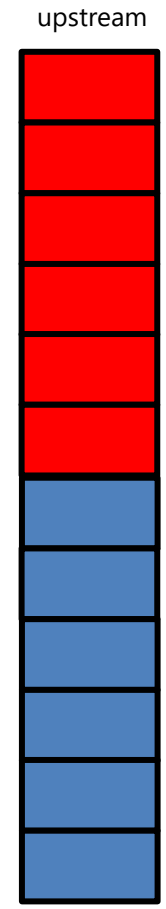


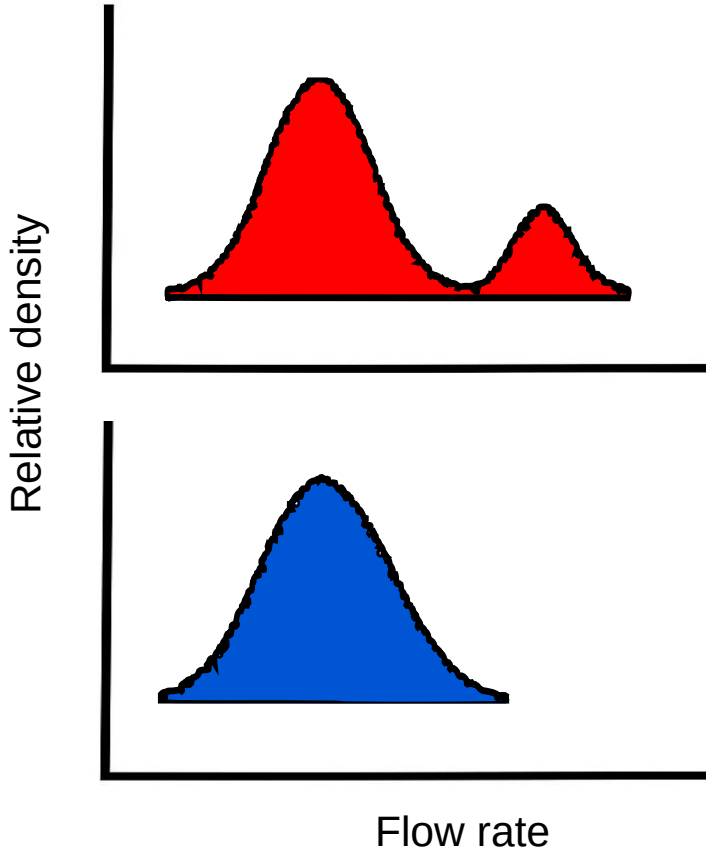
From Zelditch *et al.*, 2012

Part I - Hydrogical treatment

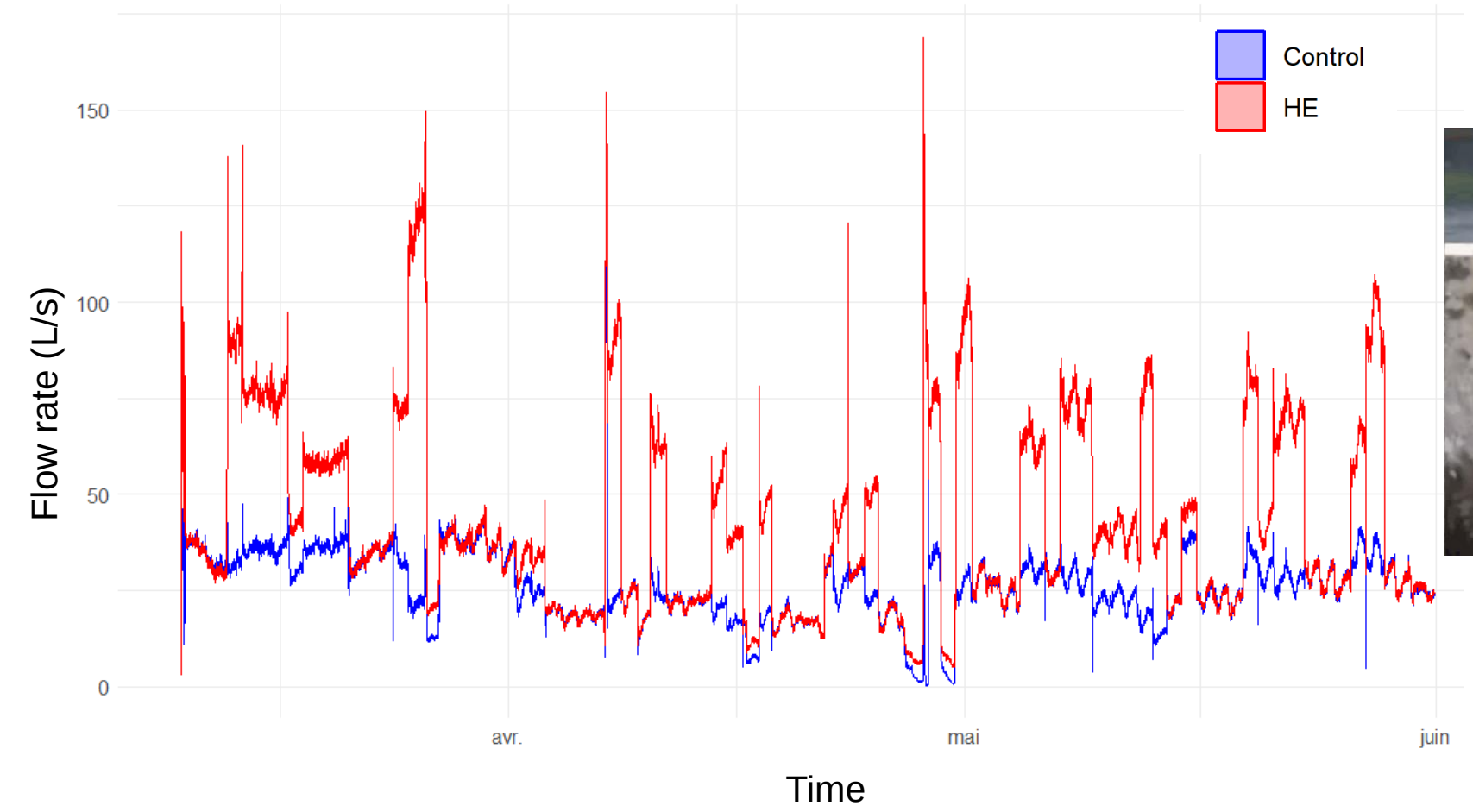


Part I - Hydrogical treatment



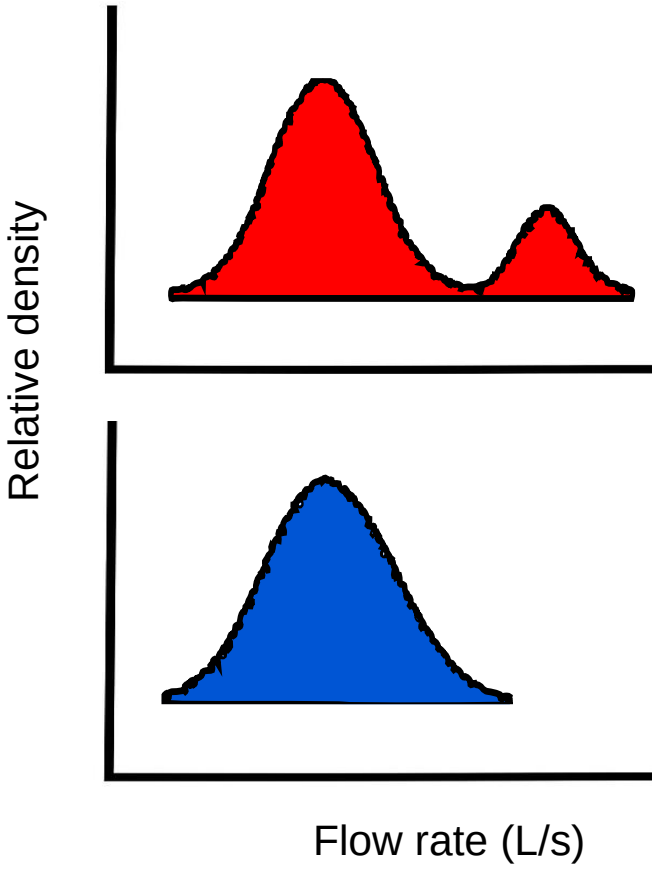


Part I - Hydrogical treatment

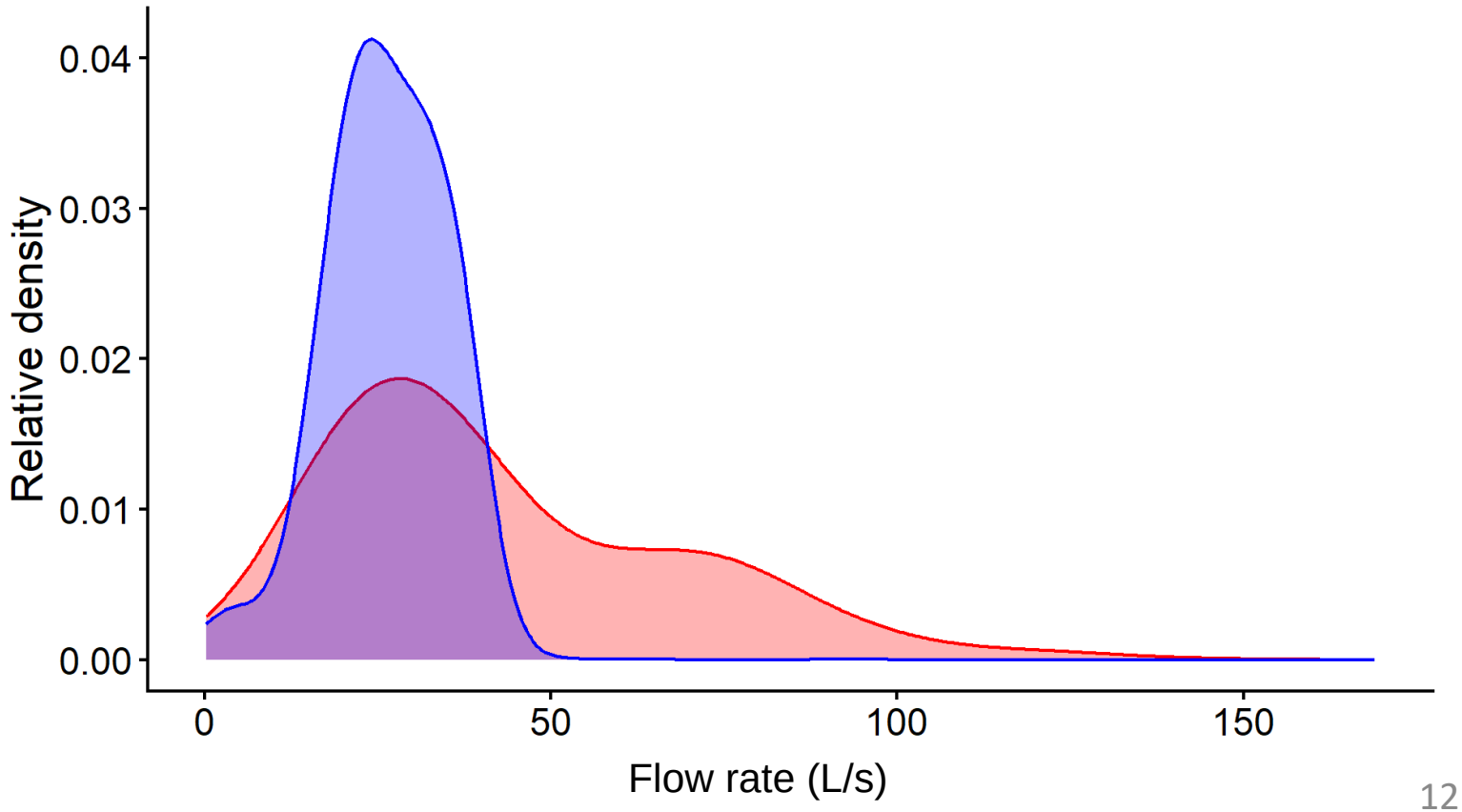


Part I - Hydrogical treatment

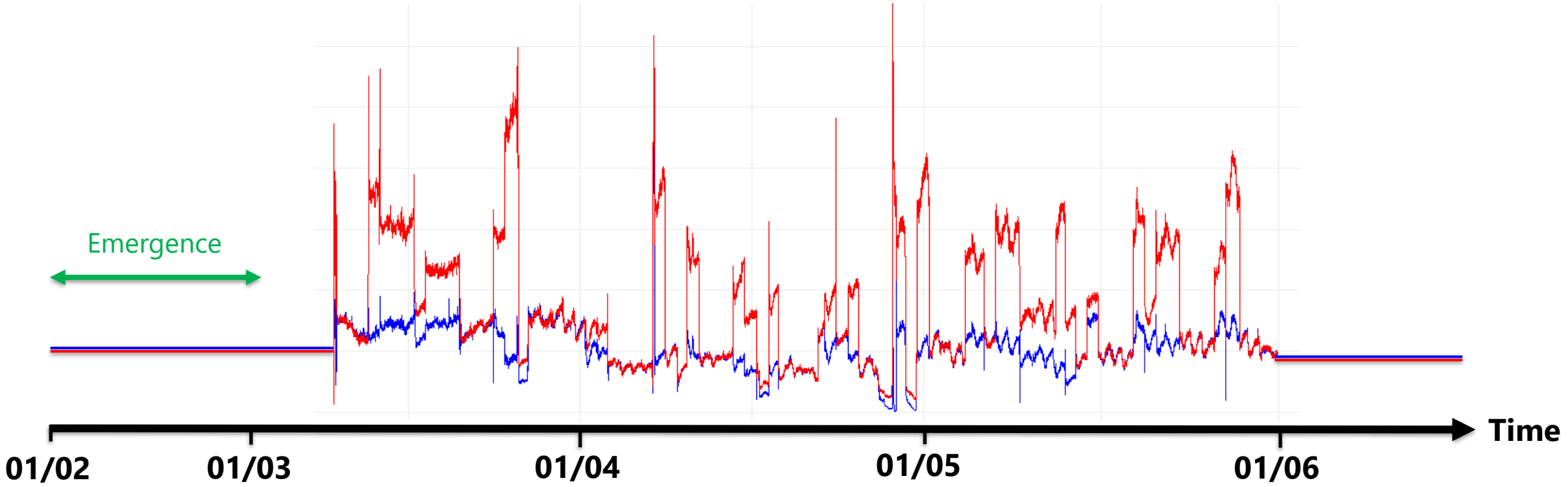
Expected distributions



Realized distributions



Part II – Fish photo shoot



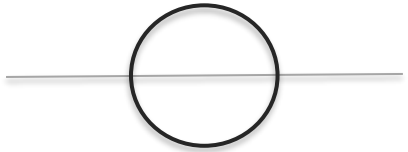
t0

t1

t2

Hypothesis

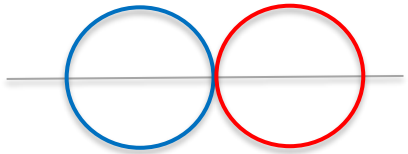
What could be the impact of hydrological events on fish morphology ? Which mecanisms ?



No change

↓

1. Stressless treatment
2. Behavior response
3. Regulotary developmental mecanisms

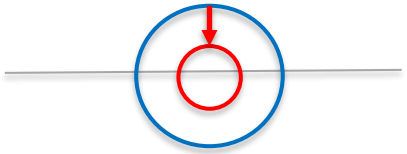


Mean change

↓

HE = Streamlined
Vs
Control = Robust

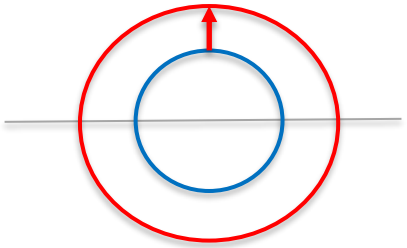
1. Developmental **Plasticity**
2. Mortality



Variability decrease

↓

Differential **Mortality**



Variability increase

↓

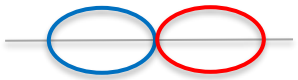
Disruption of regulatory mecanisms
(Inter-individual Vs Intra-individual)

What could be the impact of HE ?

RESULTS

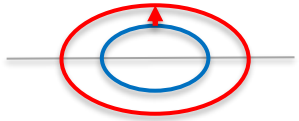
Data investigation

No change

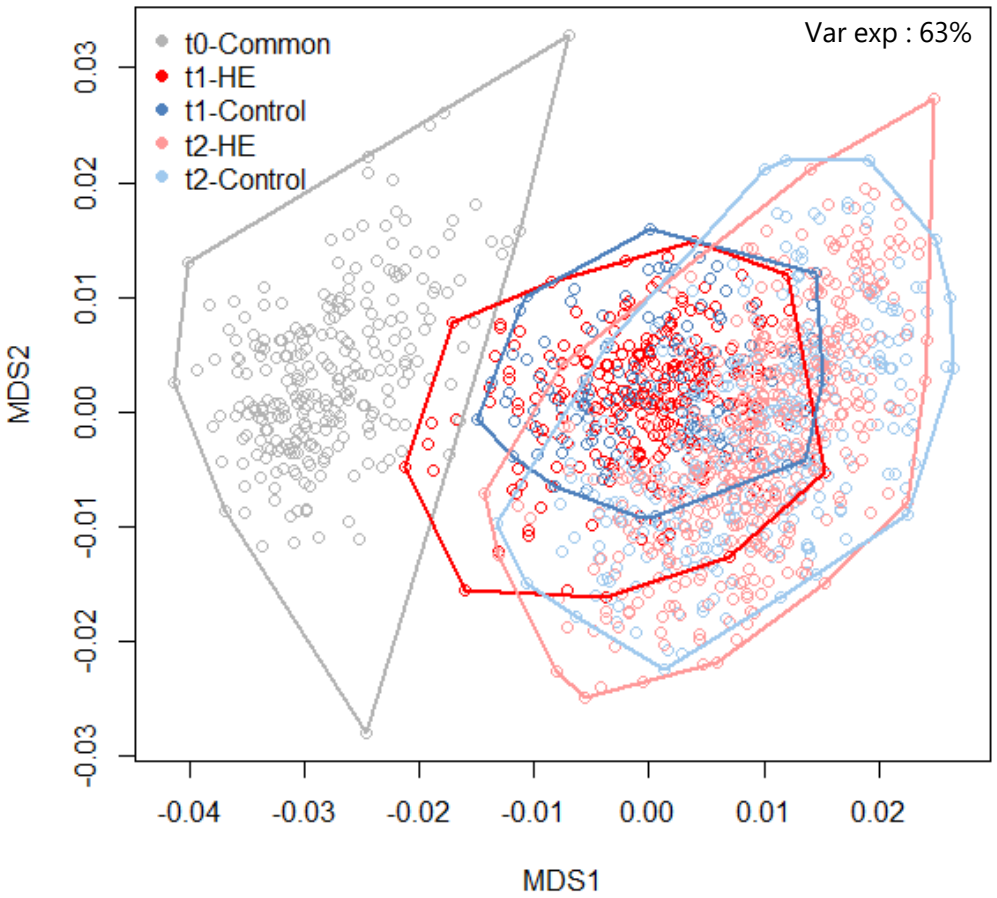


Mean change

Variability decrease



Variability increase

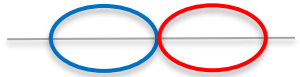


What could be the impact of HE ?

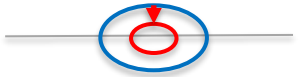
RESULTS

Allometric trajectories

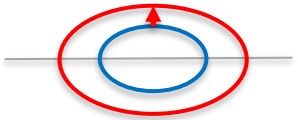
No change



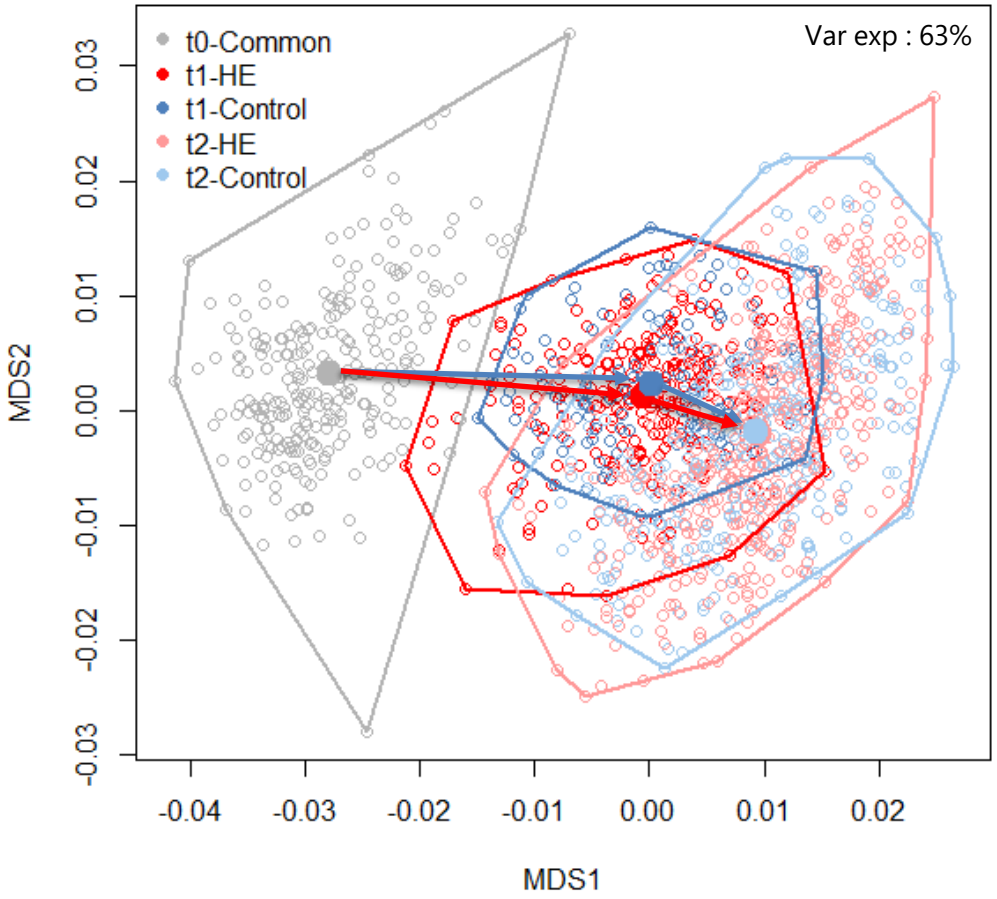
Mean change



Variability decrease



Variability increase



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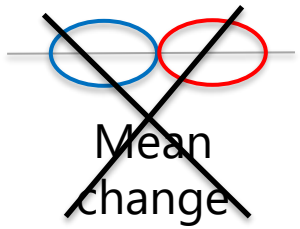
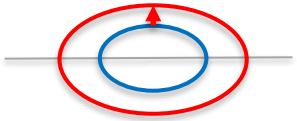
Allometric trajectories

No change

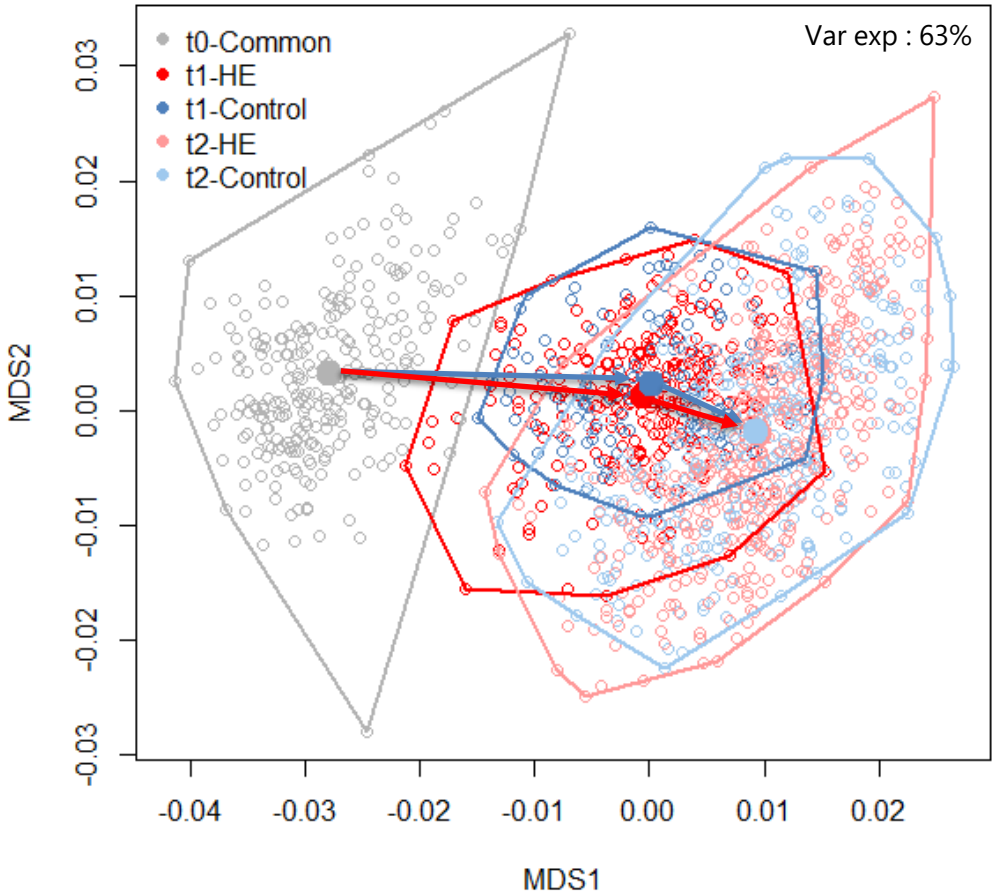


Mean change

Variability decrease



Variability increase

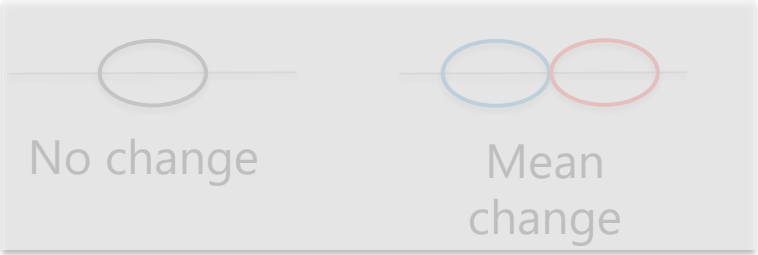


(procD.lm : Rsq treatment = 0.00381)

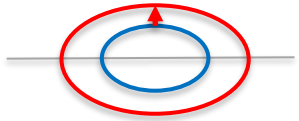
What could be the impact of HE ?

RESULTS

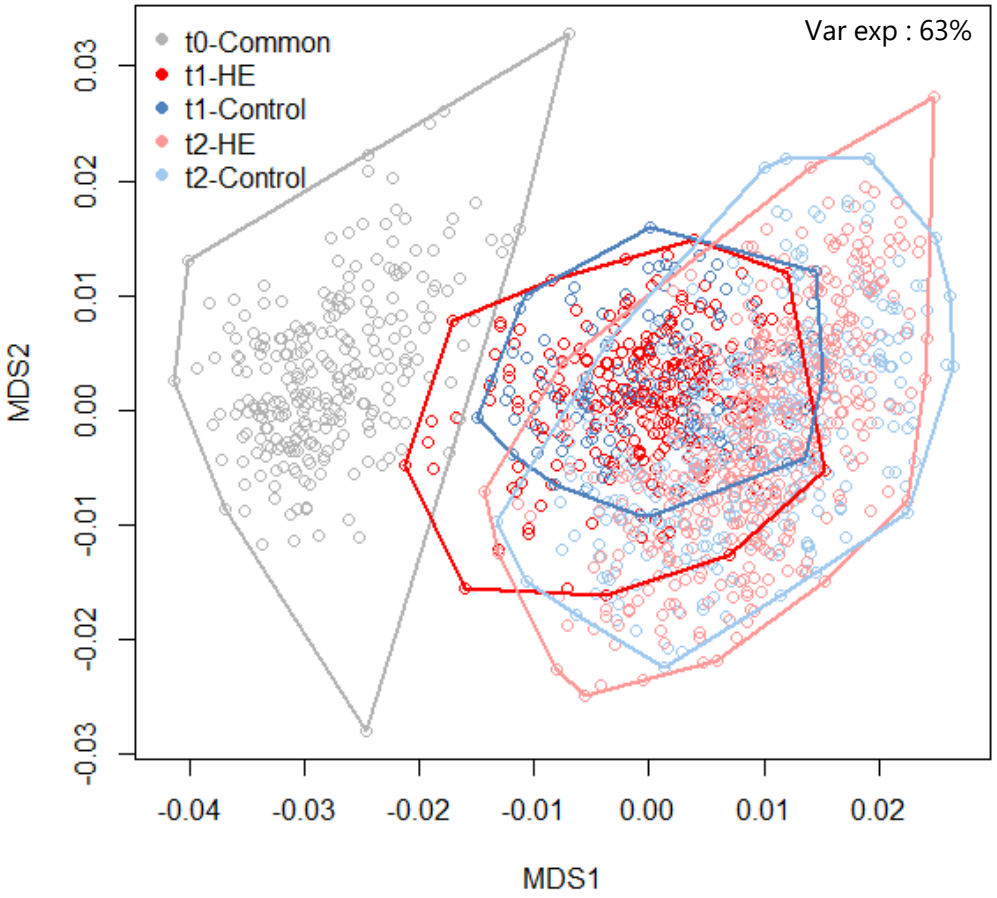
Disparity

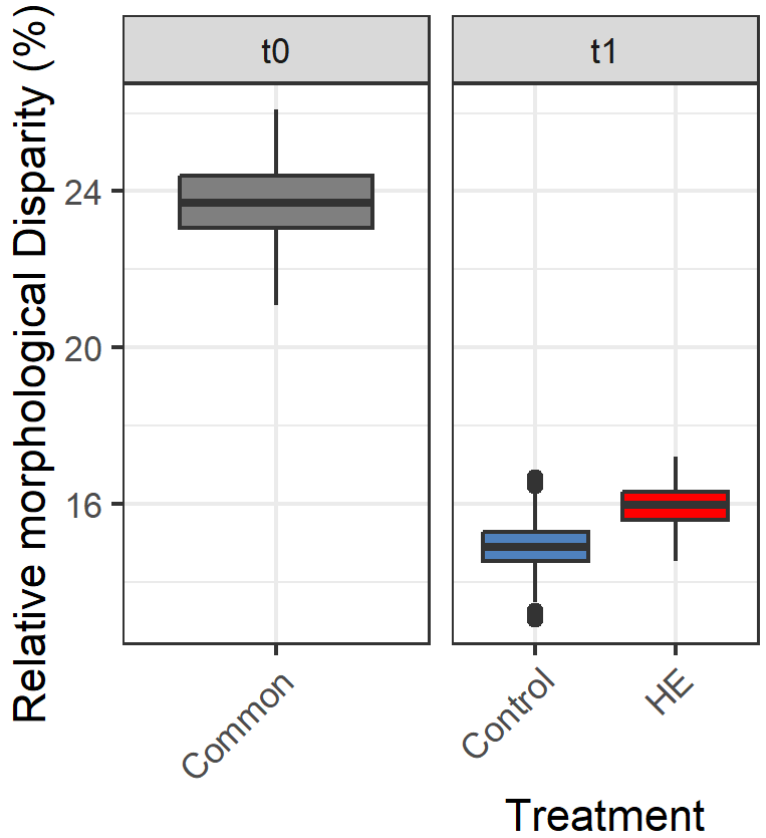


Variability decrease



Variability increase



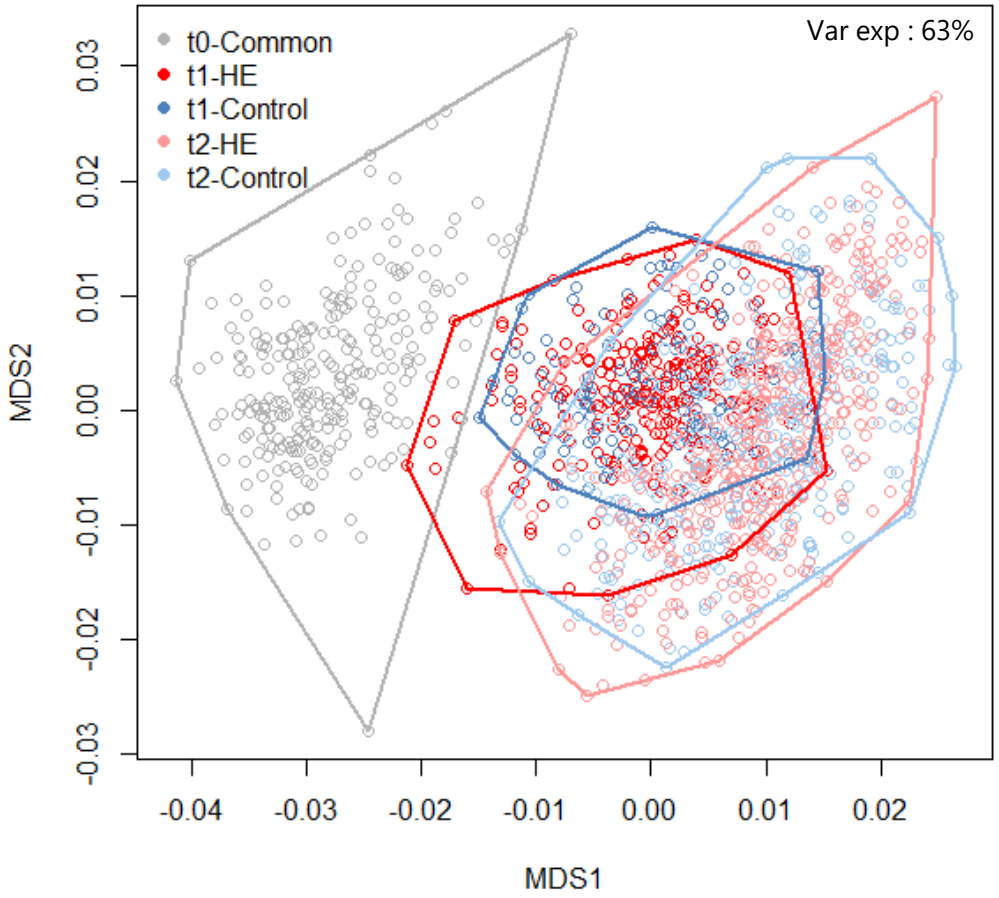


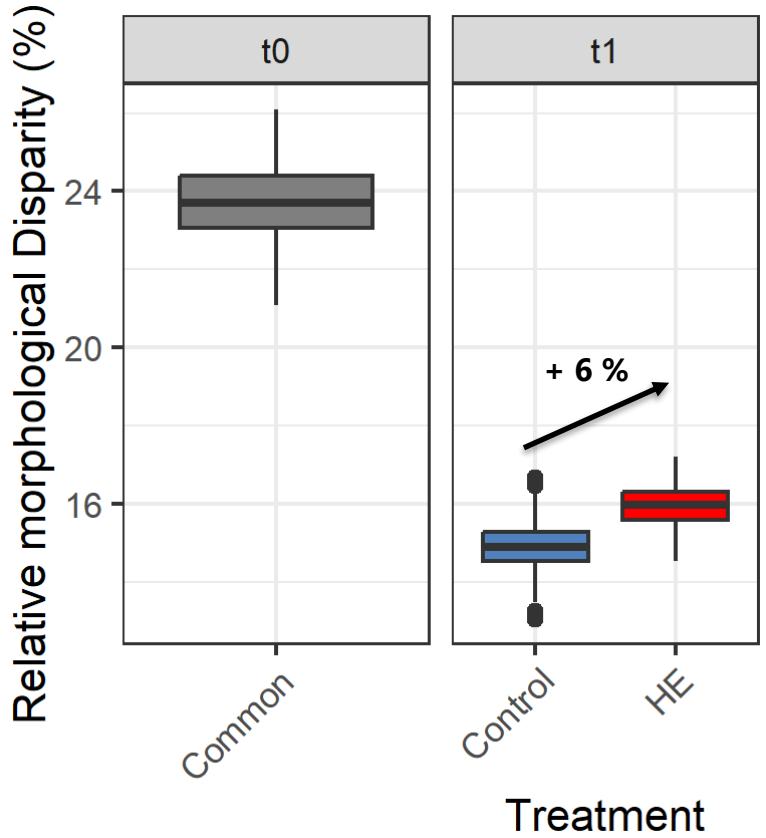
(Boostrap : frac=0.6 ; n=1000 ; replace=T)

What could be the impact of HE ?

RESULTS

Disparity





(Boostrap : frac=0.6 ; n=1000 ; replace=T)

What could be the impact of HE ?

RESULTS

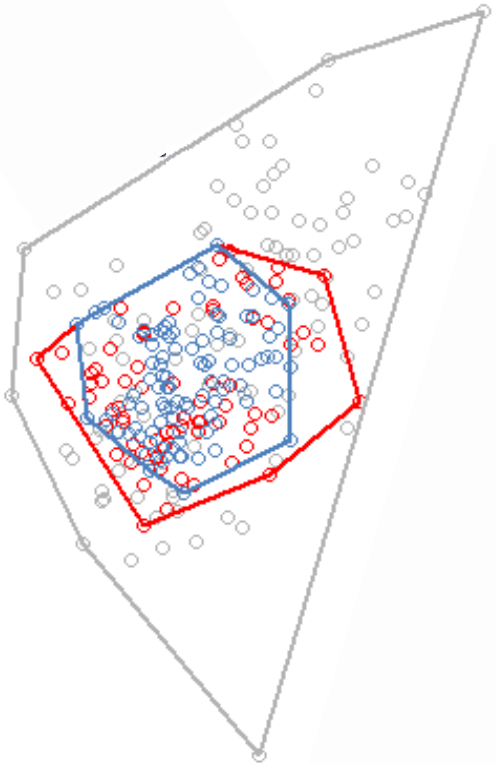
Disparity difference explained by differential mortality ?

No change

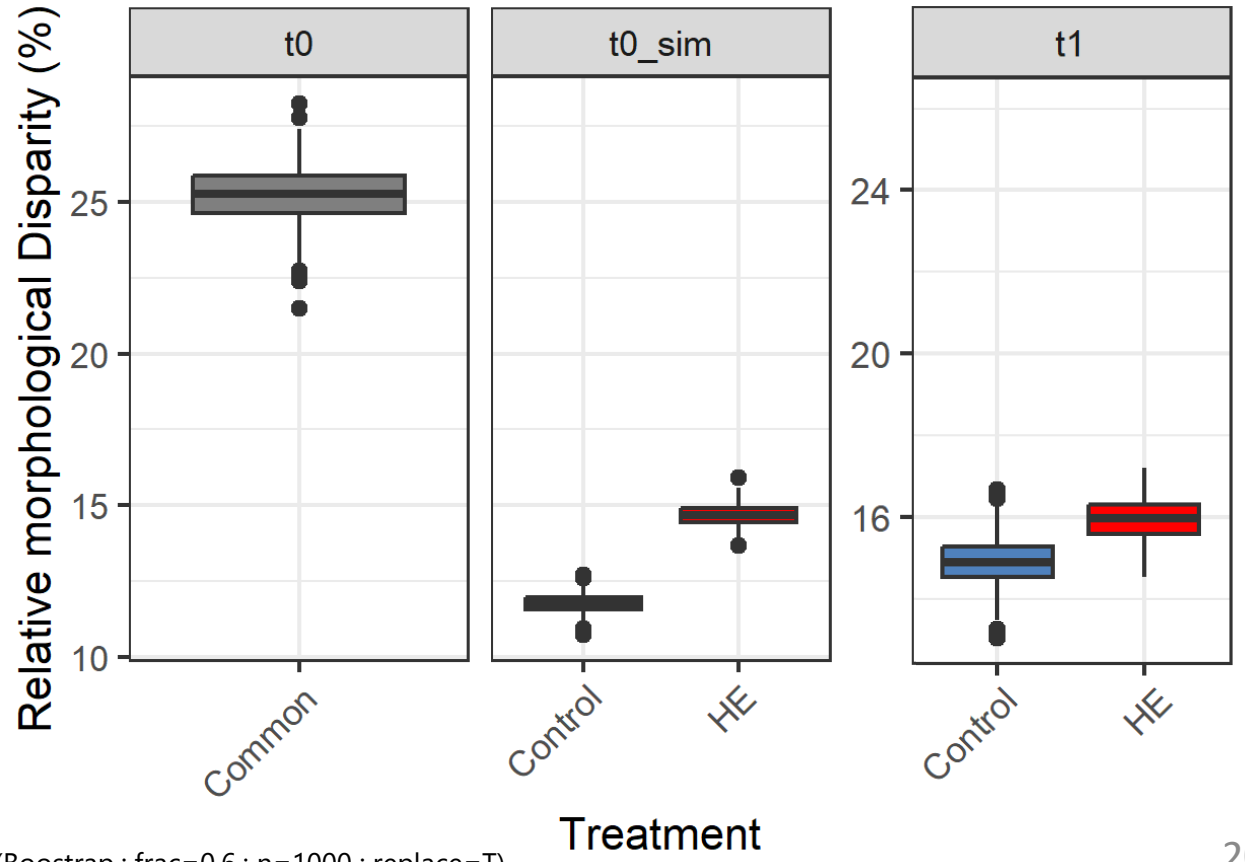
Mean change

Variability decrease

Variability increase



(mortality : HE=0.36 ; control=0.63)

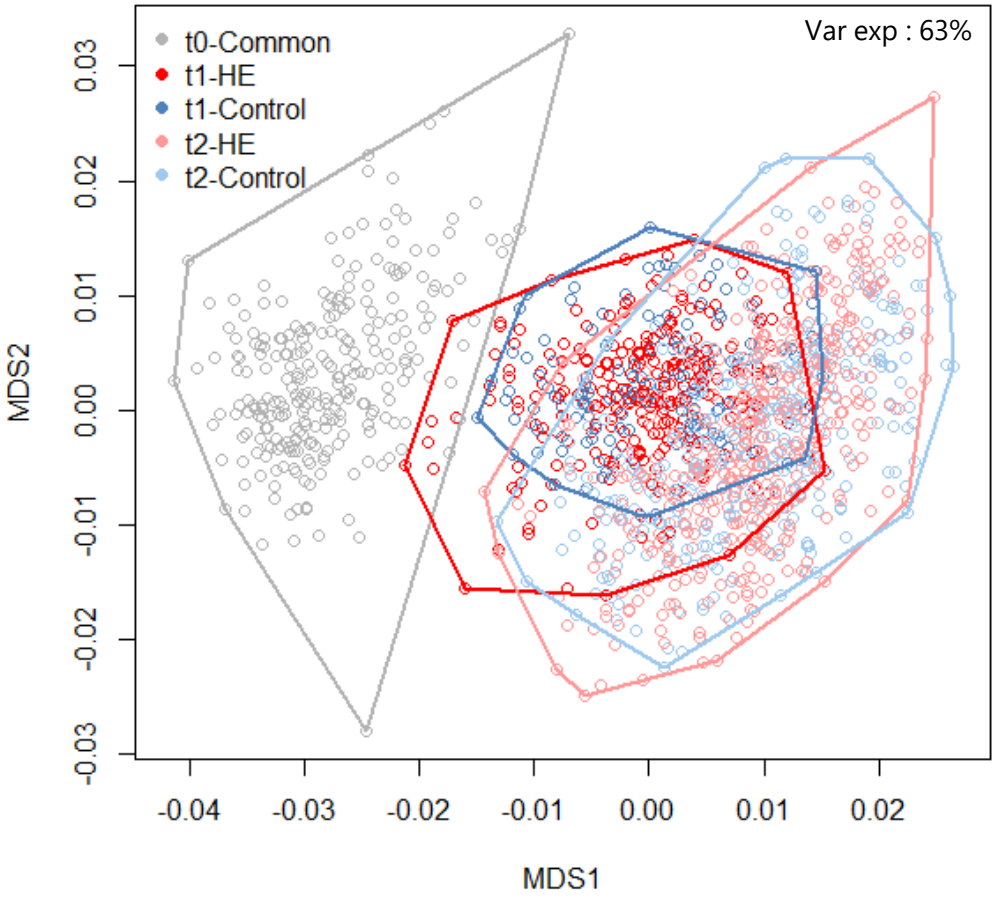


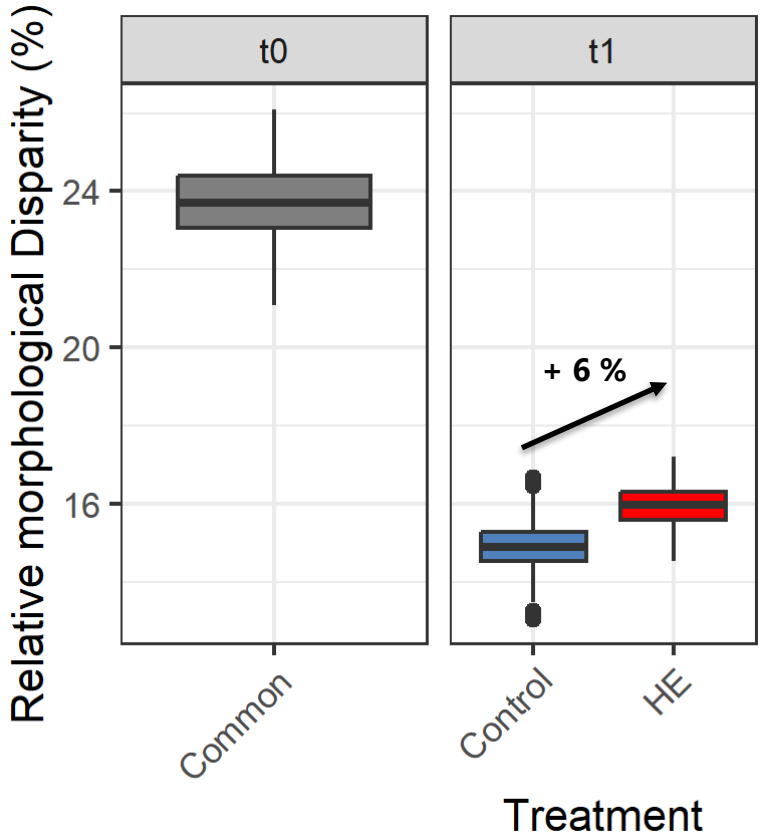
(Boostrap : frac=0.6 ; n=1000 ; replace=T)

What could be the impact of HE ?

RESULTS

Disparity



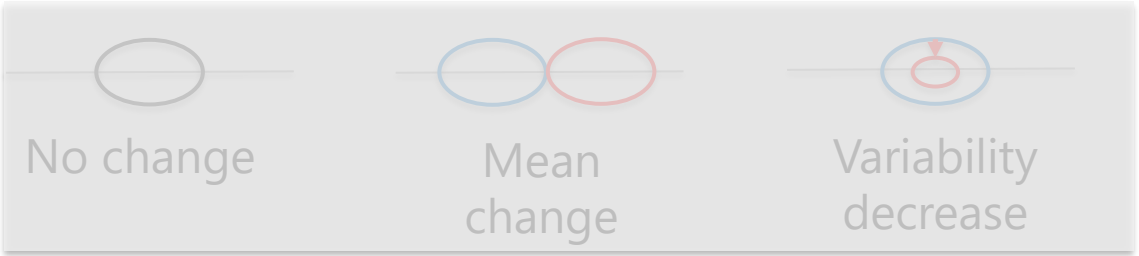


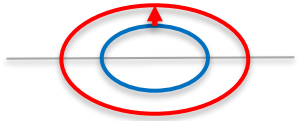
(Boostrap : frac=0.6 ; n=1000 ; replace=T)

What could be the impact of HE ?

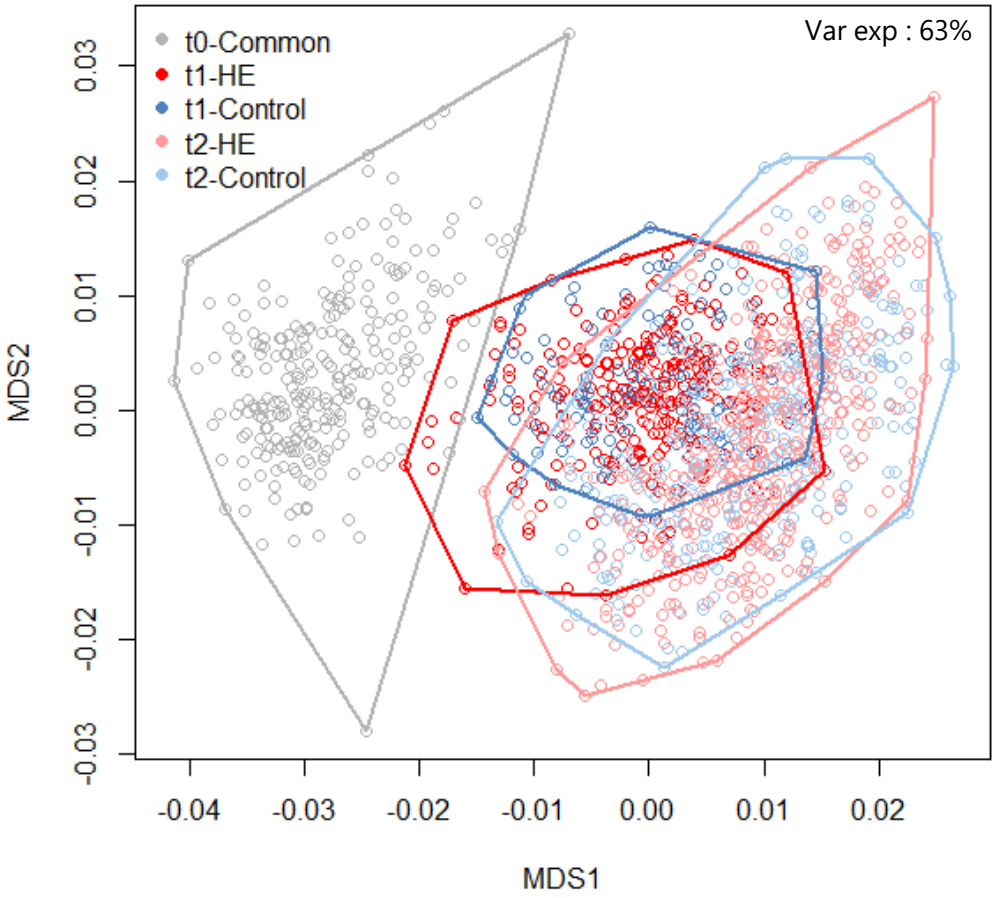
RESULTS

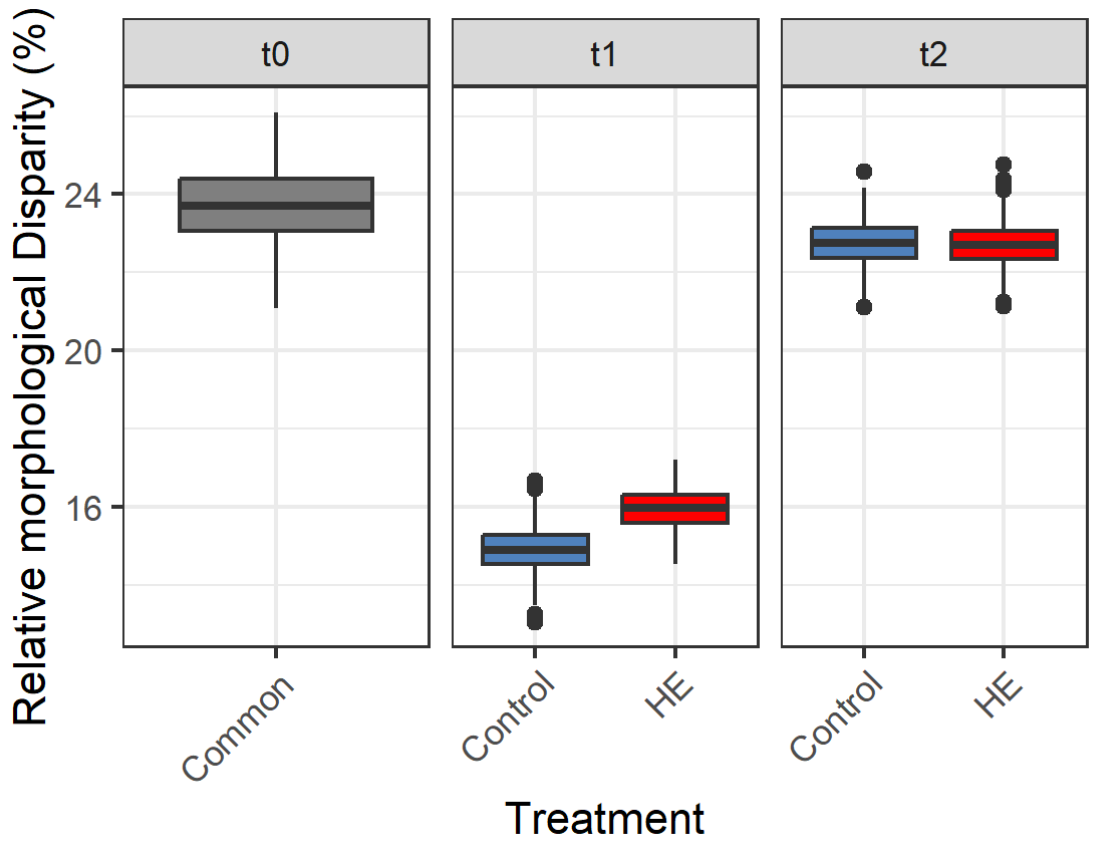
Disparity





Variability increase

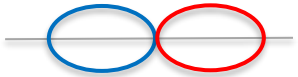




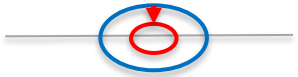
(Boostrap : frac=0.6 ; n=1000 ; replace=T)

What could be the impact of HE ?

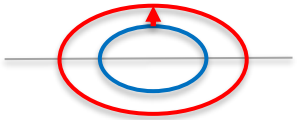
No change



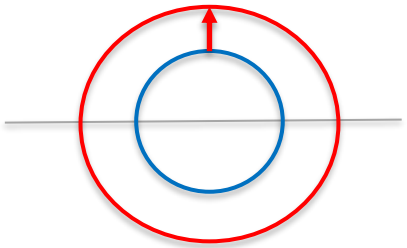
Mean change



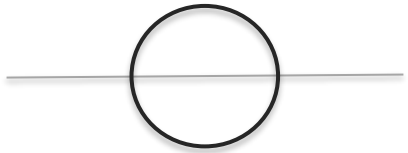
Variability decrease



Variability increase



→ T1 : Marginal difference in disparity



→ T2 : No difference

Morphological development :

1. **Have a complex temporal dynamic**
2. **Seems to be a highly tamponned process**

Thanks !

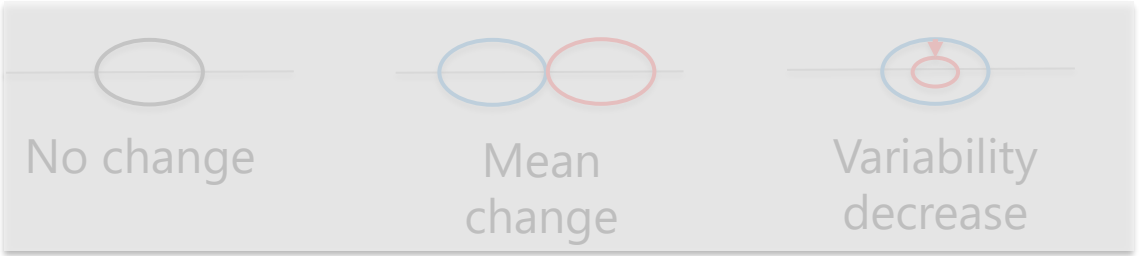
Questions ?

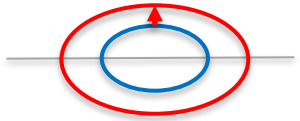
Thanks a lot at the whole Ecobiop Team !

What could be the impact of HE ?

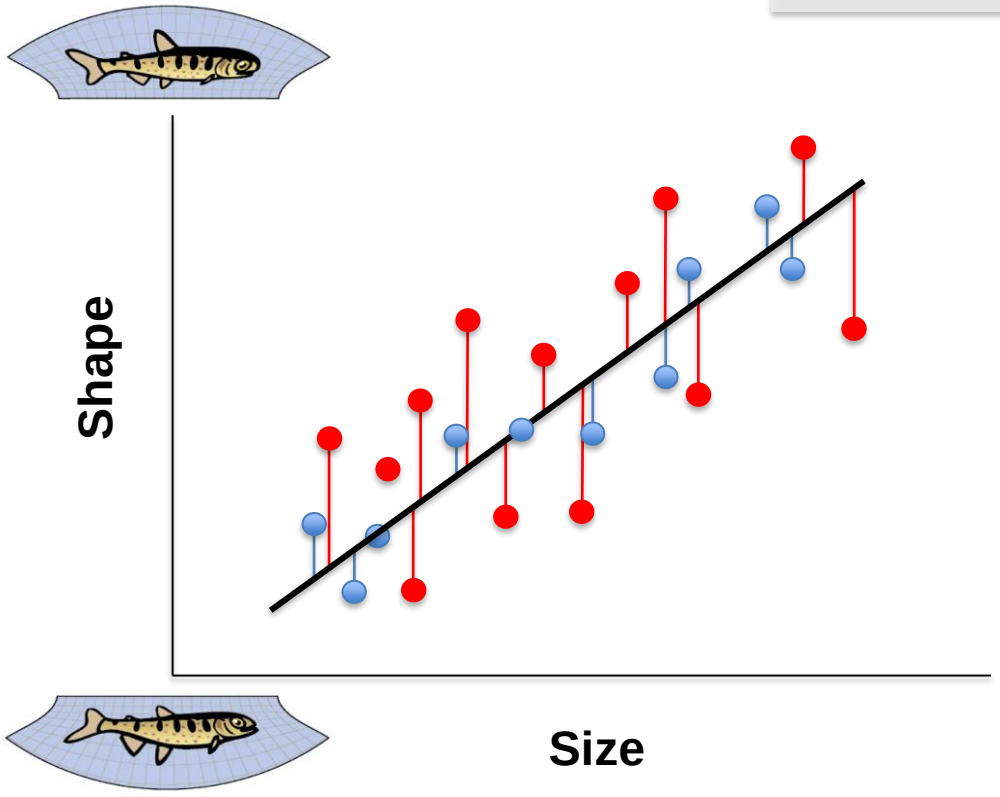
RESULTS

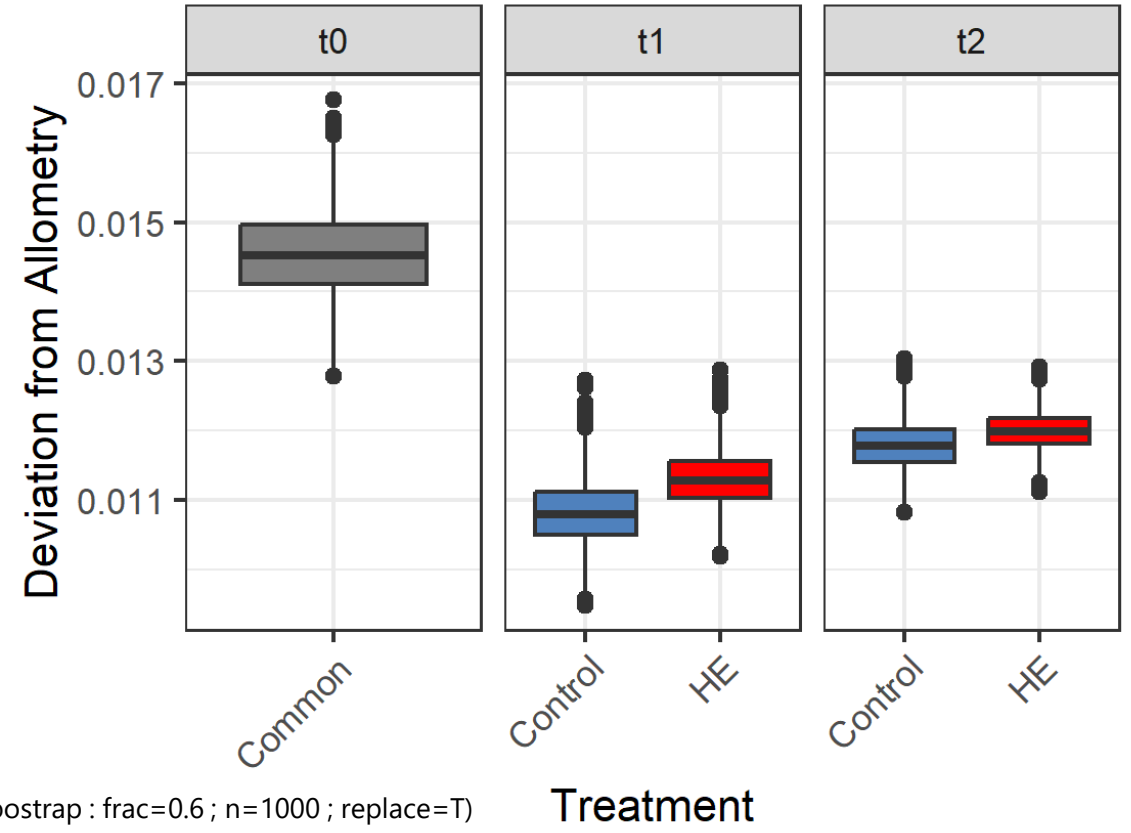
Inter-individual Variability :
Deviation from allometry





Variability increase

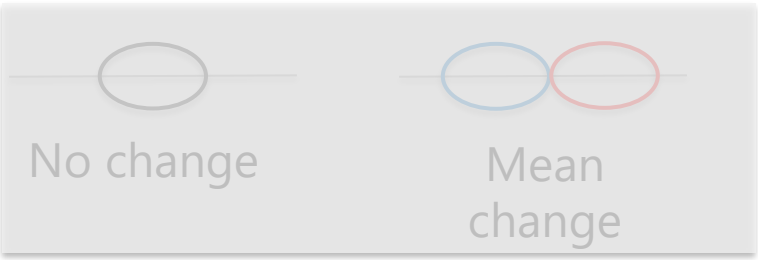


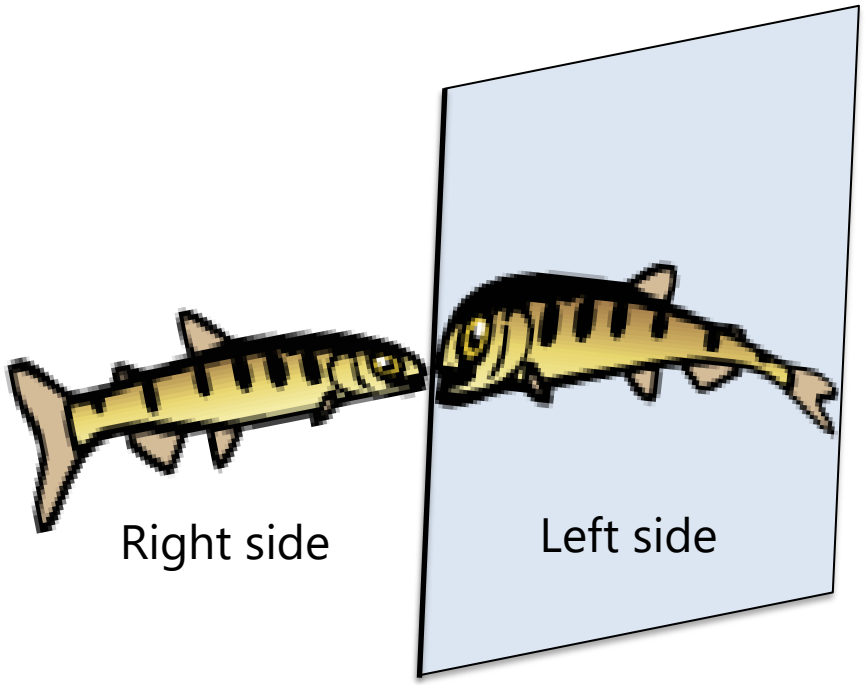


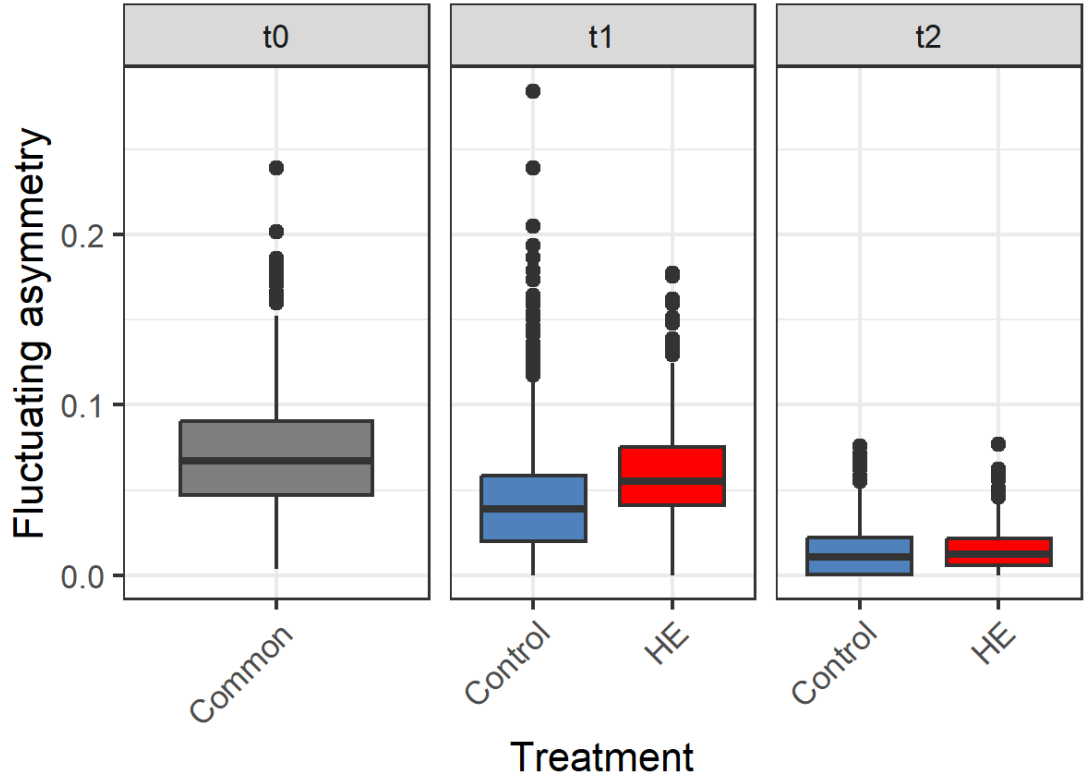
(Boostrap : frac=0.6 ; n=1000 ; replace=T)

What could be the impact of HE ?

Intra-individual Variability :
Fluctuating asymmetry

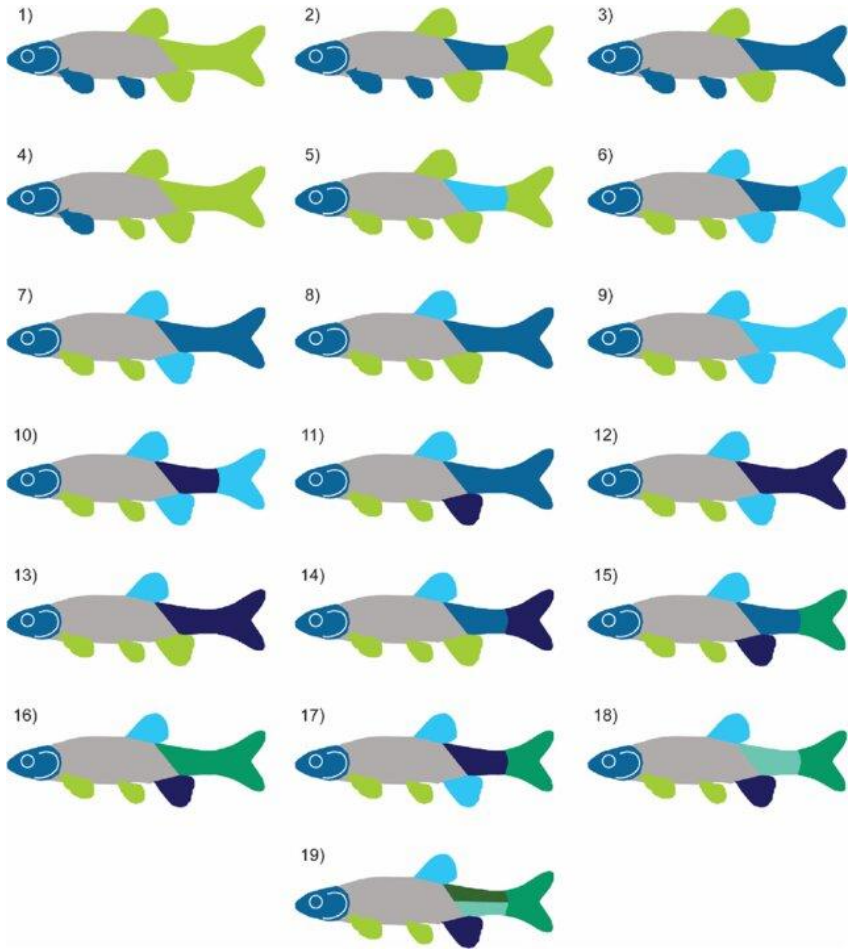


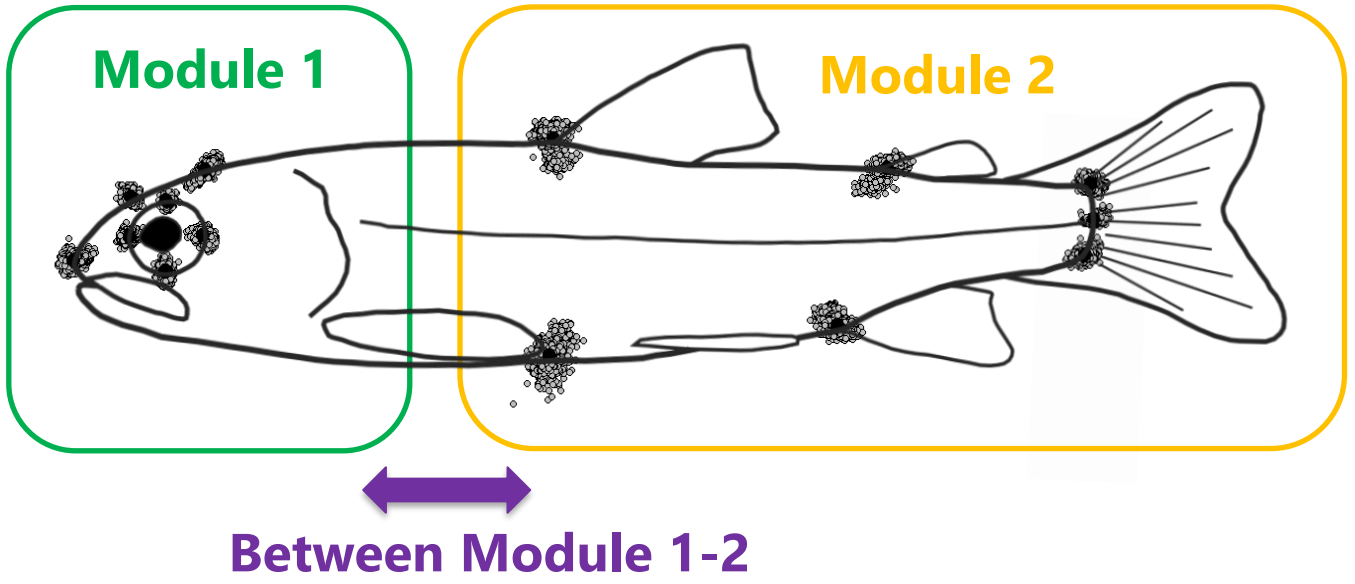




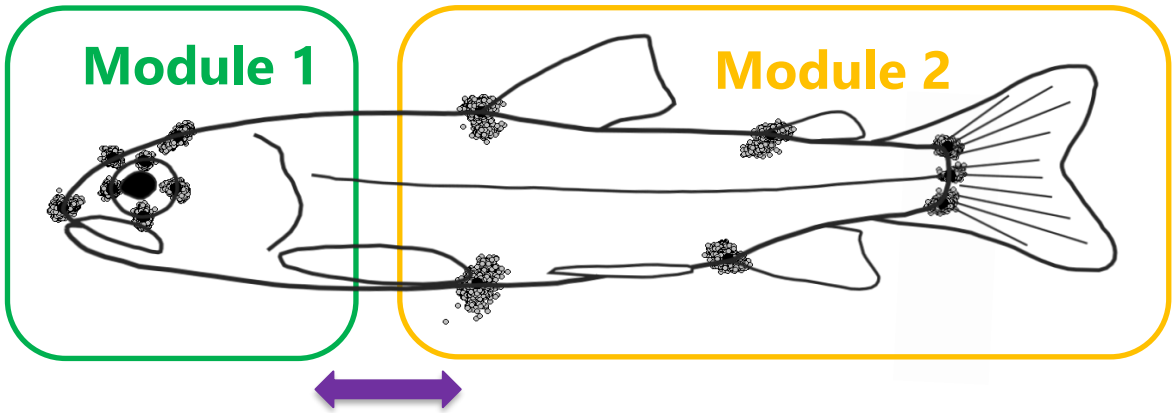
(Boostrap : frac=0.6 ; n=1000 ; replace=T)

Module choice

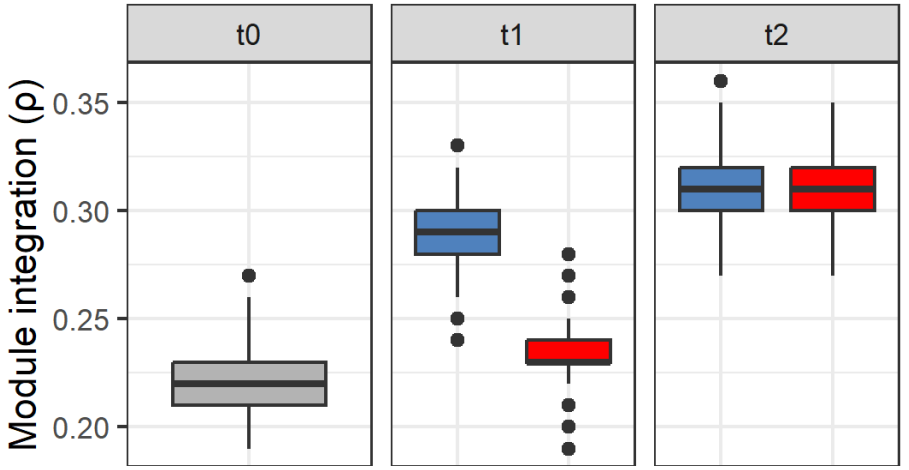




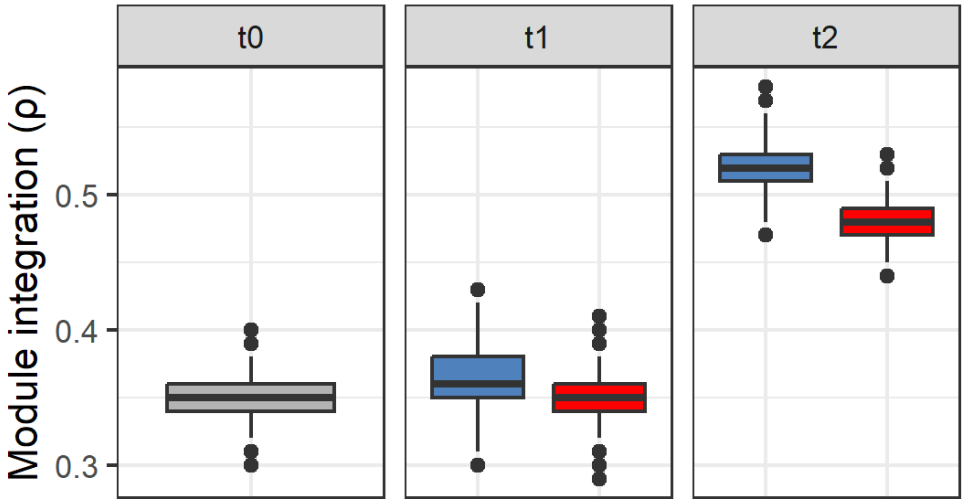
From Larouche *et al.* 2015



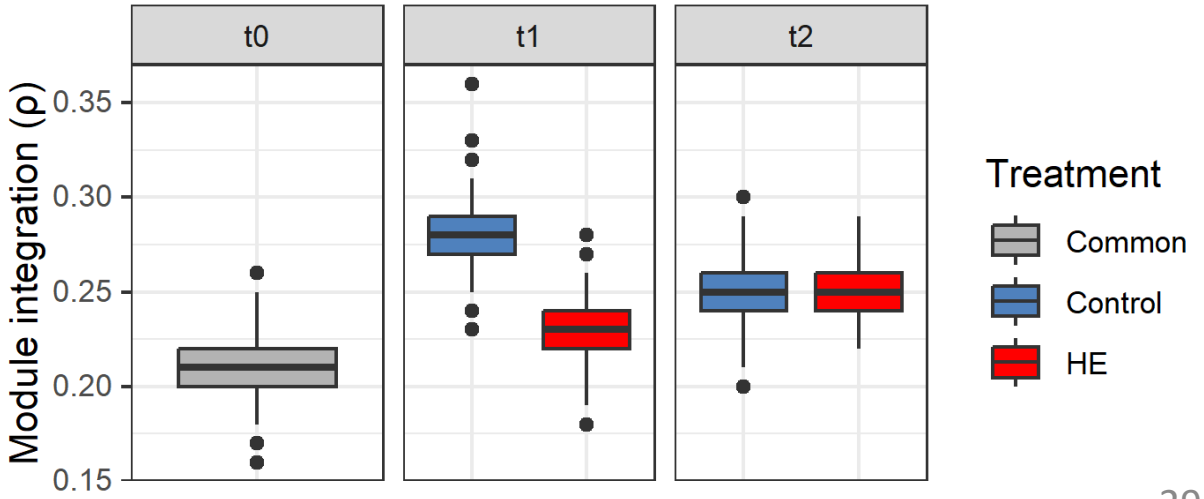
Between Module 1-2



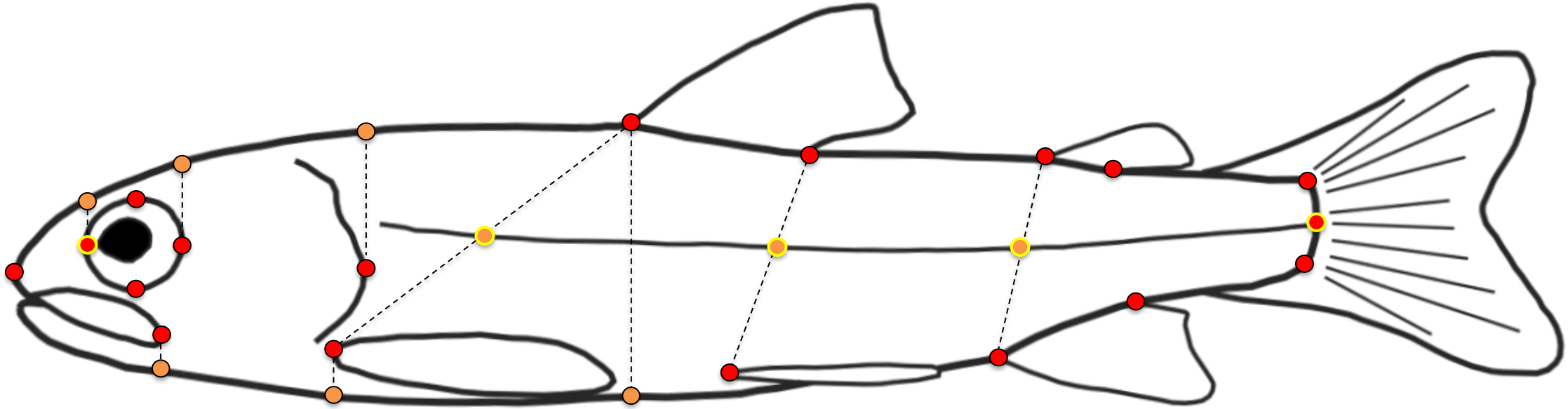
Module 1



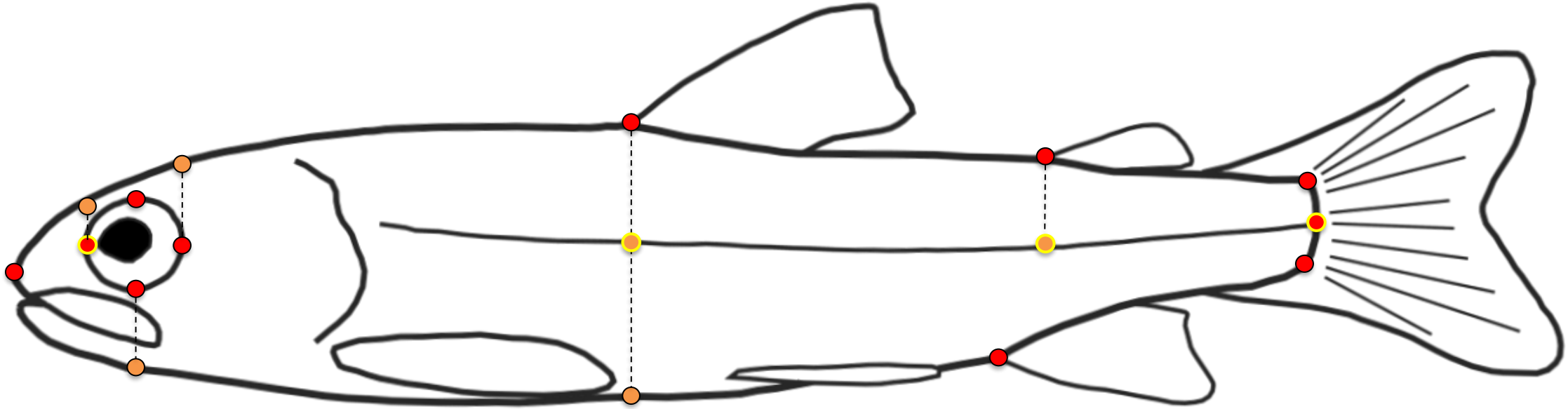
Module 2



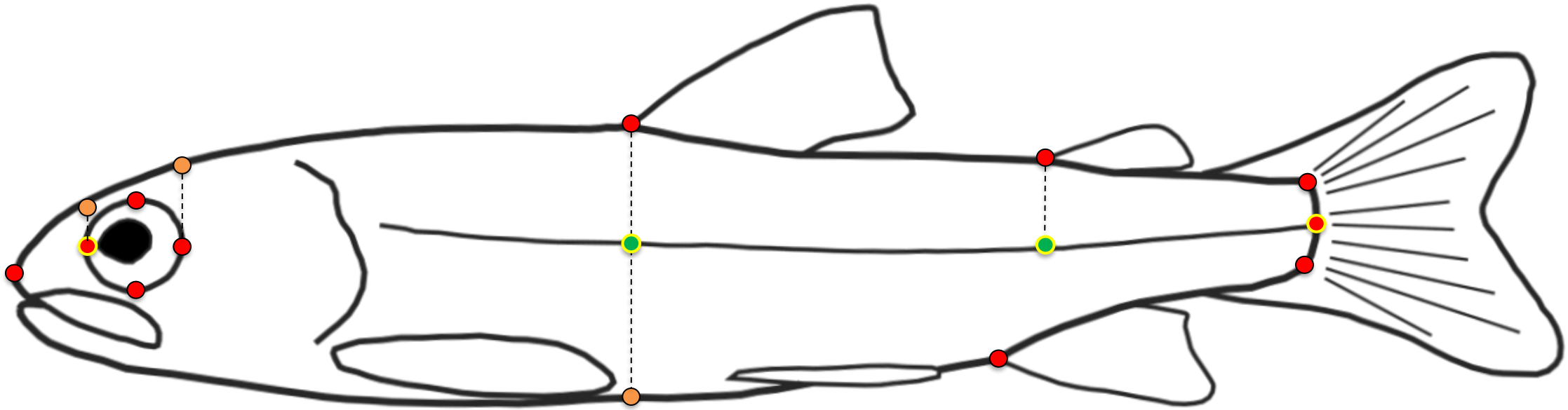
Landmarking t1-t2



Landmarking t0

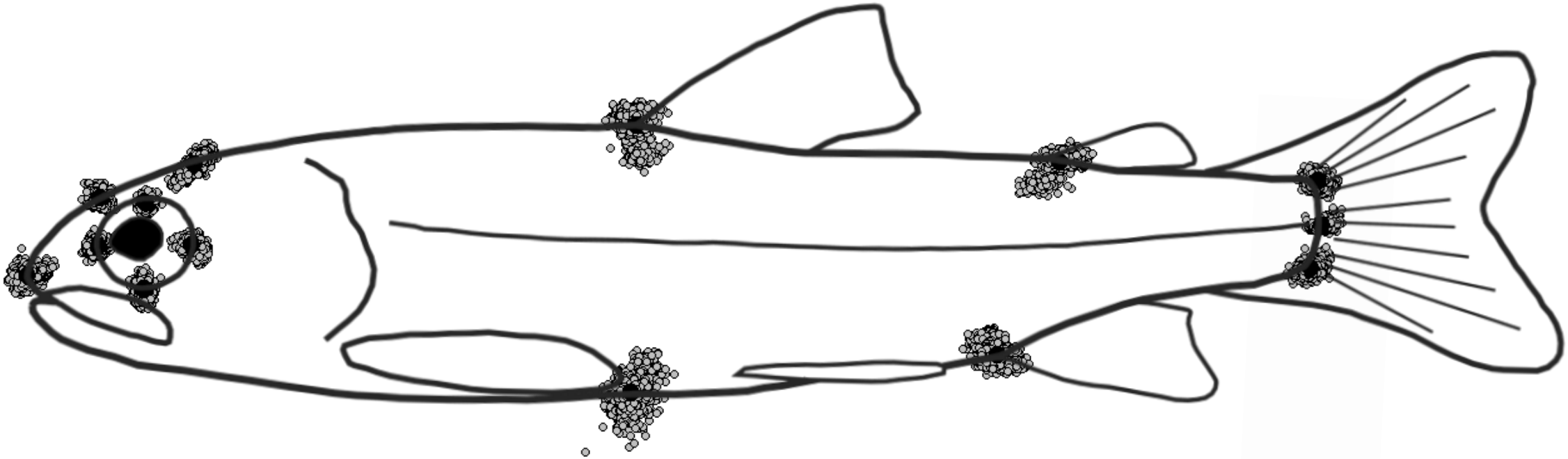


Landmarking t0-t1-t2

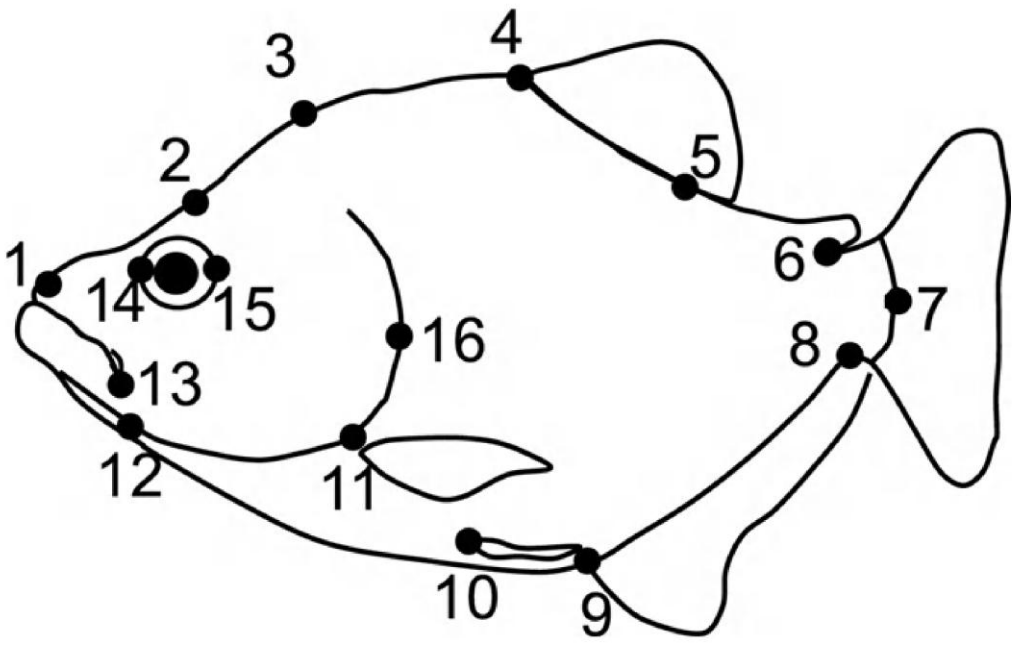


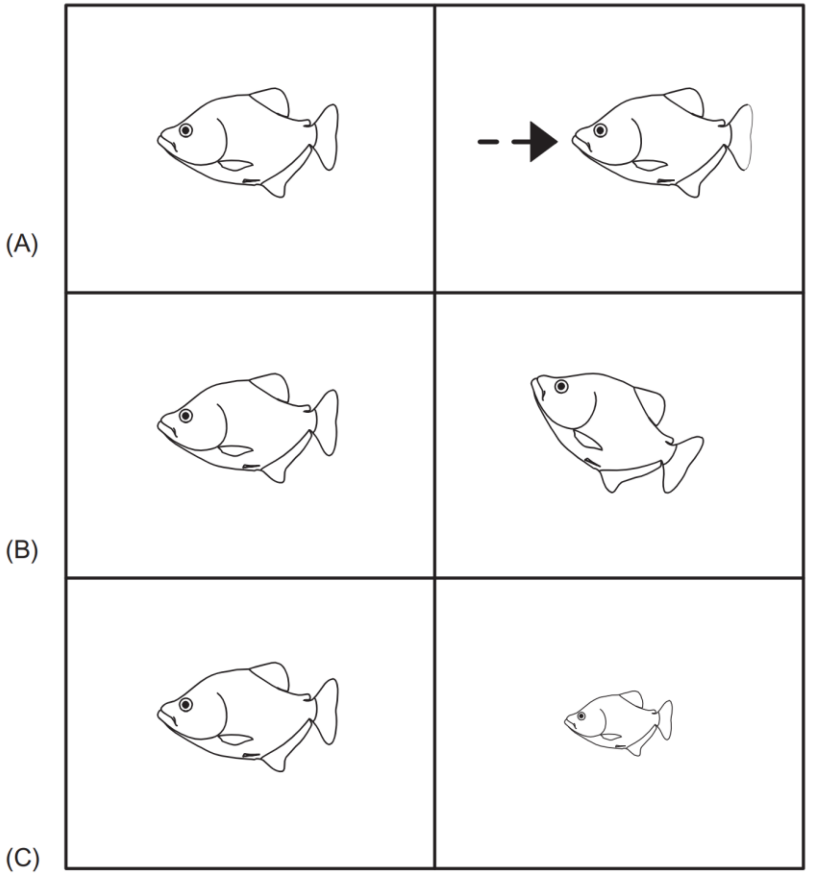
t0-t1-t2 : Are we precise ?

t0-t1-t2 : Are we precise ?



Geometrics Morphometrics





(A)Translation ; (B) Rotation ; (C) Scaling

Figure From Zelditch *et al.*, 2012

Unbending - Standardization of fish

Bending effect

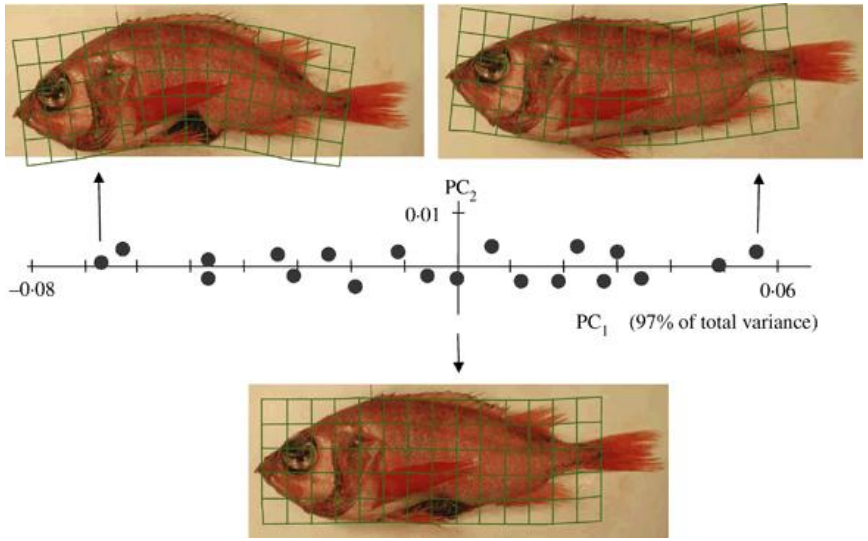
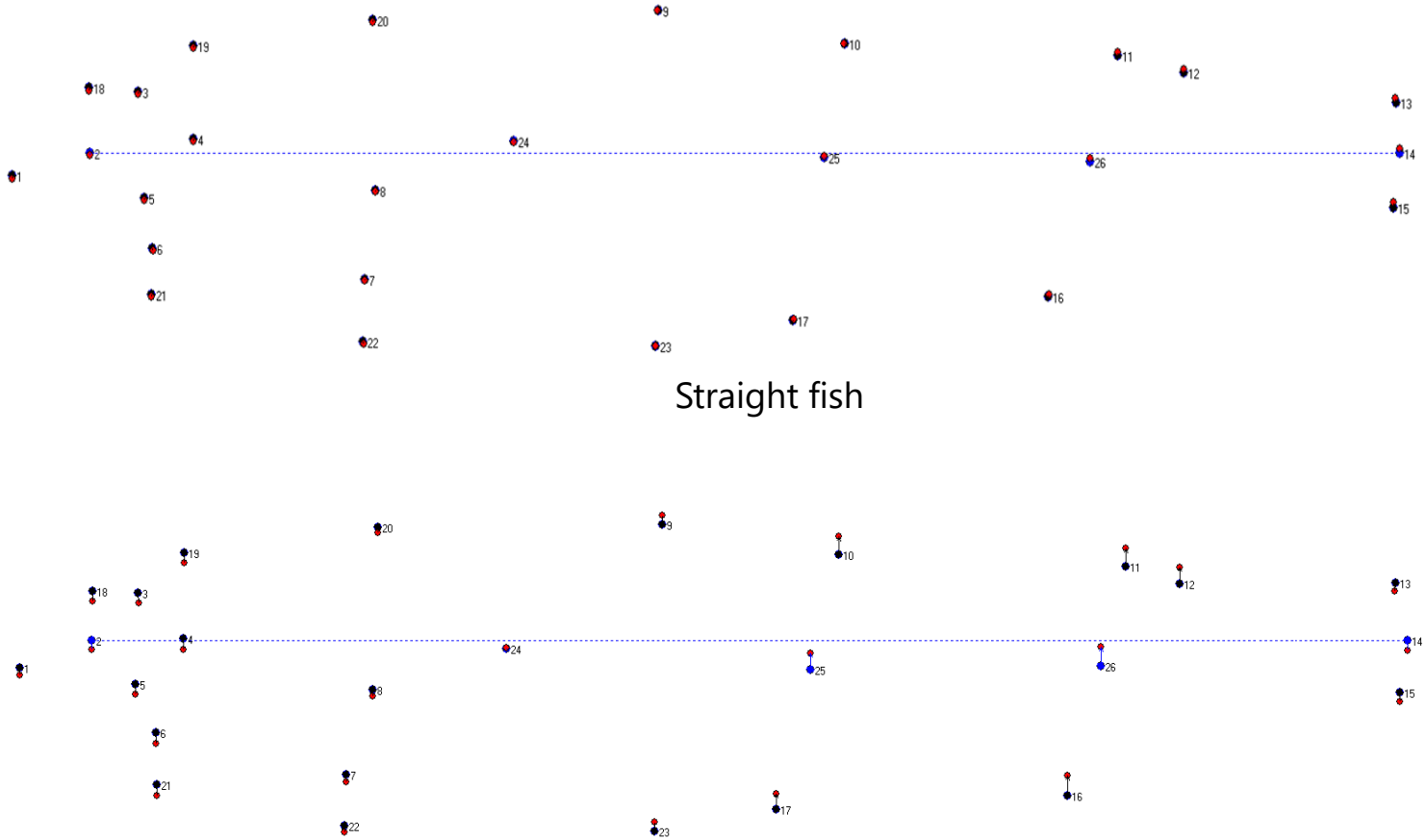


Figure From Valentin *et al.*, 2012

Standardization



Straight fish

Arched fish