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Selection for small size affects the pace-of-life syndrome in medaka impacting the invertebrate community

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Beatriz Diaz-Pauli, Eric Edeline, Charlotte Evangelista. Selection for small size affects the pace-of-life syndrome in medaka impacting the invertebrate community. The 2019 Congress of the European Society for Evolutionary Biology, European Society for Evolutionary Biology, Aug 2019, Turku, Finland. hal-02958941

HAL Id: hal-02958941

<https://hal.inrae.fr/hal-02958941>

Submitted on 6 Oct 2020

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Selection for small size affects the pace-of-life syndrome in medaka impacting the invertebrate community

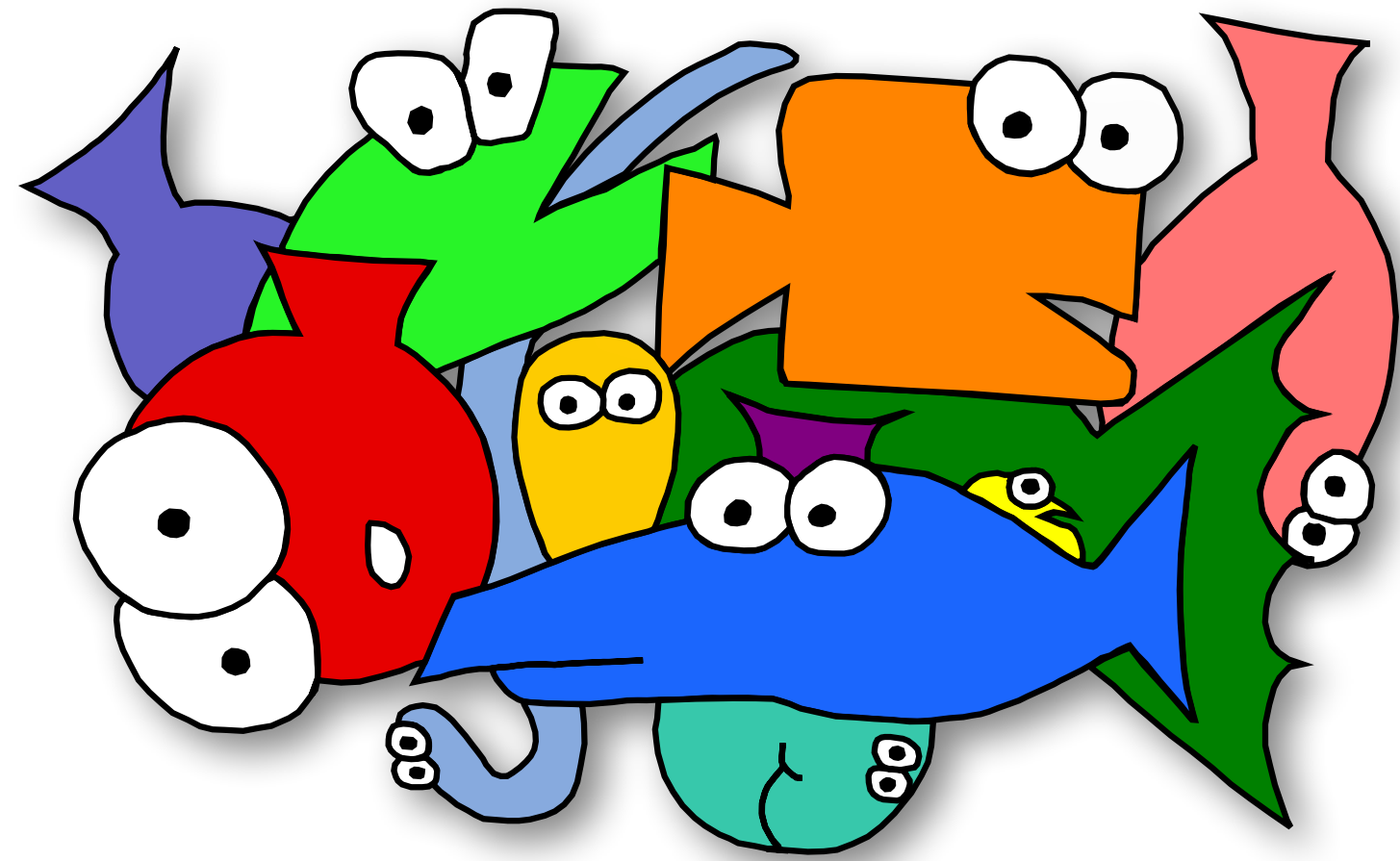
Beatriz Diaz Pauli, Eric Edeline, Charlotte Evangelista



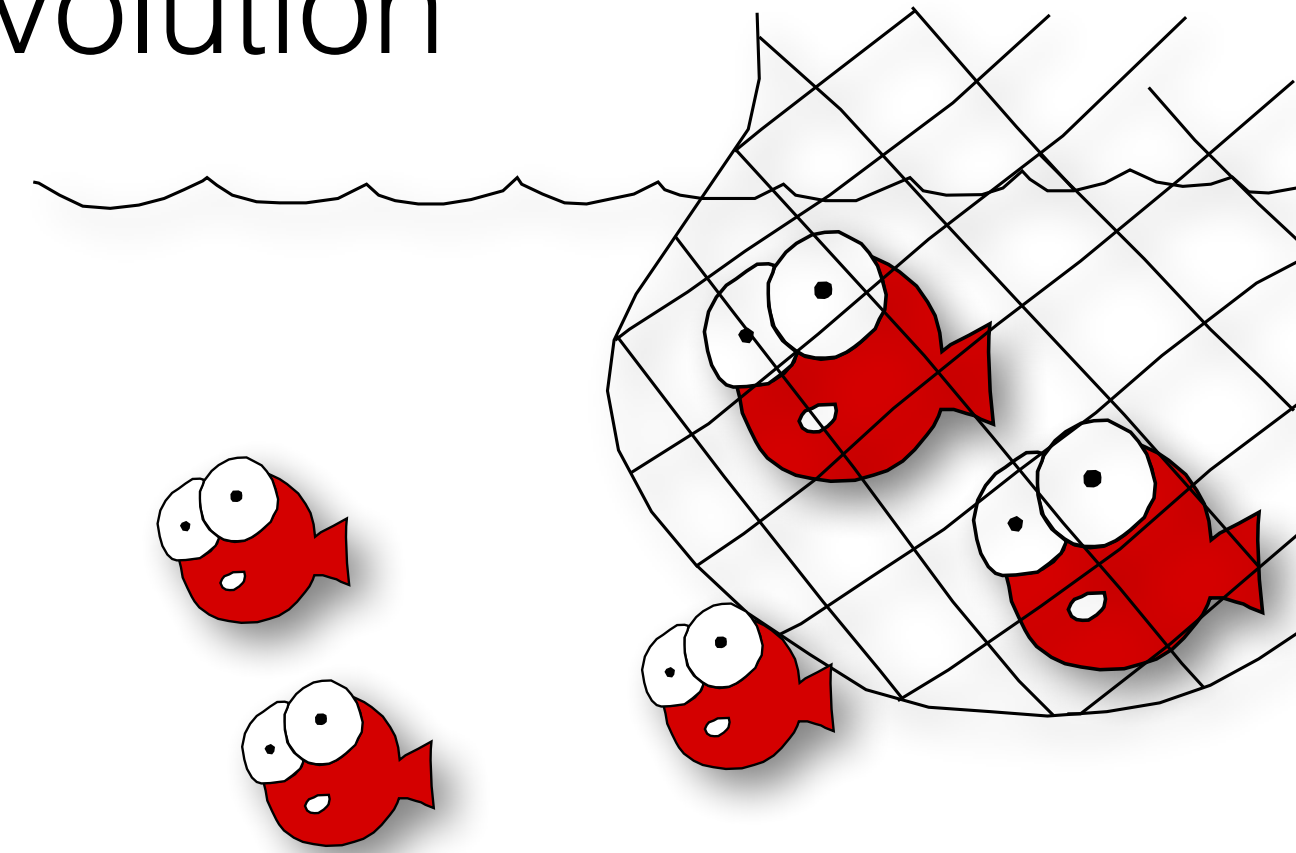
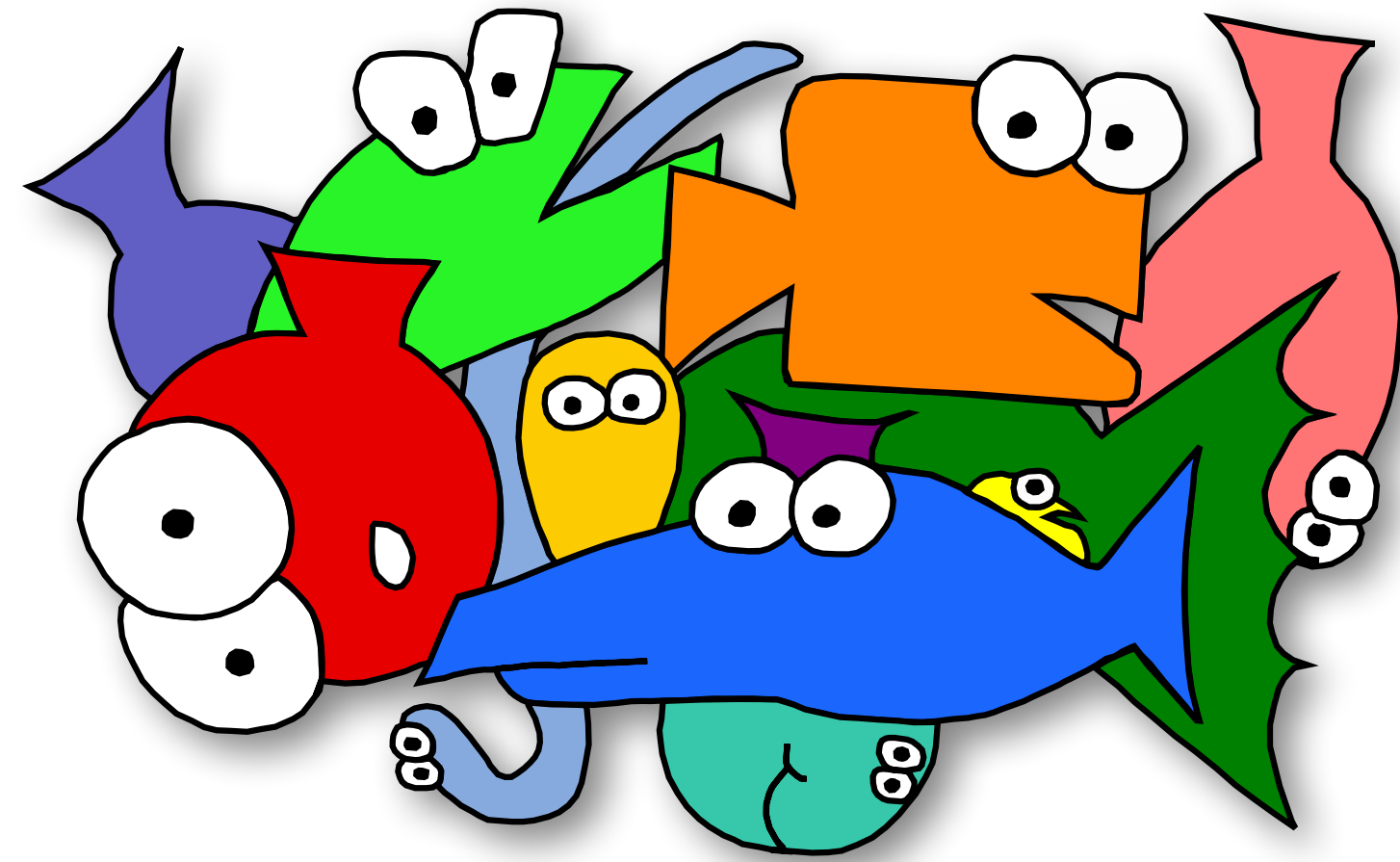
UiO : **Centre for Ecological and Evolutionary Synthesis**
University of Oslo



Fisheries-induced evolution

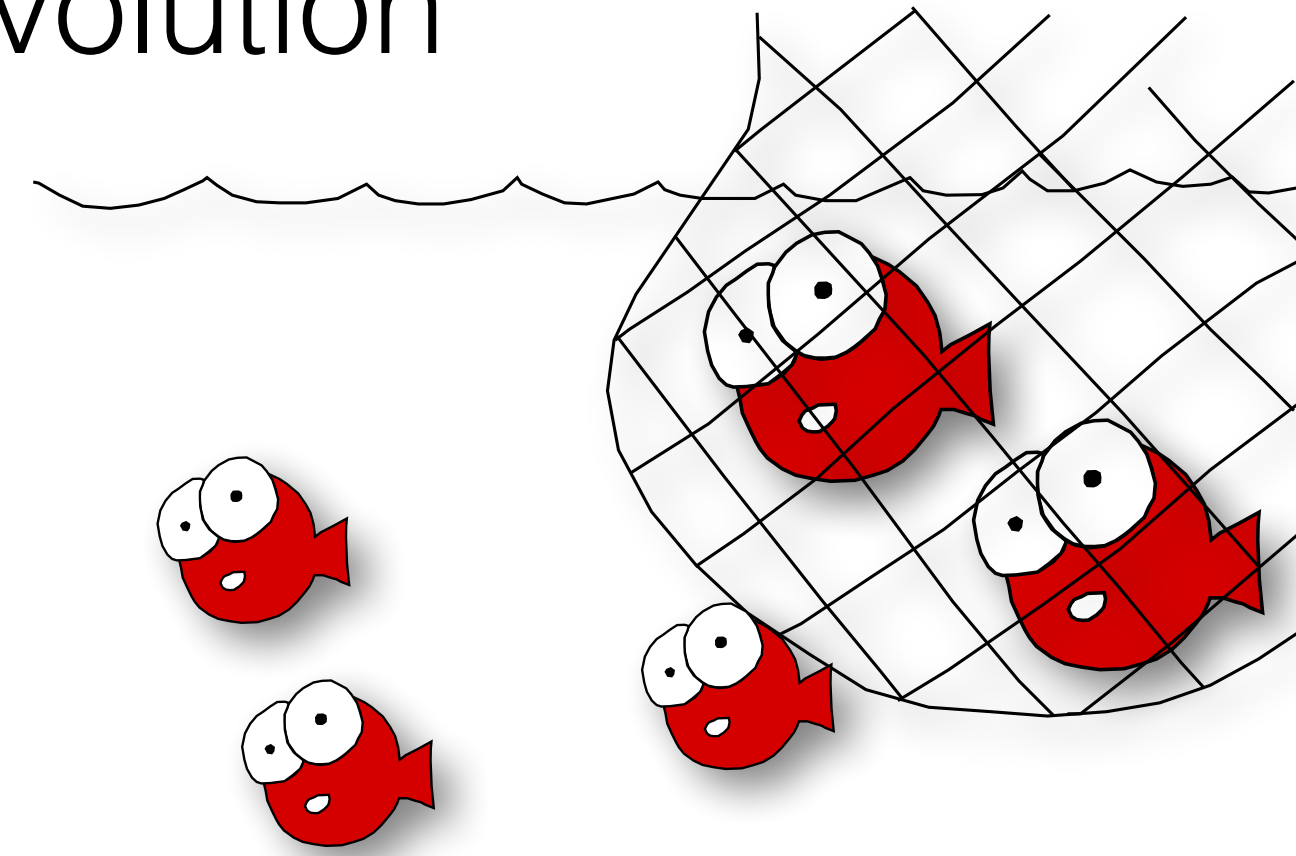
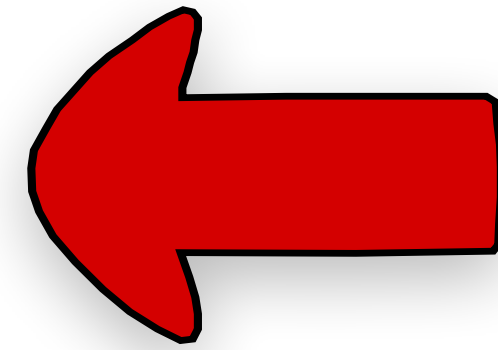


Fisheries-induced evolution

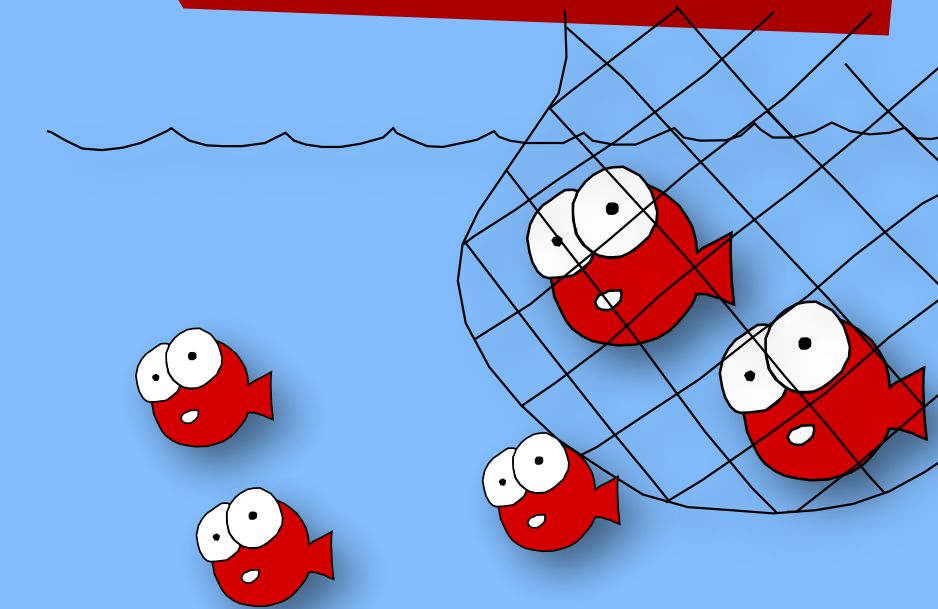
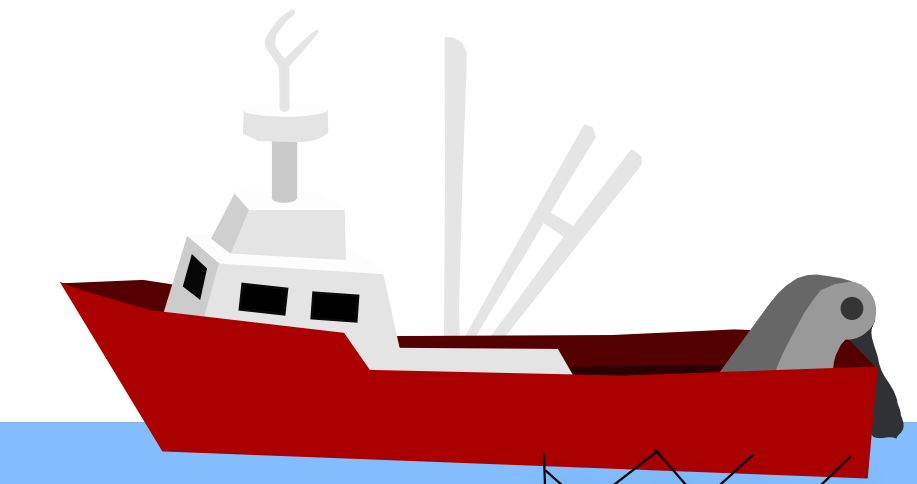


Fisheries-induced evolution

Faster life history
Early maturation

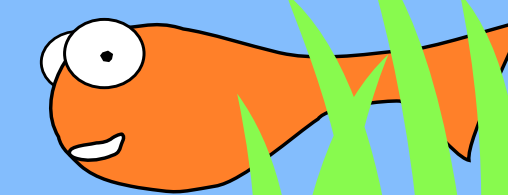
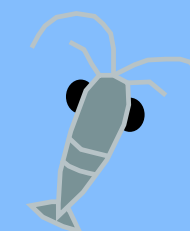
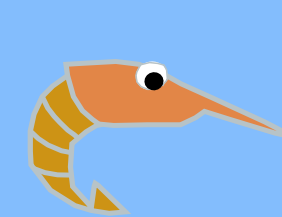
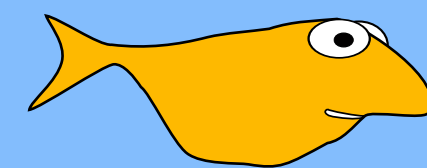
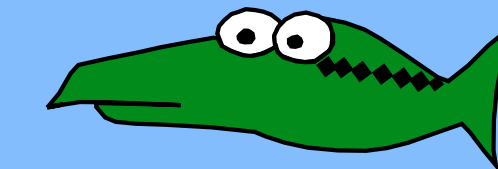


Aim



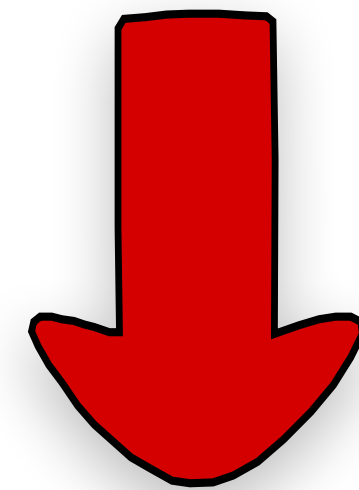
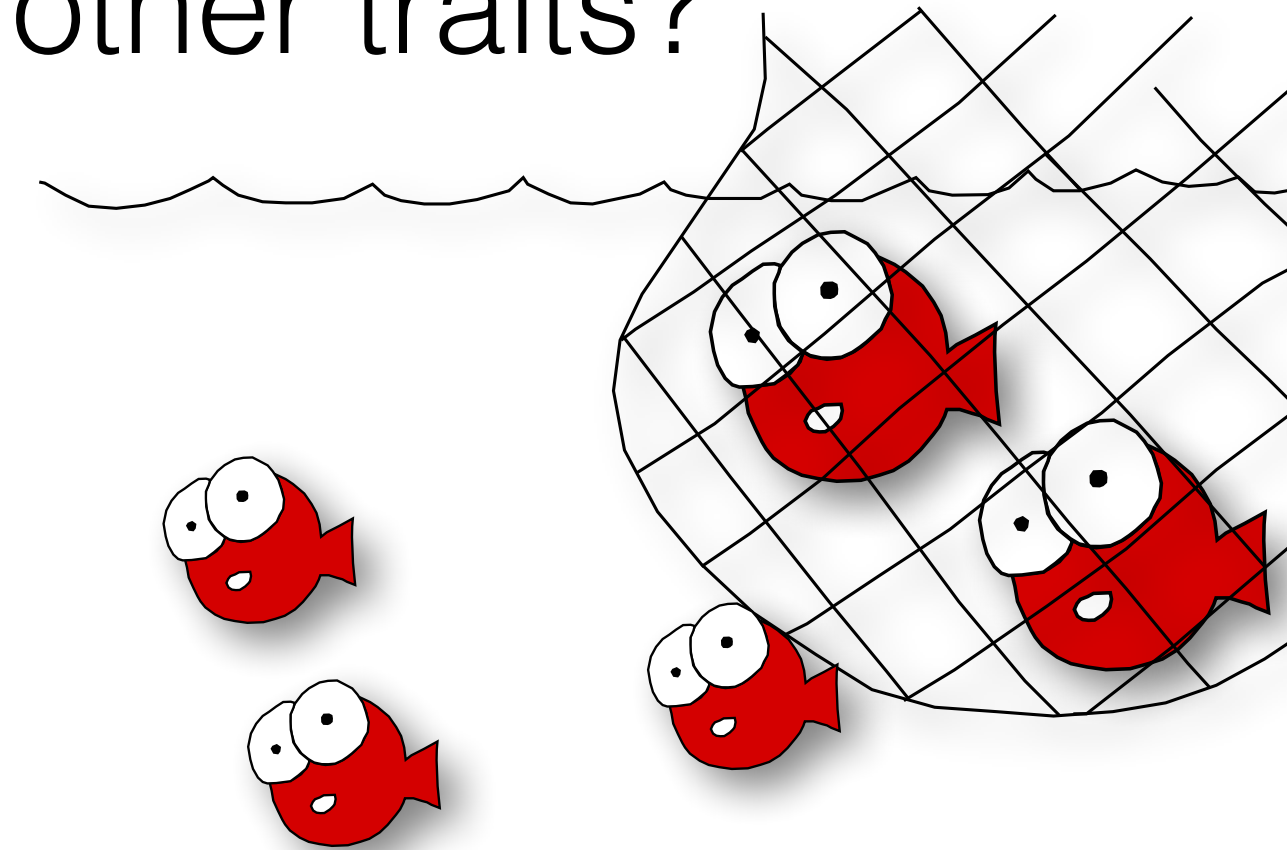
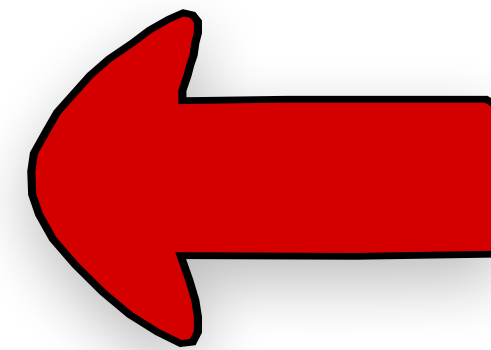
Does fishing affect other traits?

How do these changes affect the ecosystem?



Aim: Does fishing affect other traits?

Faster life history
Early maturation



Behaviour
Physiology

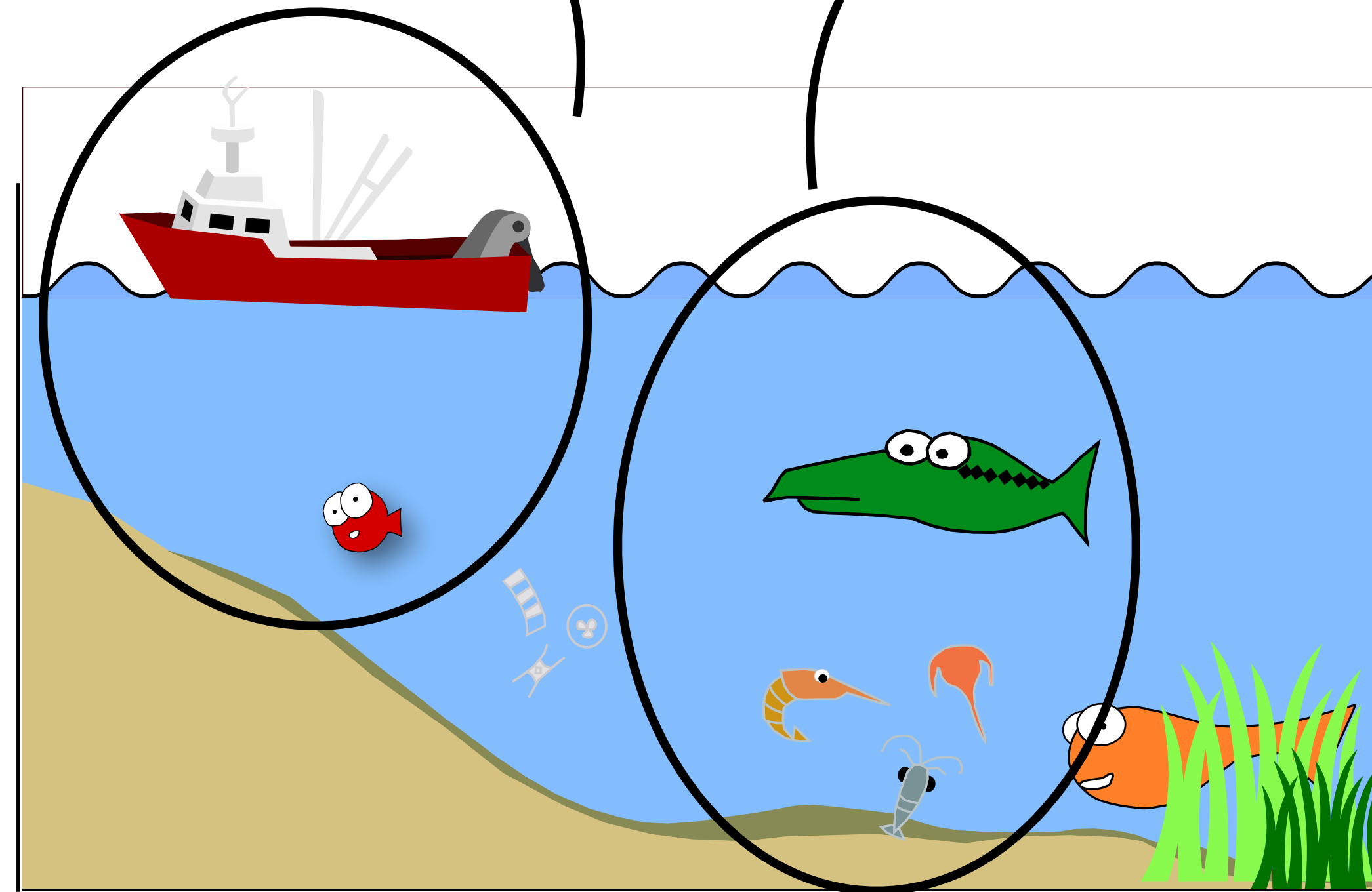
Pace-of-life syndrome

Life-histories traits coevolve
with a of suit of behavioural and physiological traits

Methods

Selection experiment in the lab

Outdoor mesocosms experiment



Methods

Selection experiment in the lab

Outdoor mesocosms experiment

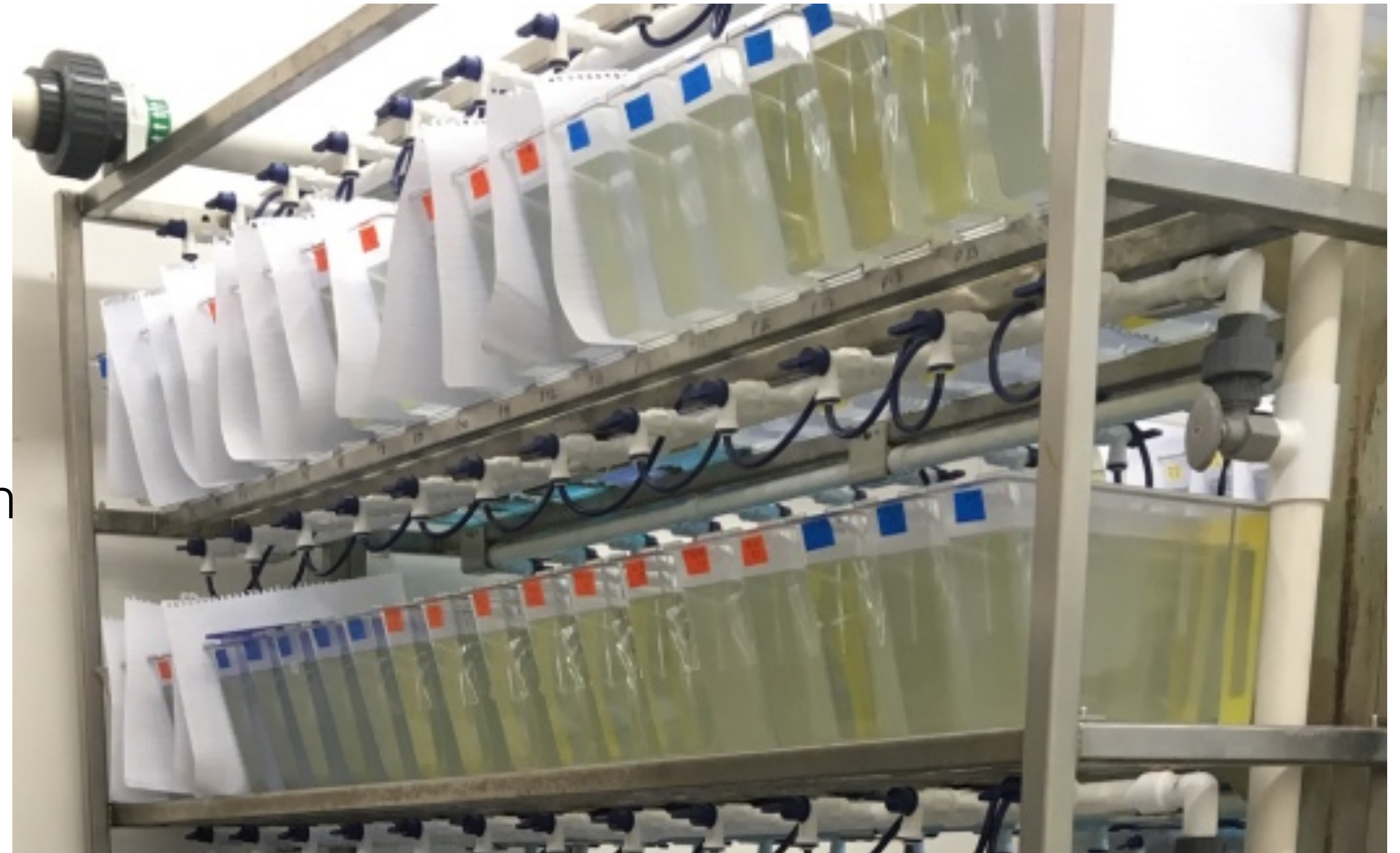


Medaka: *Oryzias latipes*

Methods

Selection experiment in the lab

- 2 lines
- 10 discrete generations
- Selection on size at 75 days post hatch

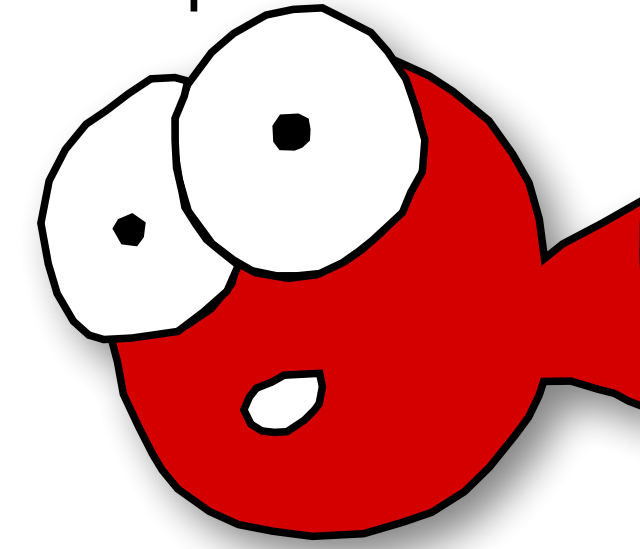


Methods

Selection experiment in the lab

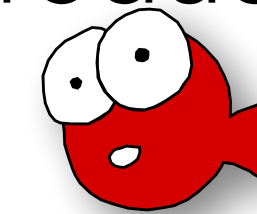
- 2 lines
- 10 discrete generations
- Selection on size at 75 days post hatch

Large-selected
for reproduction



Late maturation
Slow life history

Small-selected
for reproduction



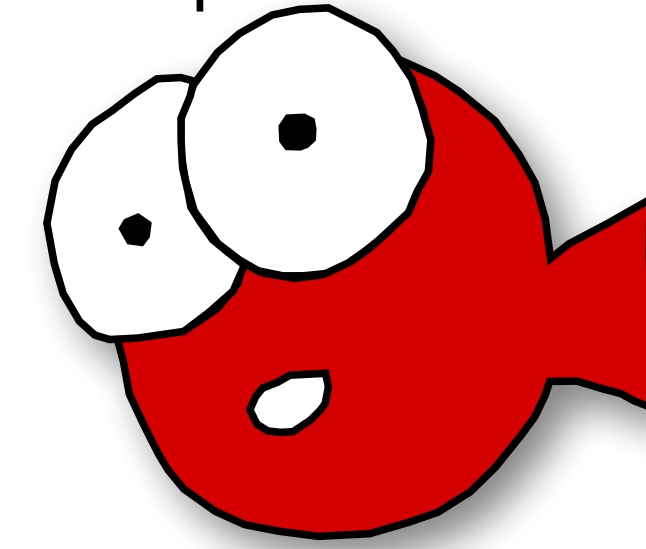
Early maturation
Fast life history

Selection experiment in the lab

- 2 lines
- 10 discrete generations
- Selection on size at 75 days post hatch

Methods

Large-selected
for reproduction



→
Late maturation
Slow life history

Small-selected
for reproduction



→
Early maturation
Fast life history

Mimics fishing selection

Methods

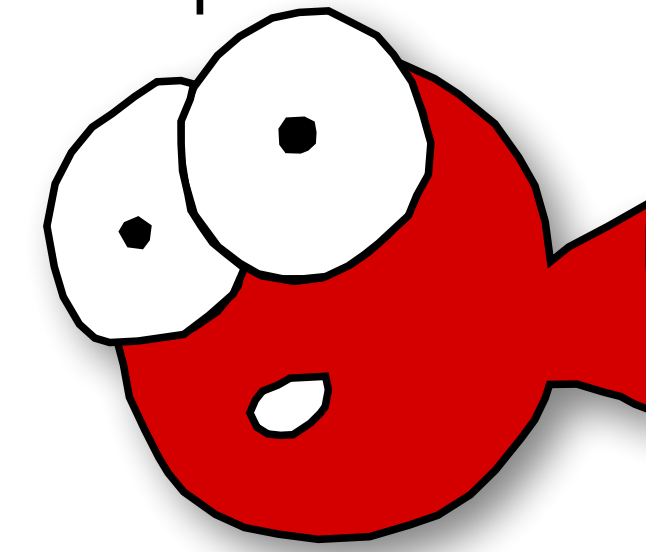
Selection experiment in the lab

- 2 lines
- 10 discrete generations
- Selection from the first hatch



Renneville et al 2018. bioRxiv

Large-selected
for reproduction



Late maturation
Slow life history

Small-selected
for reproduction



Early maturation
Fast life history

Mimics fishing selection

Methods

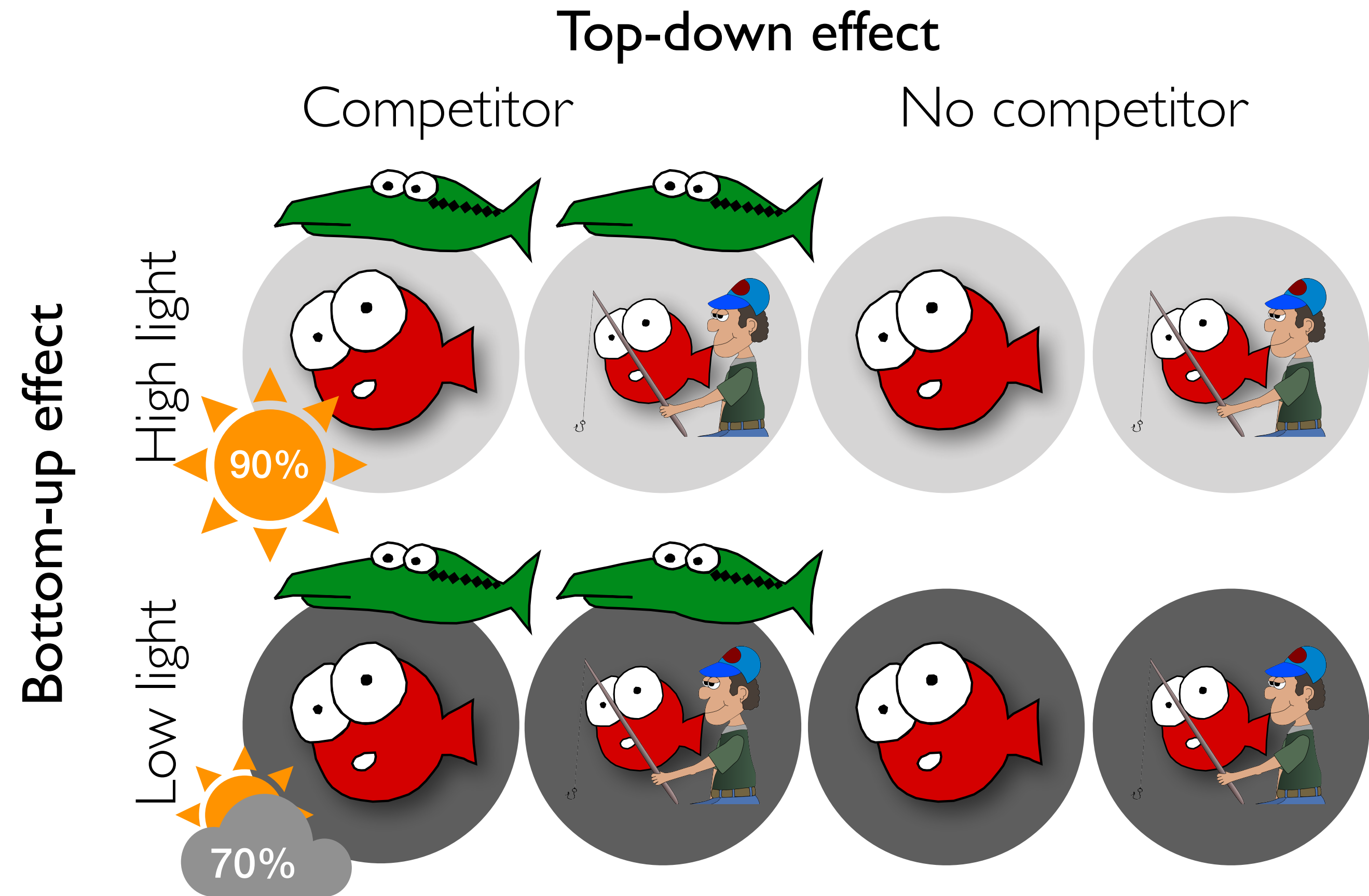
Outdoor mesocosms experiment

- 500 L
- 24 mesocosms
- 2 males & 2 females
- 6 weeks
- 3 treatments:



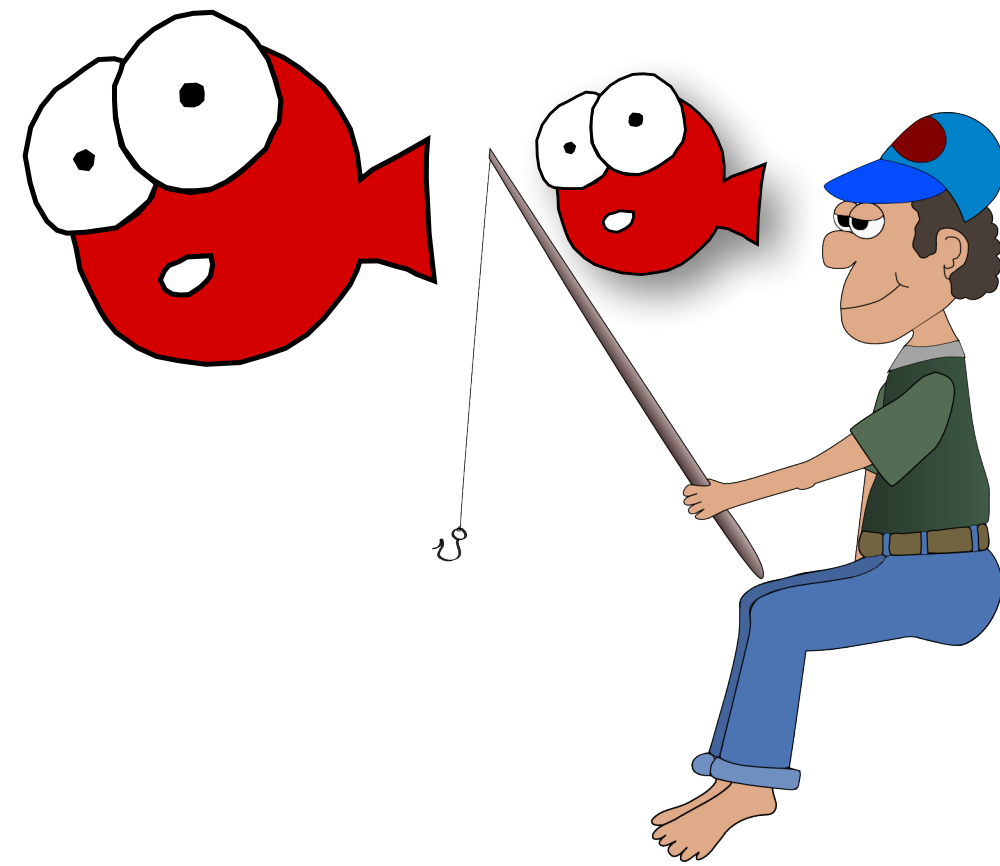
Methods

- 500 L
- 24 mesocosms
- 2 males & 2 females
- 6 weeks
- 3 treatments:
 - Size-selection (slow vs. fast life history)
 - Competitor (presence vs. absence)
 - Light intensity (high vs. low)



Methods: Fish traits

Life history

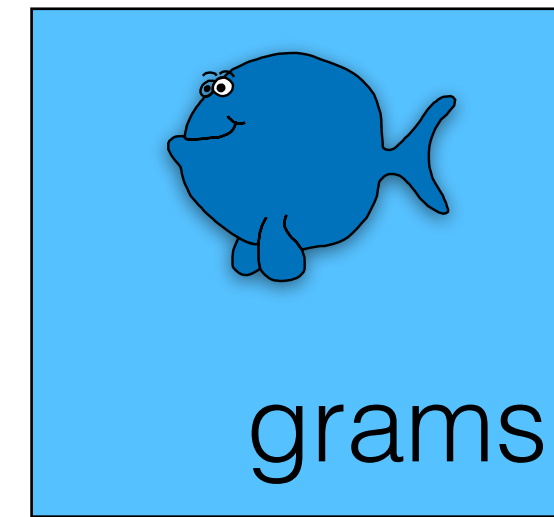


Behaviour

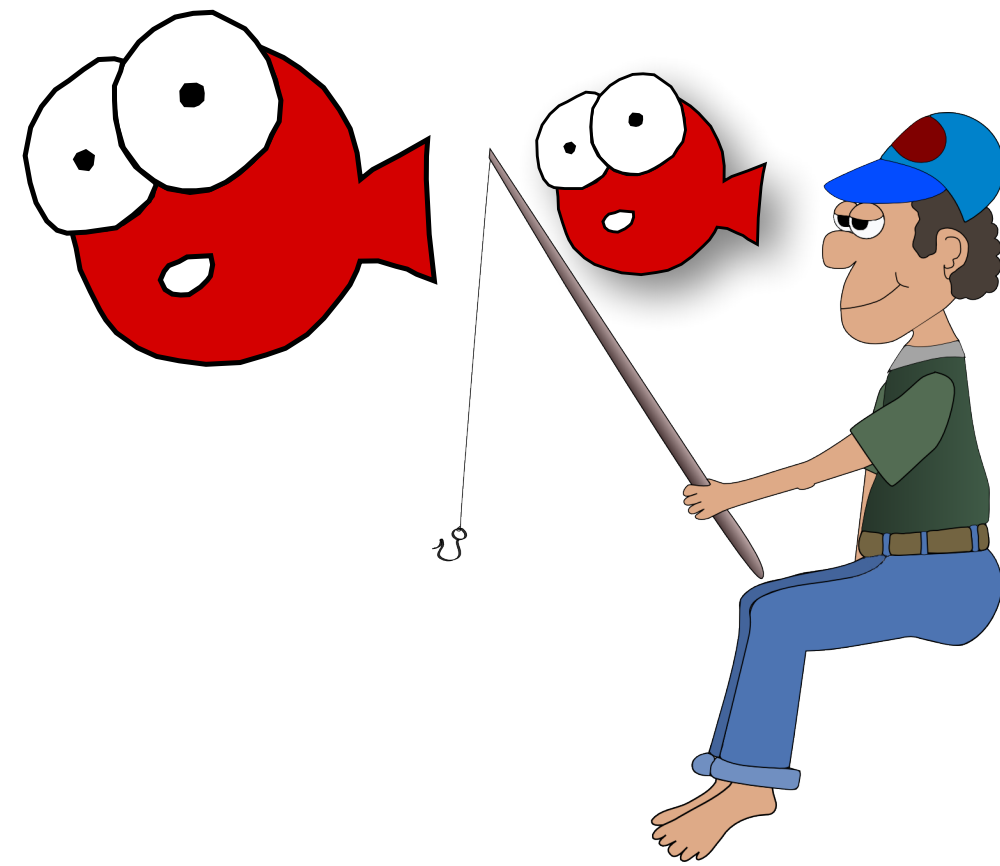
Stoichiometry

Methods: Fish traits

Life history



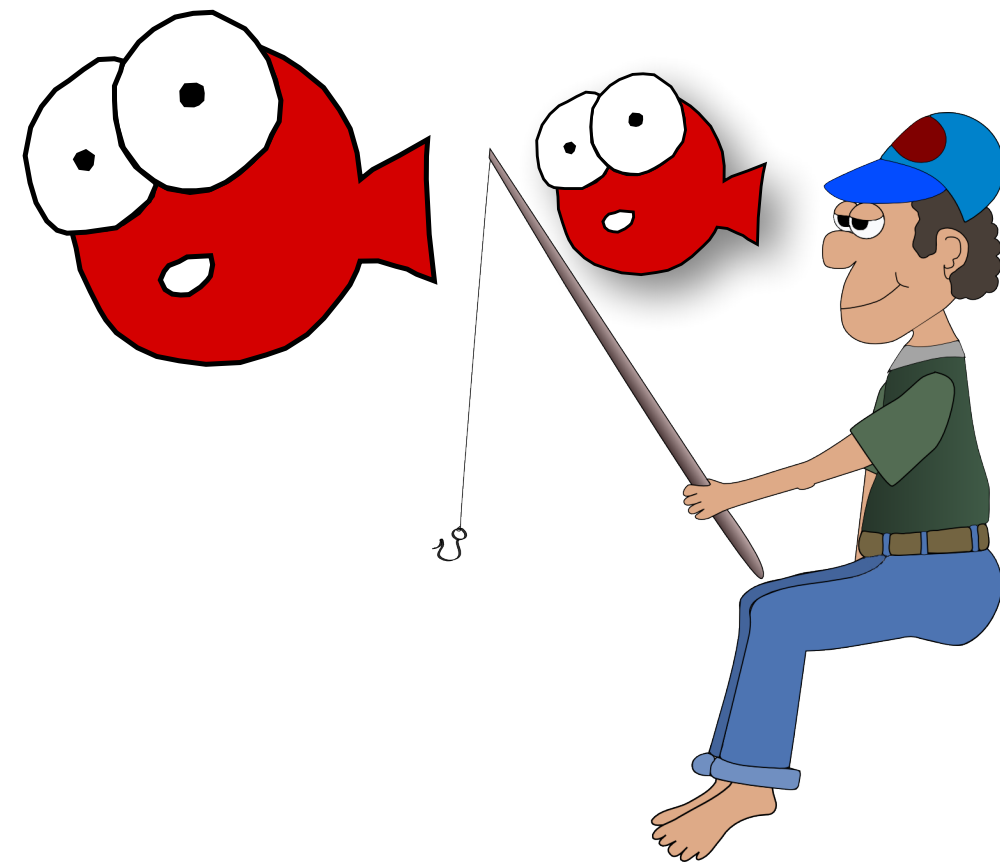
Adult growth rate



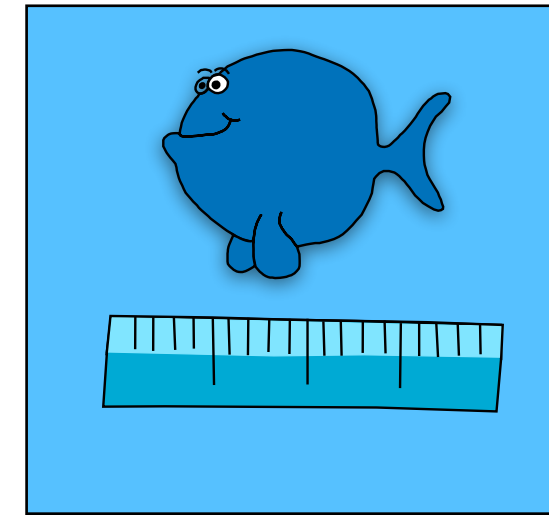
Behaviour

Stoichiometry

Methods: Fish traits

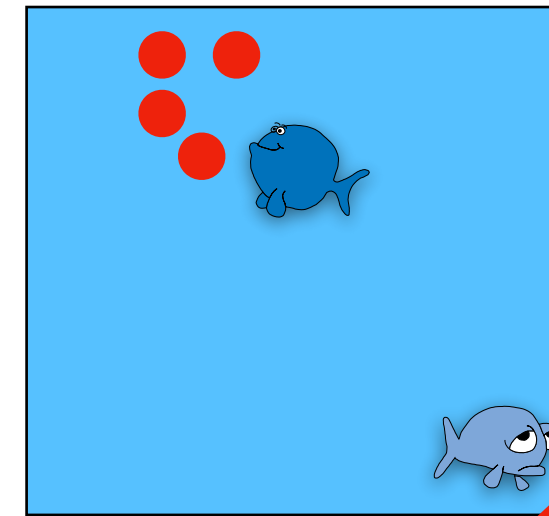


Life history

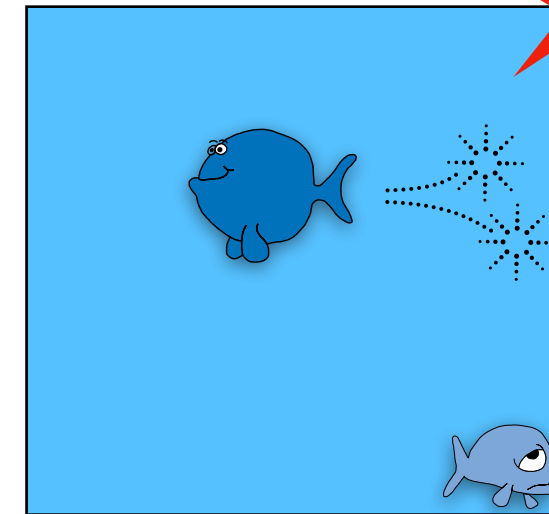


Adult growth rate

Behaviour



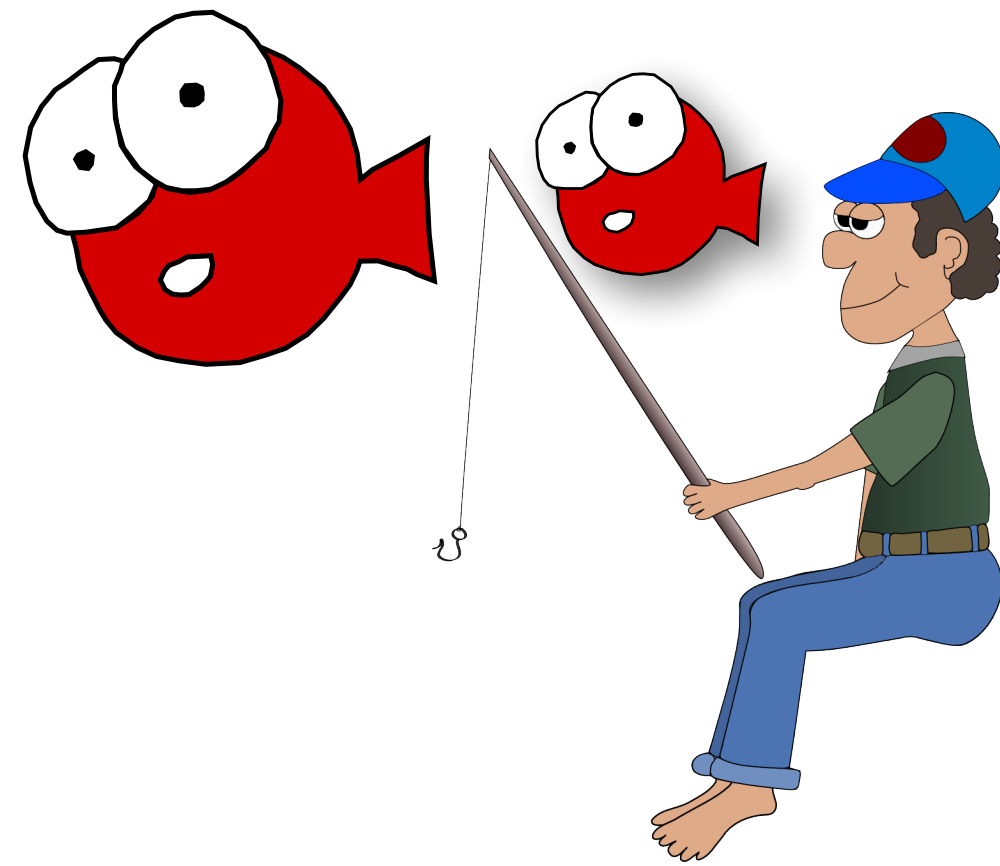
Feeding



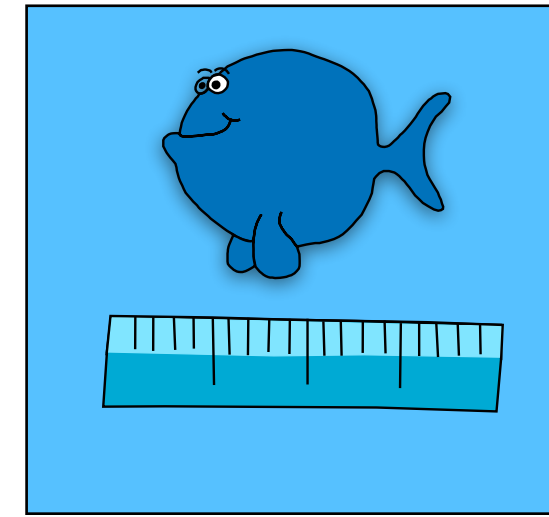
Boldness

Stoichiometry

Methods: Fish traits

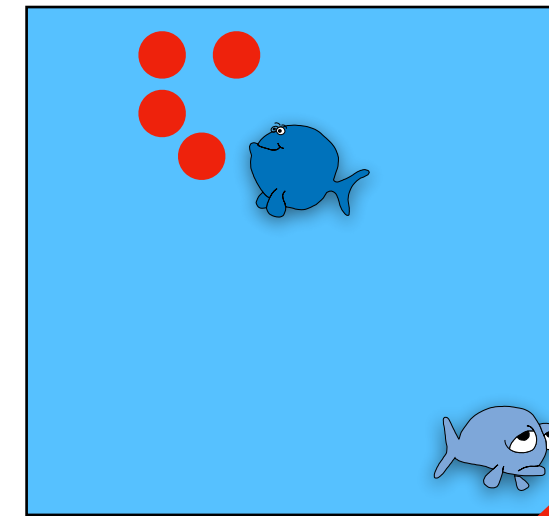


Life history

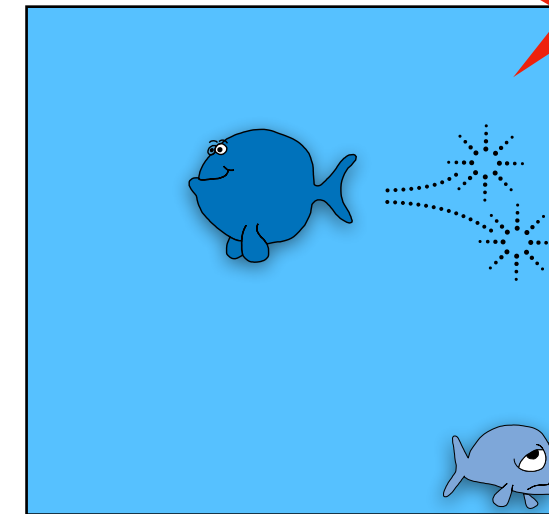


Adult growth rate

Behaviour



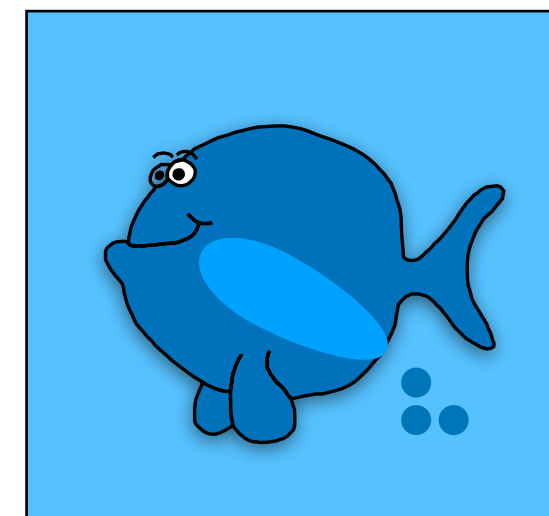
Feeding



Boldness

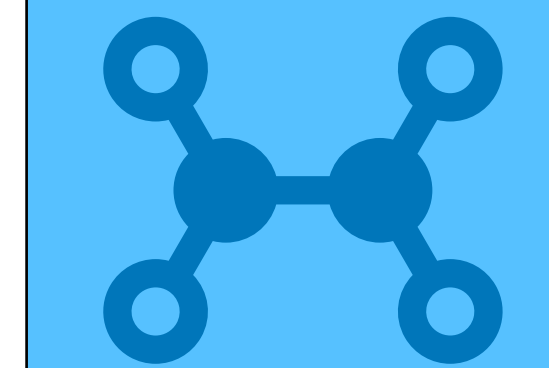
Stoichiometry

Related to fluxes of nutrients within ecosystem



Excretion rate NH_4

C:N & C:P



Proportion Nitrogen and Phosphorous relative to Carbon

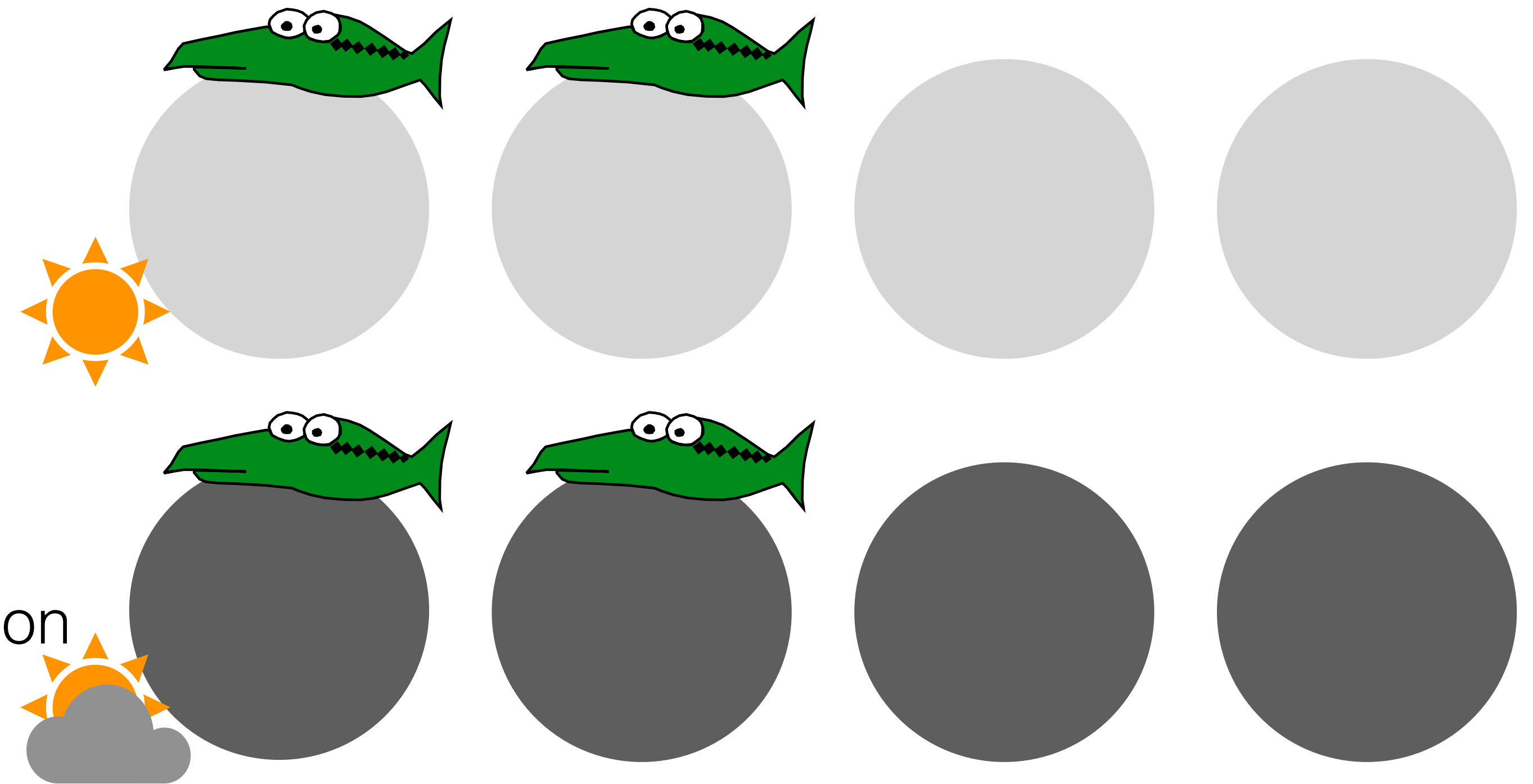
Methods: Ecosystem traits

Community abundance

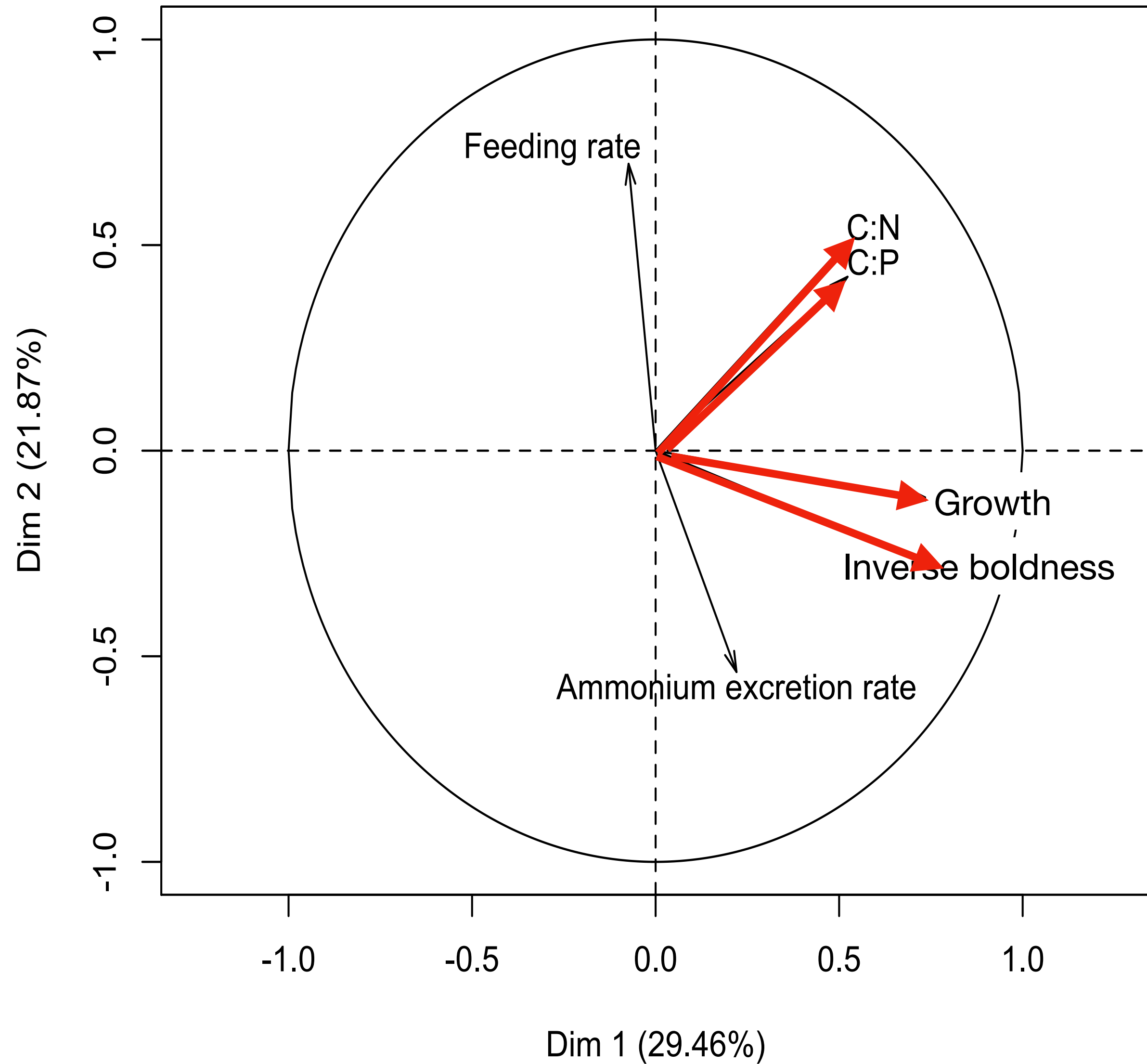
- Zooplankton
- Zoobenthos: 6 taxa

Ecosystem processes:

- Respiration & GPP
- Nutrients in water: P & N
- Sediment stoichiometry
- Pelagic & Benthic algae concentration



Results: Fish traits



Traits covariate —> Pace-of-life syndrome

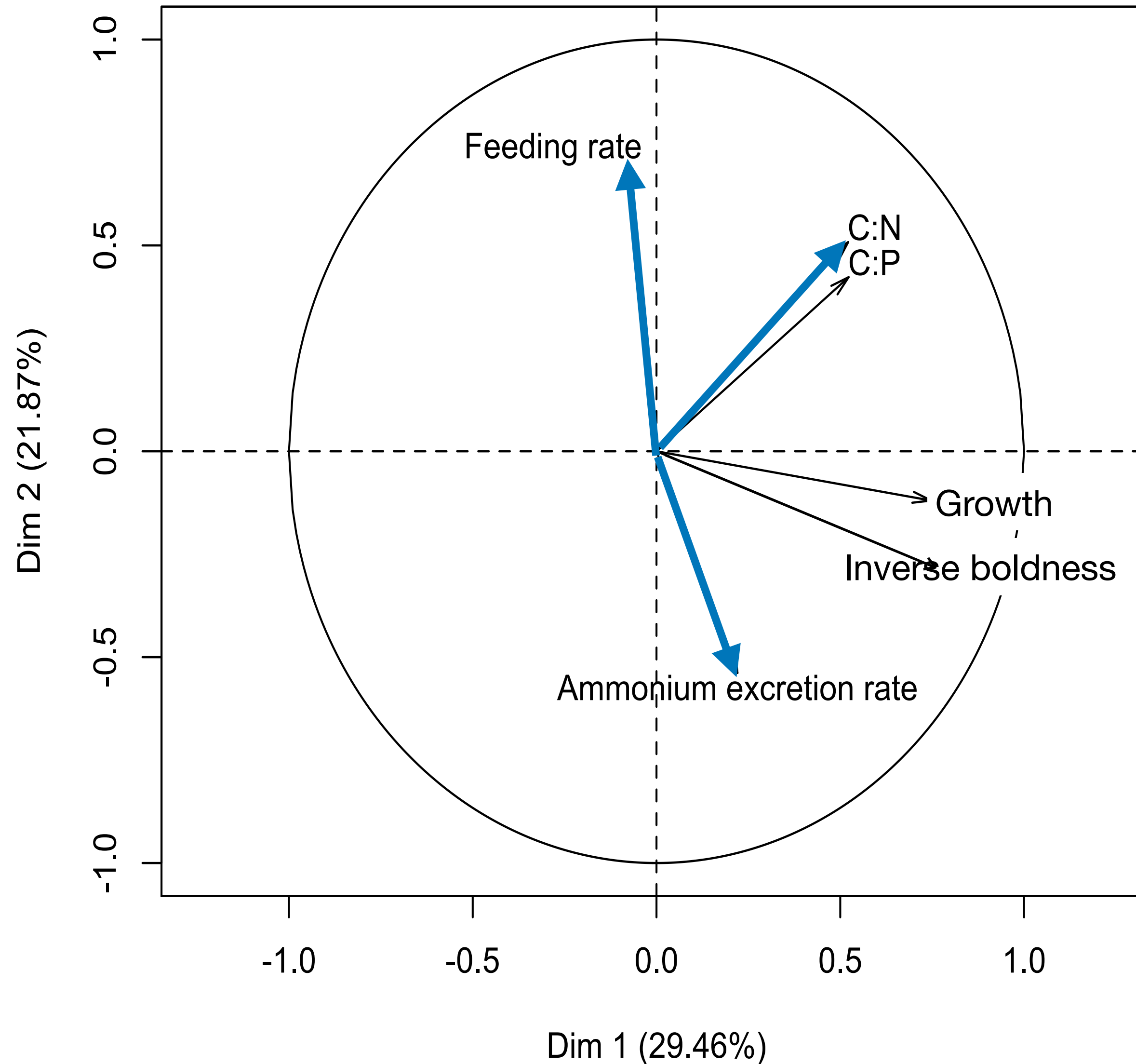
1st axis:

- + Growth rate
- - Boldness
- + Carbon: +C:N & C:P

2nd axis:

- + Feeding rate
- + C:N
- - Excretion of NH₄

Results: Fish traits



Traits covariate —> Pace-of-life syndrome

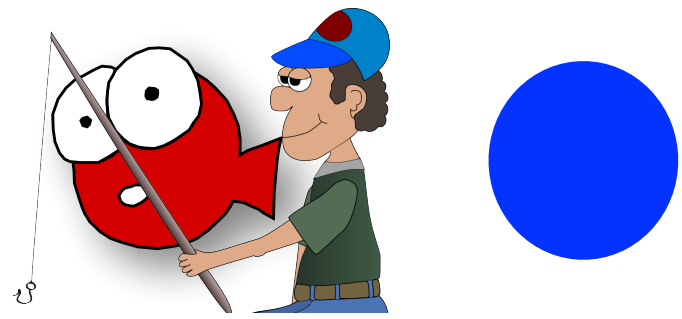
1st axis:

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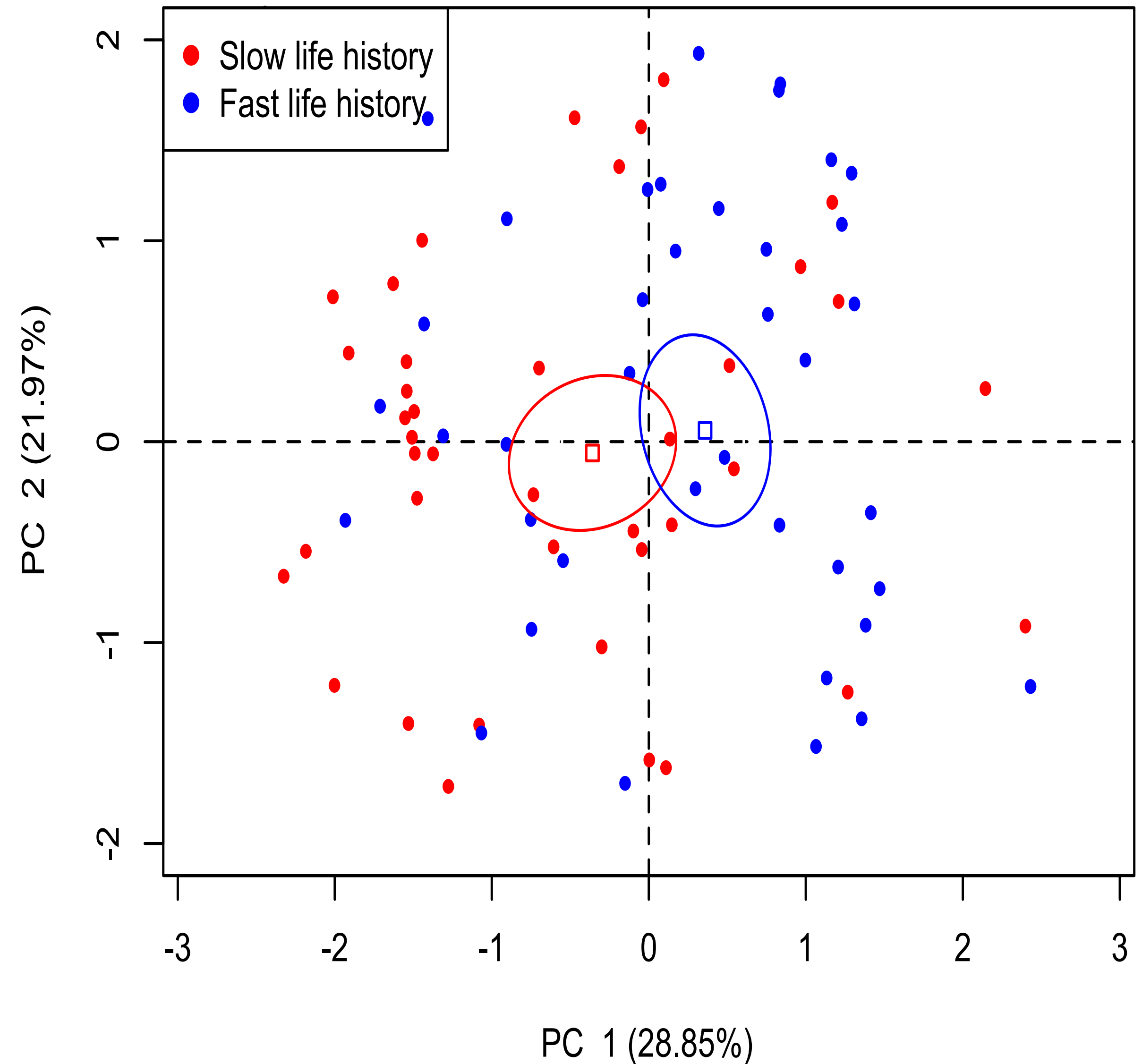
Results: Fish traits



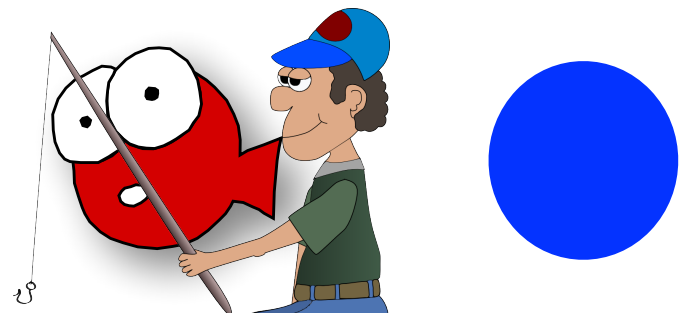
Small-selected line \rightarrow Fast pace of life

- + Carbon: +C:N & C:P
- + Growth rate
- - Boldness

v -test = 2.26, $P = 0.023$



Results: Fish traits



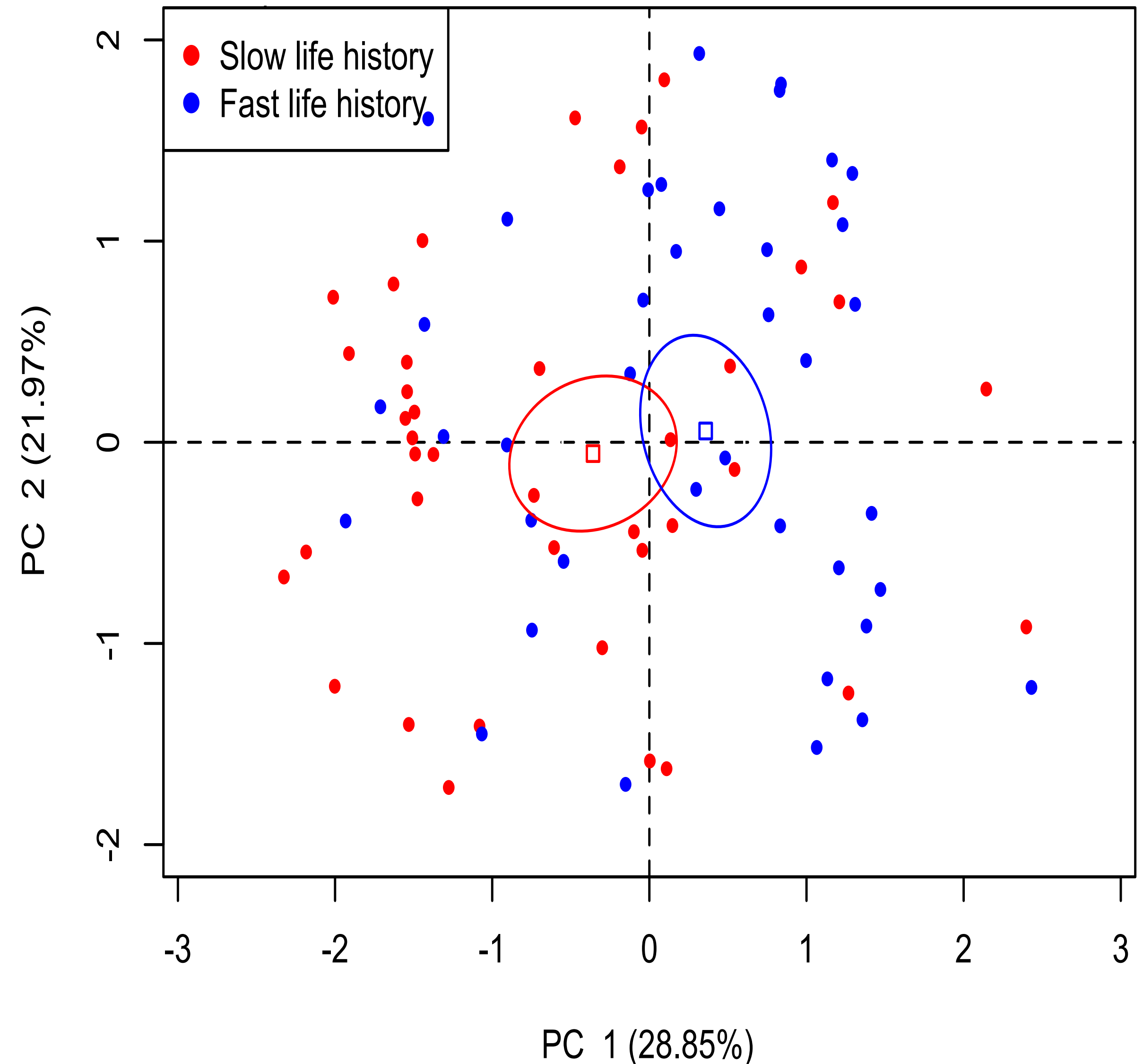
Small-selected line \rightarrow Fast pace of life

- + Carbon: +C:N & C:P
- + Growth rate
- - Boldness

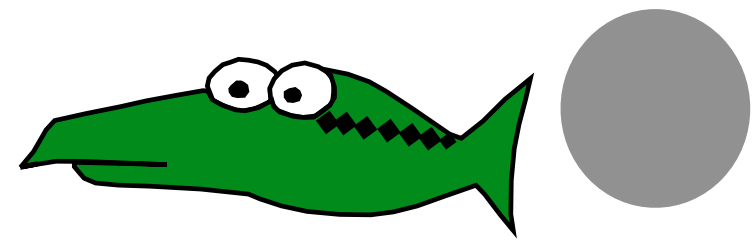
Small-selected had earlier maturation:

Weight increase linked +C (fat tissue)
 \rightarrow and investment in reproduction

$$v\text{-test} = 2.26, P = 0.023$$



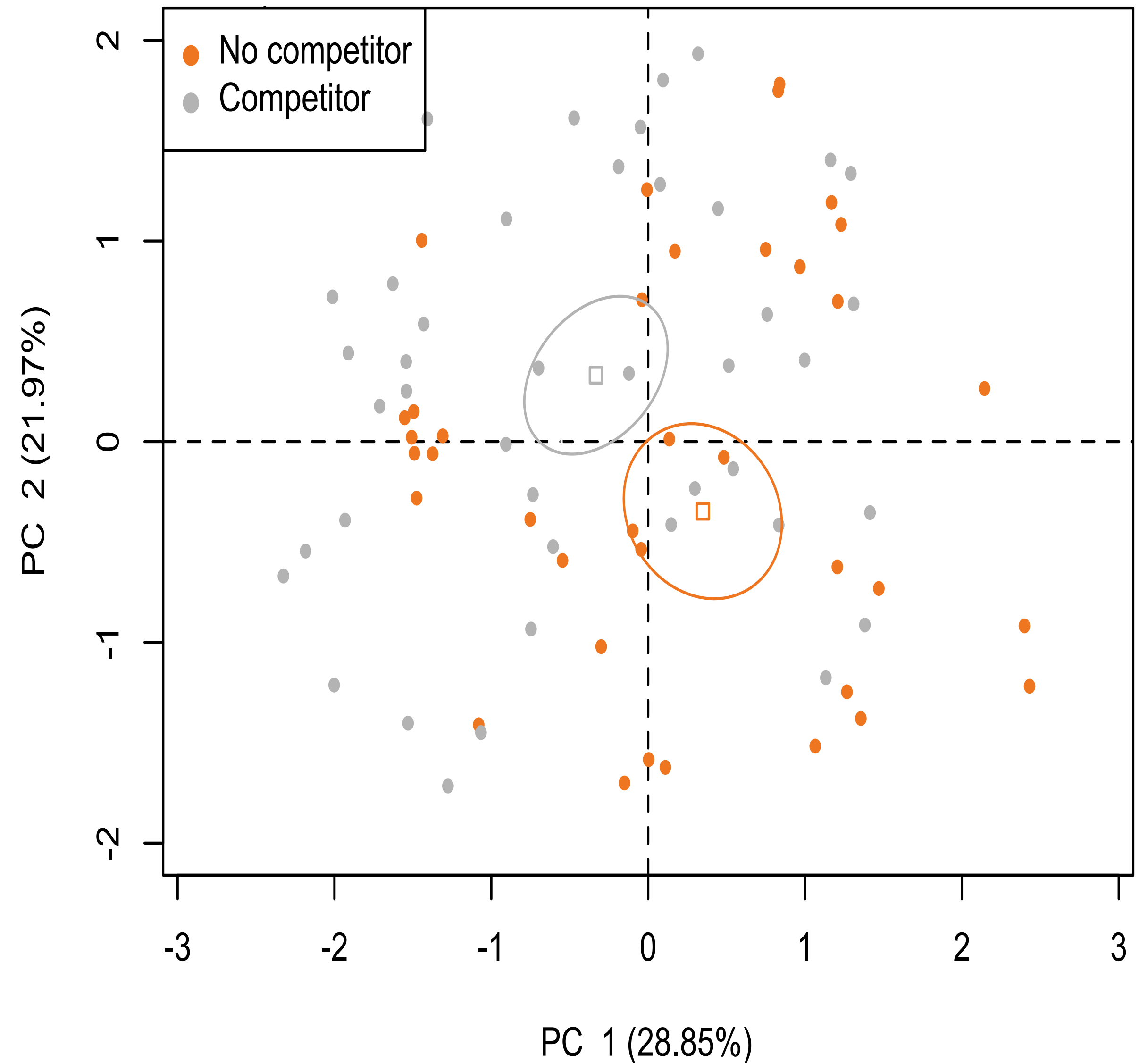
Results: Fish traits



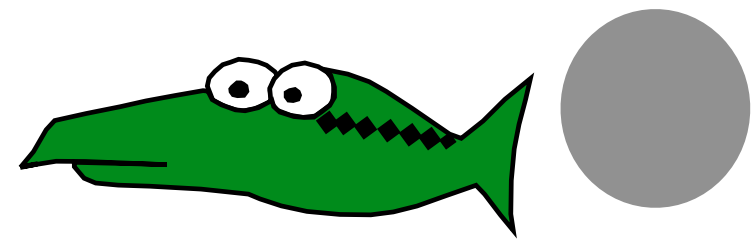
Competitor presence \rightarrow Slow pace of life

- - Carbon: +C:N & C:P
- - Growth rate
- + Boldness

v -test = -2.39, $P = 0.016$



Results: Fish traits

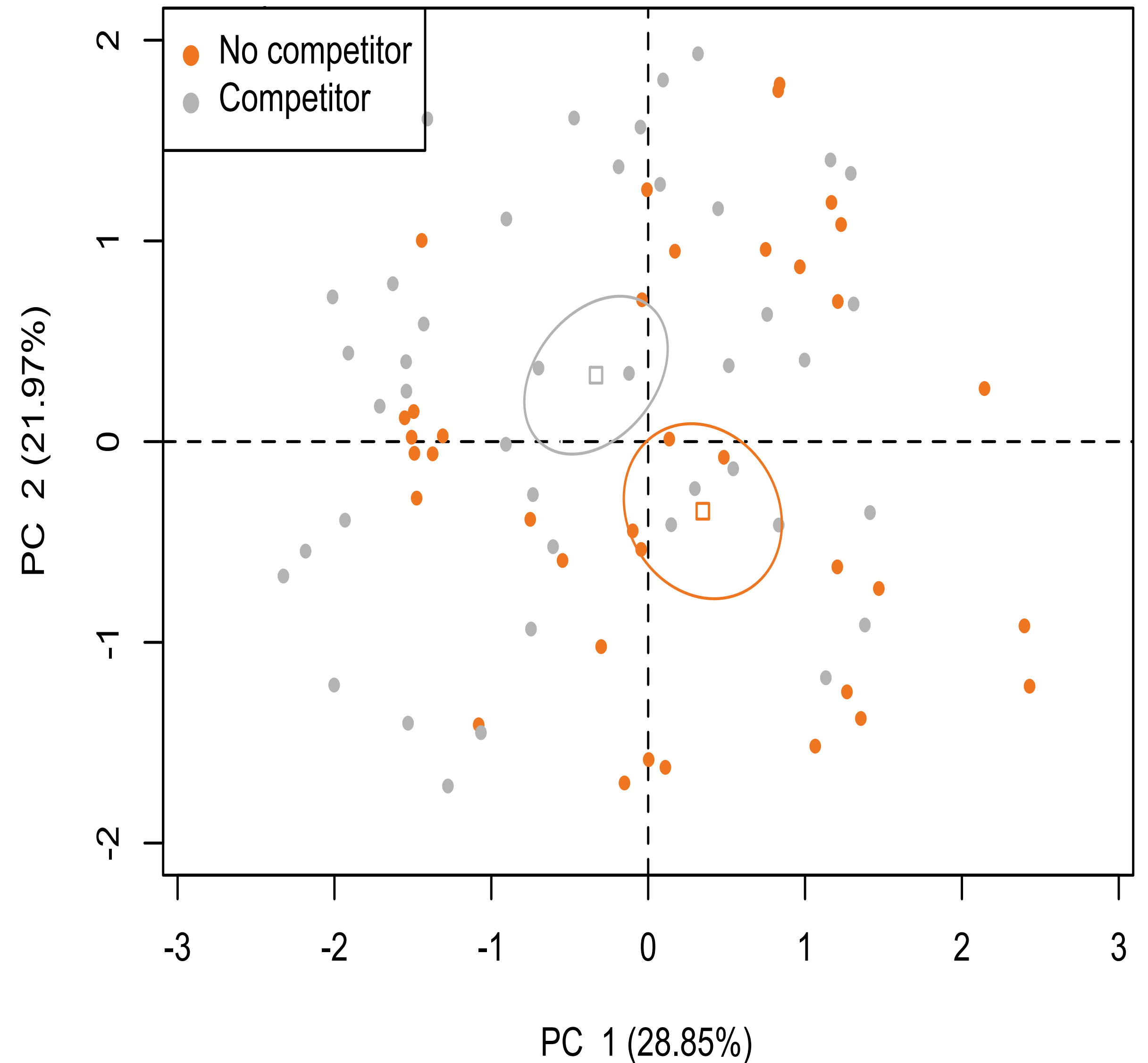


Competitor presence \rightarrow Slow pace of life

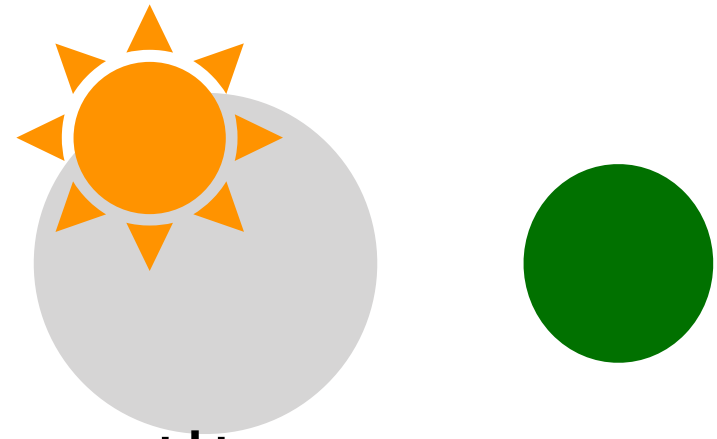
- - Carbon: +C:N & C:P
- - Growth rate
- + Boldness

Slow growth due to lower access to resources

$$v\text{-test} = -2.39, P = 0.016$$



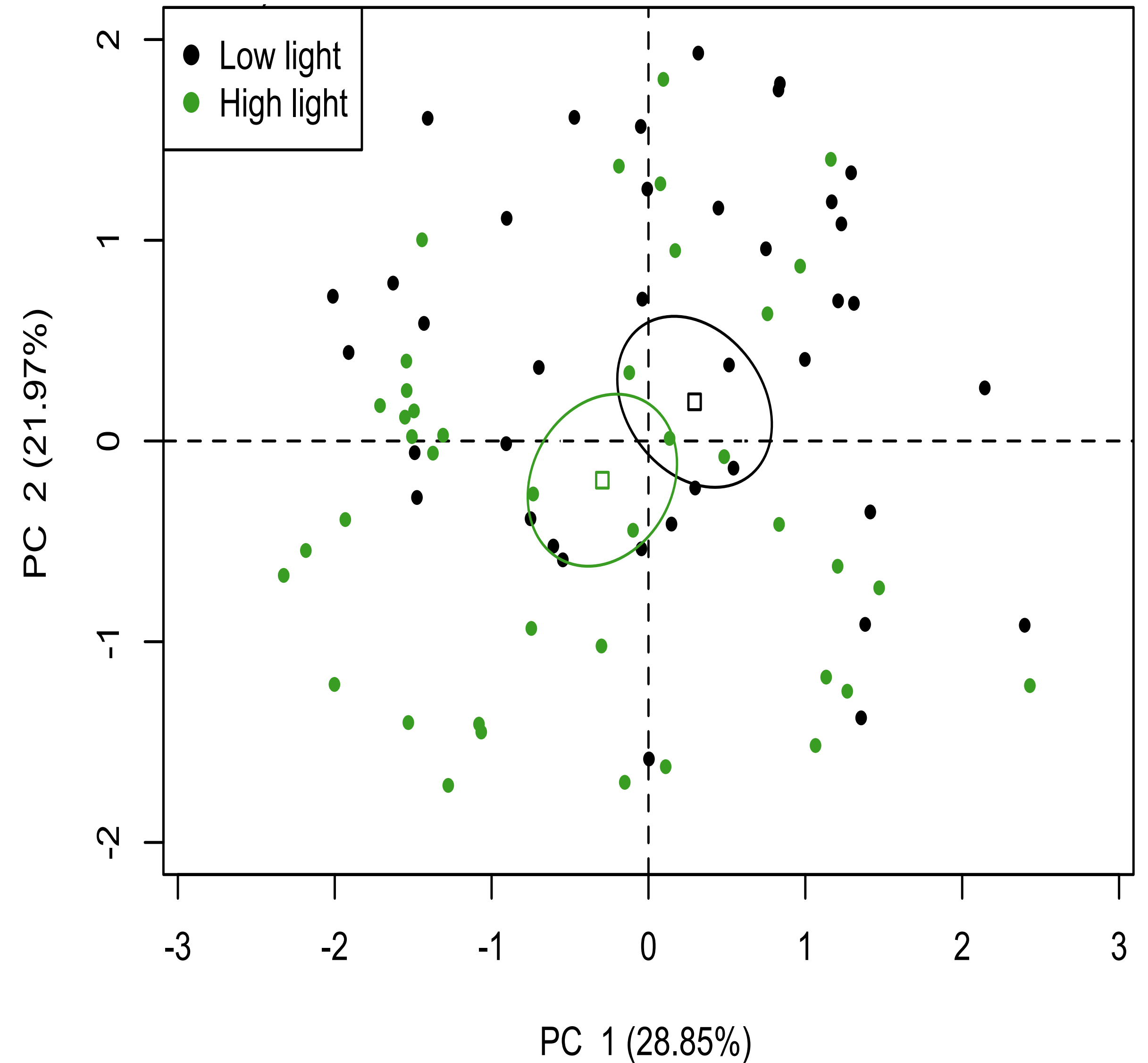
Results: Fish traits



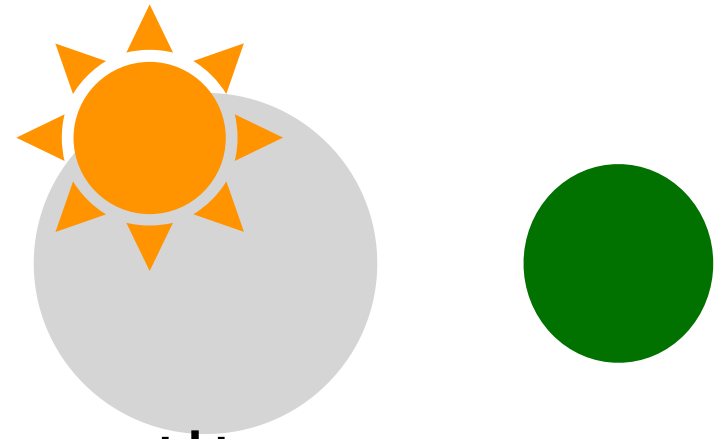
Competitor presence \rightarrow Slow pace of life

- - Carbon: +C:N & C:P
- - Growth rate
- + Boldness
- *** But smaller effect

v -test = -2.06, $P = 0.038$



Results: Fish traits



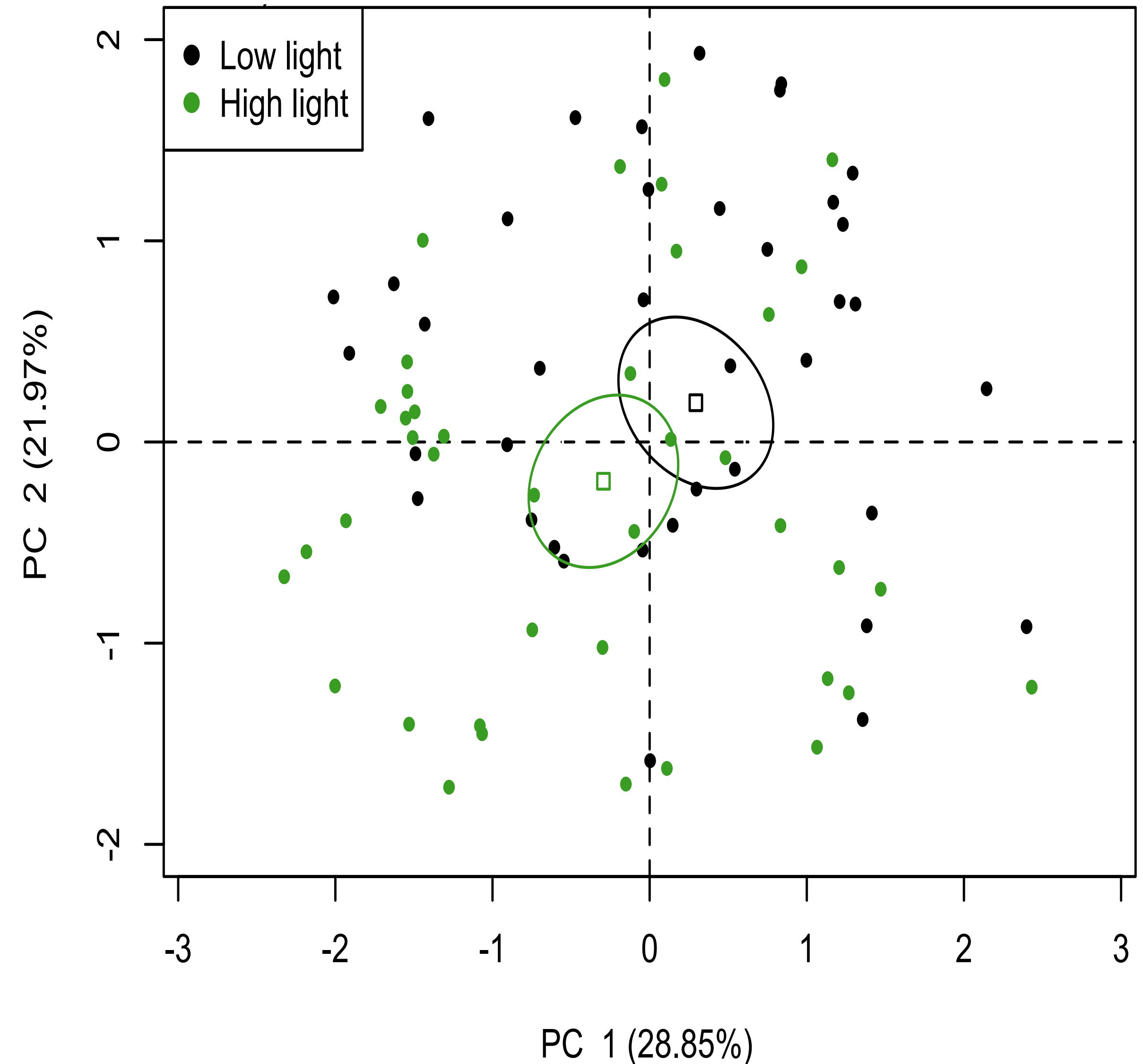
Competitor presence \rightarrow Slow pace of life

- - Carbon: +C:N & C:P
 - - Growth rate
 - + Boldness
- *** But smaller effect

Slow growth due to lower access to resources

High light \rightarrow more algae, but low quality
 \rightarrow less plankton

$$v\text{-test} = -2.06, P = 0.038$$



Results: Community abundances

2nd axis:

- + Feeding rate
- + C:N
- - Excretion of NH_4



Lower abundance:

- Bosminidae
- Cyclopidae
- Planorbidae

Probably by feeding on them



Results: Community abundances

2nd axis:

- + Feeding rate
- + C:N
- - Excretion of NH₄



Lower abundance:

- Bosminidae
- Cyclopidae
- Planorbidae

Results: Ecosystem processes

No fish trait effect on any process

Take-home message

- 1) Selection for small size not only changes life history
- but behaviour and stoichiometric traits
- 2) Growth, behavioural and stoichiometric traits covary
- Size-selection for small size \longleftrightarrow fast pace of life
- 3) Individual traits variation in feeding, C:N and excretion
led to changes in 3 invertebrate species abundance

Thank you for listening



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