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Response of a cold water species – the Arctic charr (*Salvelinus alpinus*) – to climate warming

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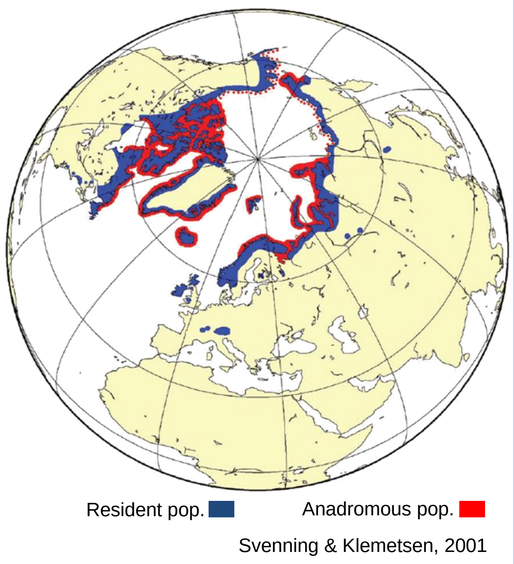
Biological model: the Arctic charr

The **most cold-adapted freshwater fish:**

- wide circumpolar distribution
- strong **stenothermic requirements**
- alpine pop. at the **southern edge**
- alpine lakes highly concerned by warming

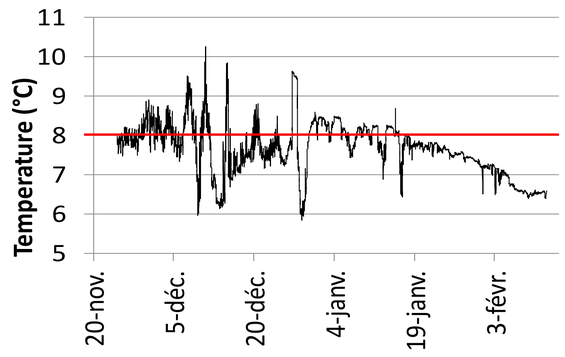


Svenning & Klemetsen, 2001

→ Arctic charr is assumed to be **vulnerable to increasing T°**

Problematic: impact of T° on early stages

- Literature indicates that **incubation is imperiled if T°>8°C**
- In southern populations, **temperature on spawning ground sometimes exceeds 8°C** (here, in Lake Geneva, 40 m depth in 2014-2015):



→ **Effect of T°** and the **adaptive potential** of pop.
→ **Direct** *vs* **indirect** effects? Interact° with other stressors?

Experiment 1: local adaptation and adaptive potential facing increasing T°

Hyp: T°contrasted habitats could lead to contrasted responses to T° (local adaptation)

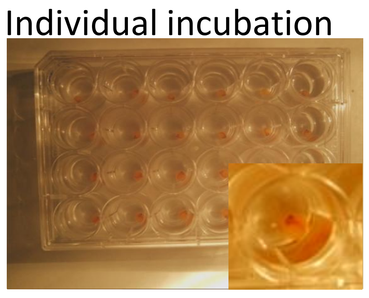
- Common garden with several pops from T°contrasted lakes
- Factorial crossings within populations (separate genetic and environmental components of phenotypic variance/quantitative genetics)

Spawners sampling

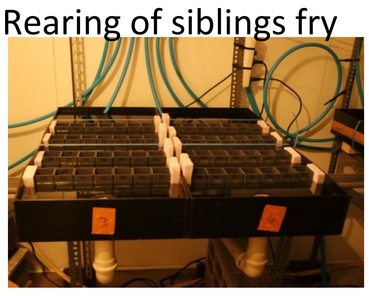
Ova and milt extraction

Artificial crossings

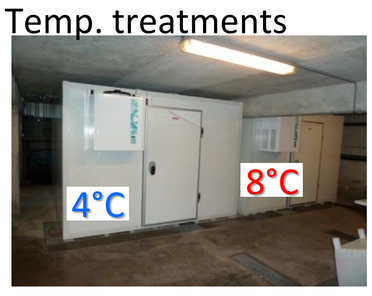
Individual incubation



Rearing of siblings fry



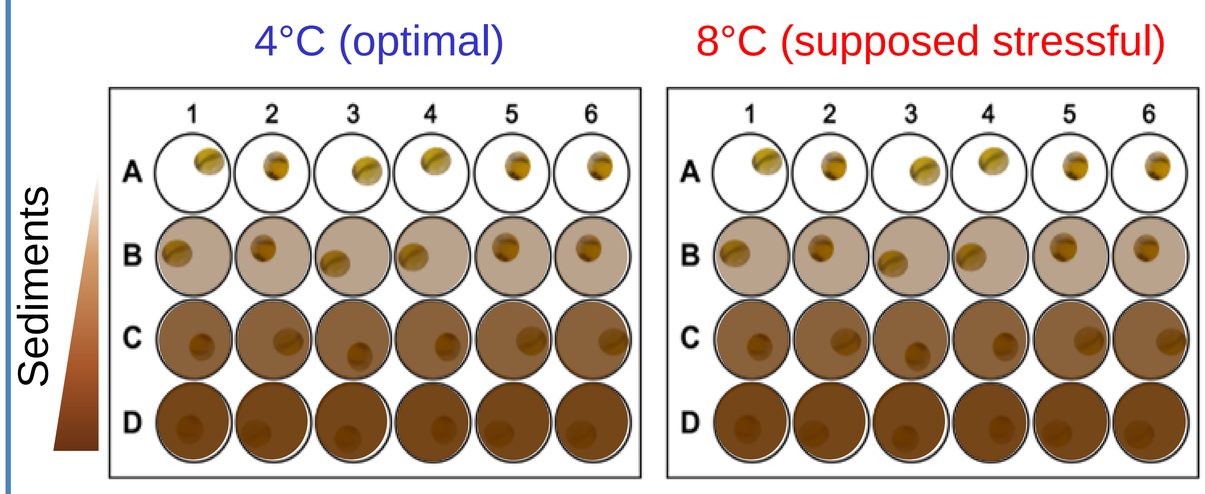
Temp. treatments



Experiment 2: crossed effect of T° and an other factor (sediment cover)

Hyp: Oxygen demand is supposed to increase with T°, and oxygen disponibility is supposed to decrease with sediments

- Domesticated population (INRA stock)
- Exposition of eggs to a double gradient of T° and sediment concentration in microplates

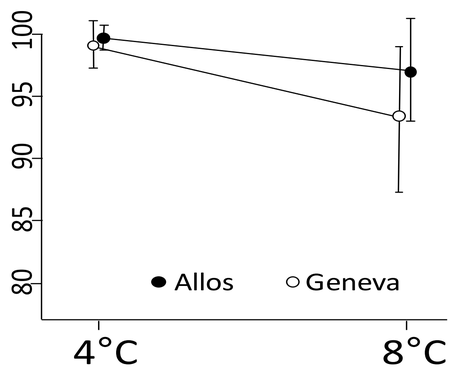


Response variables: ecology and physiology approach

1-'Basic' ecological traits and reaction norms

Survival, timing of development, size at different stages + malformations

Survival (eyed-hatched)



3- Ecophysiological tradeoffs

How physiology shapes life-history tradeoffs?

Resource allocation

growth maintenance

2-Analysis of oxidative balance

Quantification of defences and damages from/of reactive oxygen species (ROS)

Temperature, sediments,... → metabolism ↓

Antiox. ROS

Damages/repairs

The project

- Started 2015
- Funded by ONEMA (2015-2018) (~125k€)

- 1 PhD (Ministry grant)
- Experiment 1: test in 2015, running in 2016
- Experiment 2: test in 2016

Funded by: ONEMA Office national de l'eau et des milieux aquatiques

Leader: INRA SCIENCE & IMPACT

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