LIGHT ENVIRONMENT AFFECTS ENDOCRINE AND IMMUNE RHYTHMS IN PIKEPERCH (*SANDER LUCIOPERCA*)

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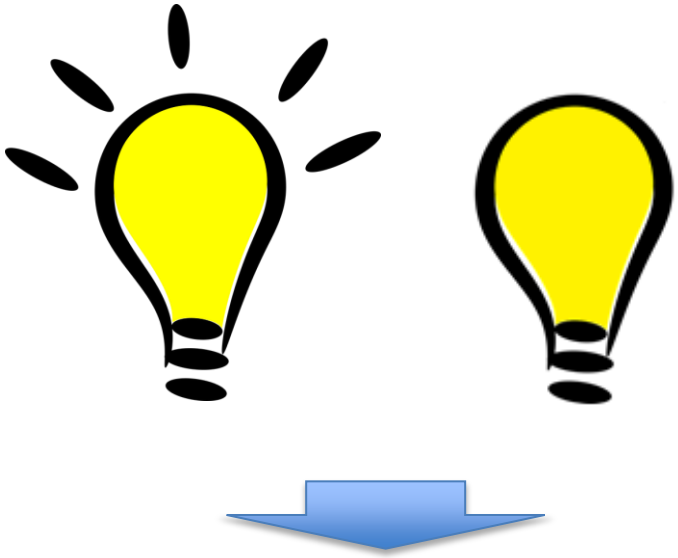
Sexual maturation
Migration
Behaviour

Light intensity



Behaviour, growth, sexual maturity, foraging…

Spectrum

Better growth in guppy (*P. reticulate*) and whitefish (*C. peled*)

Better growth in common carp (*C. carpio)*

Better growth and feed effiency in pikeperch (*S. lucioperca)*

Preferences correlated to the environment they evolved in

In the past :

NEUROPHYSIOLOGICAL STRESS RESPONSE OF PIKEPERCH JUVENILES TO INTENSIVE CULTURE CONDITIONS (WP22)

Main objective

To find out the optimal combinations between environmental and husbandry practices for improving the growth rate and welfare of pikeperch

(Baekelandt et al, 2017)

Factors	Modality	References
Photoperiod	10 L : 14 D	Sarameh et al., 2012
	24 L : 0 D	Teletchea et al., 2009
Light intensity	10 lux	Luchiari et al., 2006
	100 lux	
Light spectrum	White	Luchiari et al., 2009
	Red	
Rearing density	15kg/m^3	Steenfeldt et al., 2010
	30kg/m^3	
Temperature	21 °C	Dalsgaard et al., 2013
	26 °C	Wang et al., 2009
Oxygen saturation	60 %	Dalsgaard et al., 2013
	90 %	
Alimentation	Semi-floating	Steenfeldt et al., 2010
	Sinking	
Handling	Yes	Arlinghaus, 2007
	No	

Factorial fractional design

Experimental unit = tank

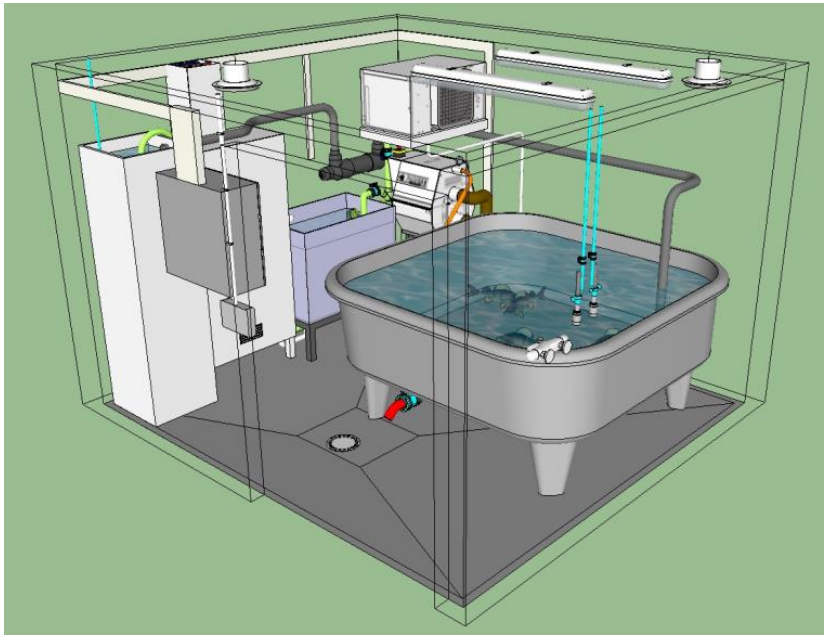
8 factors * 2 modalities/factor

↓

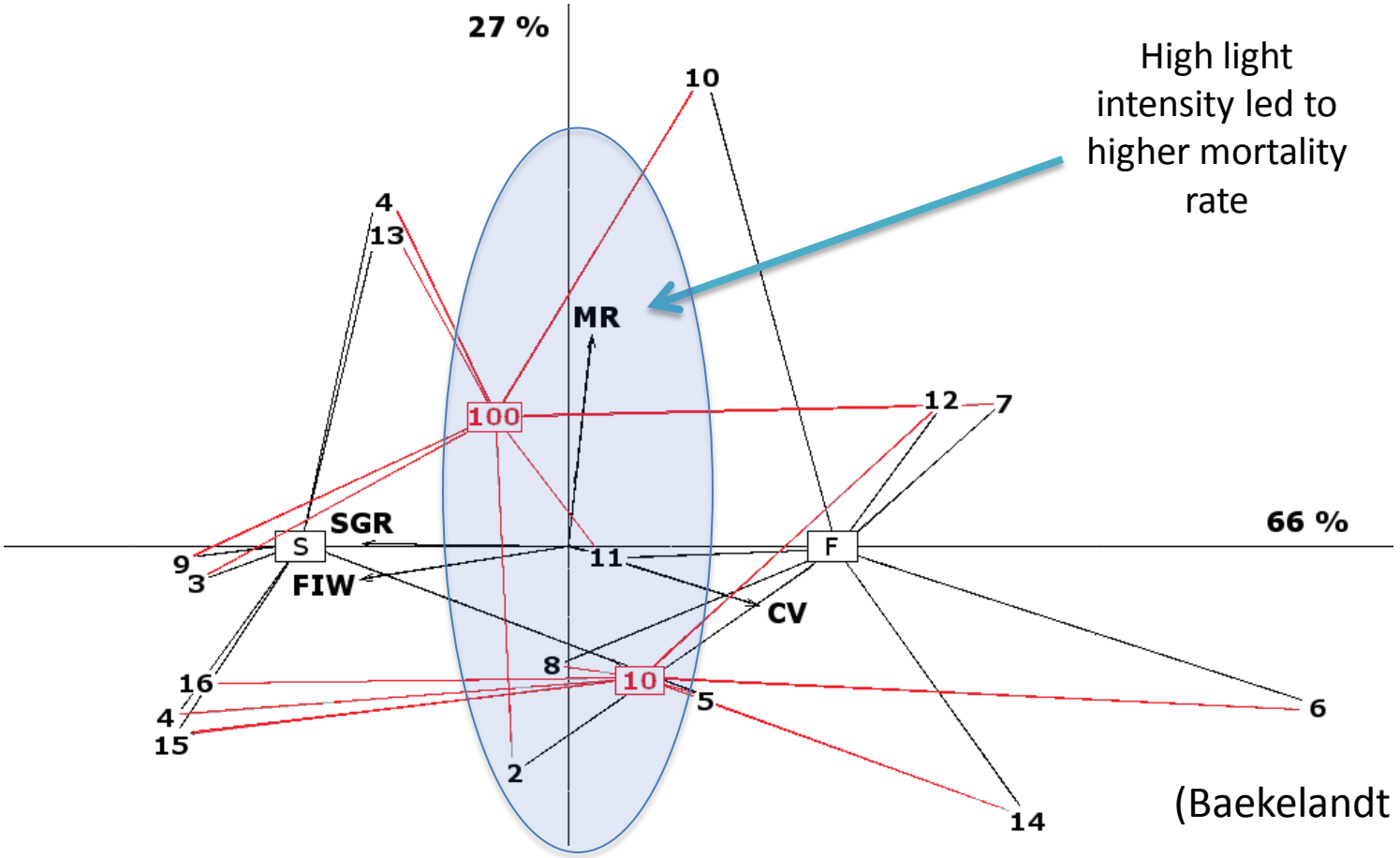
2^8 = 256 combinations

Using factorial fractional design ↓

16 different combinations



→ **Screening approach**



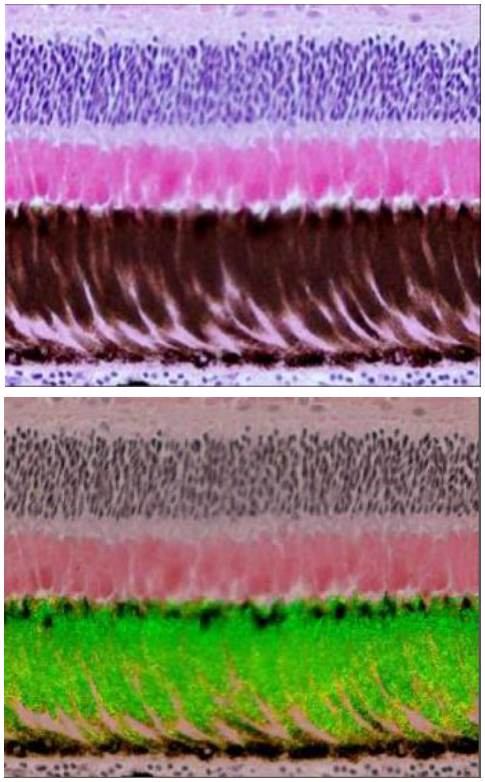
High light intensity led to higher mortality rate

(Baekelandt et al, 2017)

- Nocturnal and crepuscular predator

- Specialized retina with a *tapetum lucidum*, a light-reflecting layer increasing the eye sensitivity
    - ➢ Deleterious effects of unsuitable light characteristics

Retina



Dubielzig D. (UW-Madison)

Guanine in the retinal tapetum

www.pinterest.com

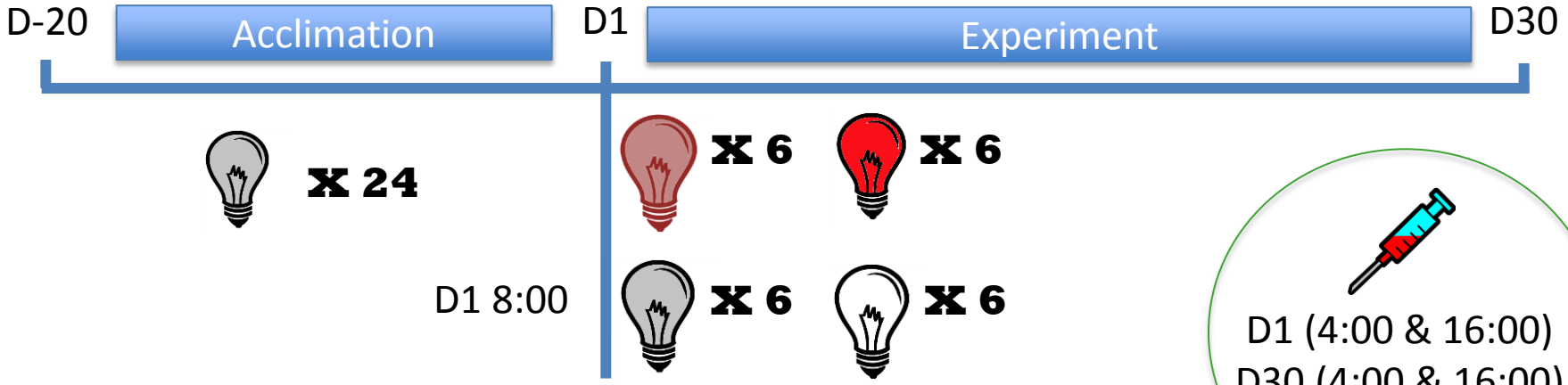
Objectives

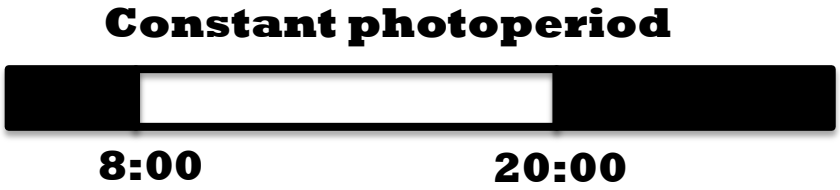
- ✓ To assess the effects of light spectrum (Red vs. White) and light intensity (10 vs. 100 lux) on husbandry, stress markers and immunity of pikeperch

- ✓ To characterize circadian rhythms in pikeperch

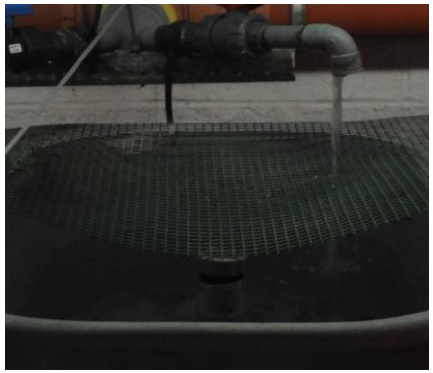
-> Little knownledge : effects of the light environment on immune system

Experimental design



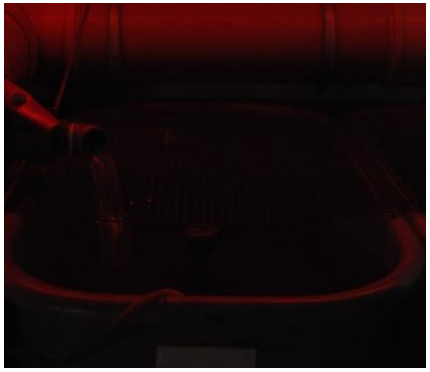


10 lux / white

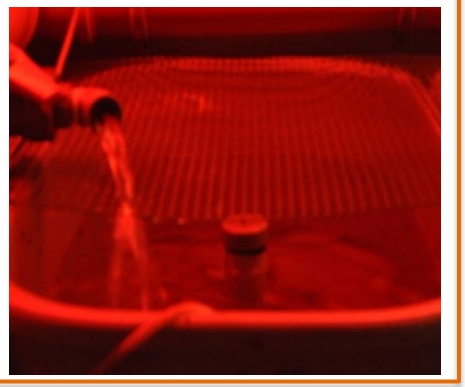


100 lux / white

10 lux / red



100 lux / red



Tested variables

Husbandry variables:

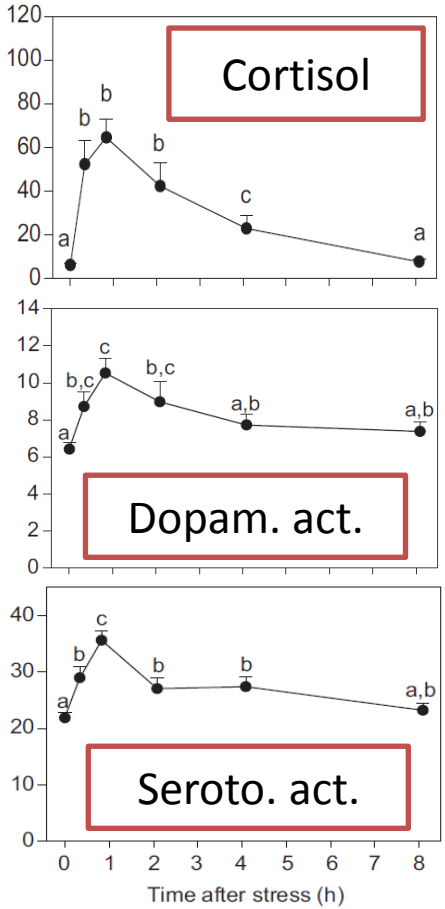
- Mortality
- Individual weight
- Specific Growth Rate
- Weight heterogeneity

Stress markers:

- Plasma cortisol
- Plasma glucose
- Brain neurotransmitters (seroto- & dopaminergic activities)
- *GR1* gene expression

- The activation of **serotonergic** and **dopaminergic systems** is also involved in the primary responses to stress

- Complex interaction with HPI axis



Gesto et al, 2013

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Immune variables:

- Lysozyme & peroxydase activities
- Gene expressions (head kidney)

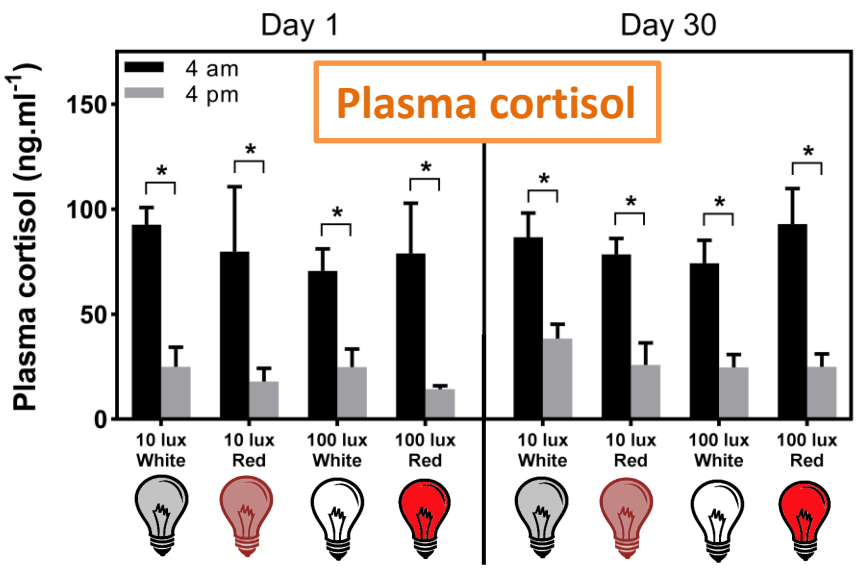
Antimicrobial activity
- *complement C3*
- *C-type lysozyme*
- *Hepcidin c*

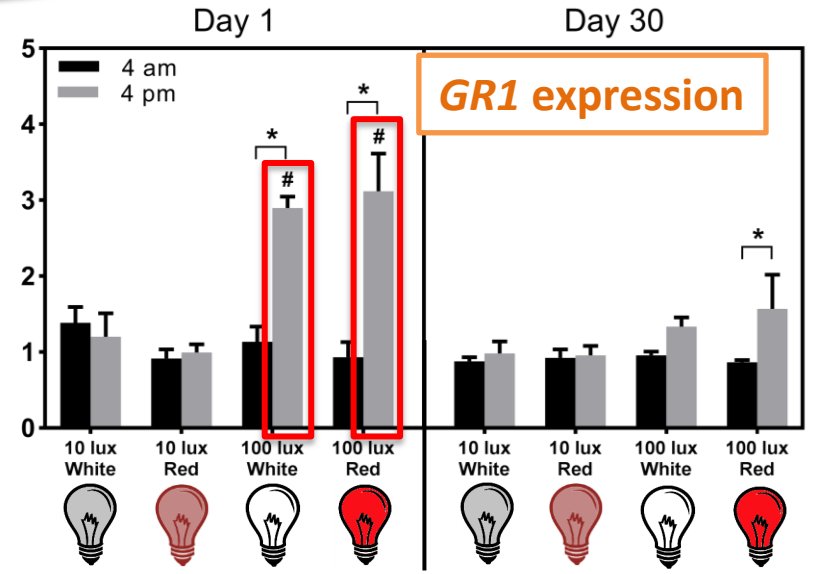
Inflammatory activity
- *TNF-α*
- *IL-1*

Results

-> MR, FIW, CV, … : No effect during the 30-days experiment

Stress markers

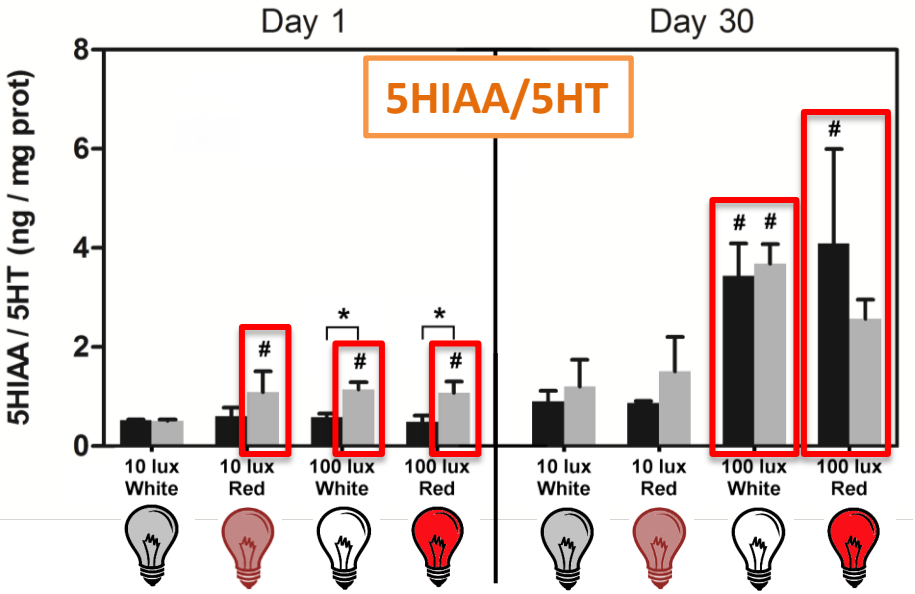




- Circadian rhythm of cortisol level
- No effect of light environment on cortisol levels

Rapid metabolism of cortisol?
Interest for using various stress indicators to account for the stress responsiveness in pikeperch

Serotonergic activity

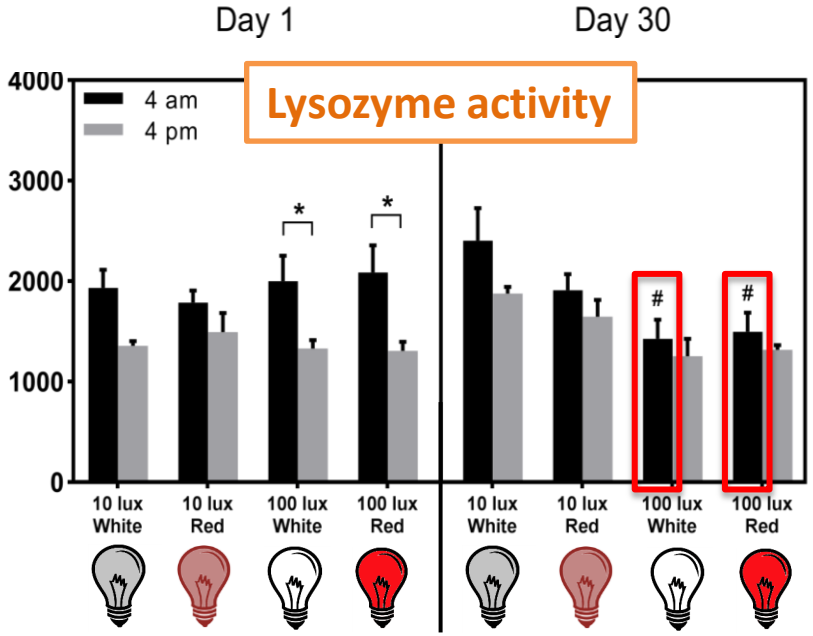


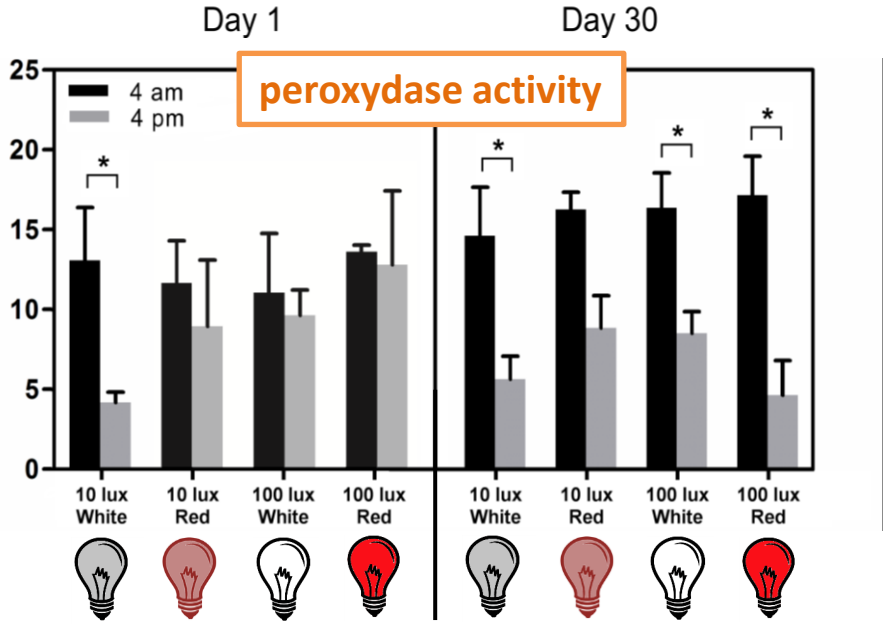
Dopaminergic activity

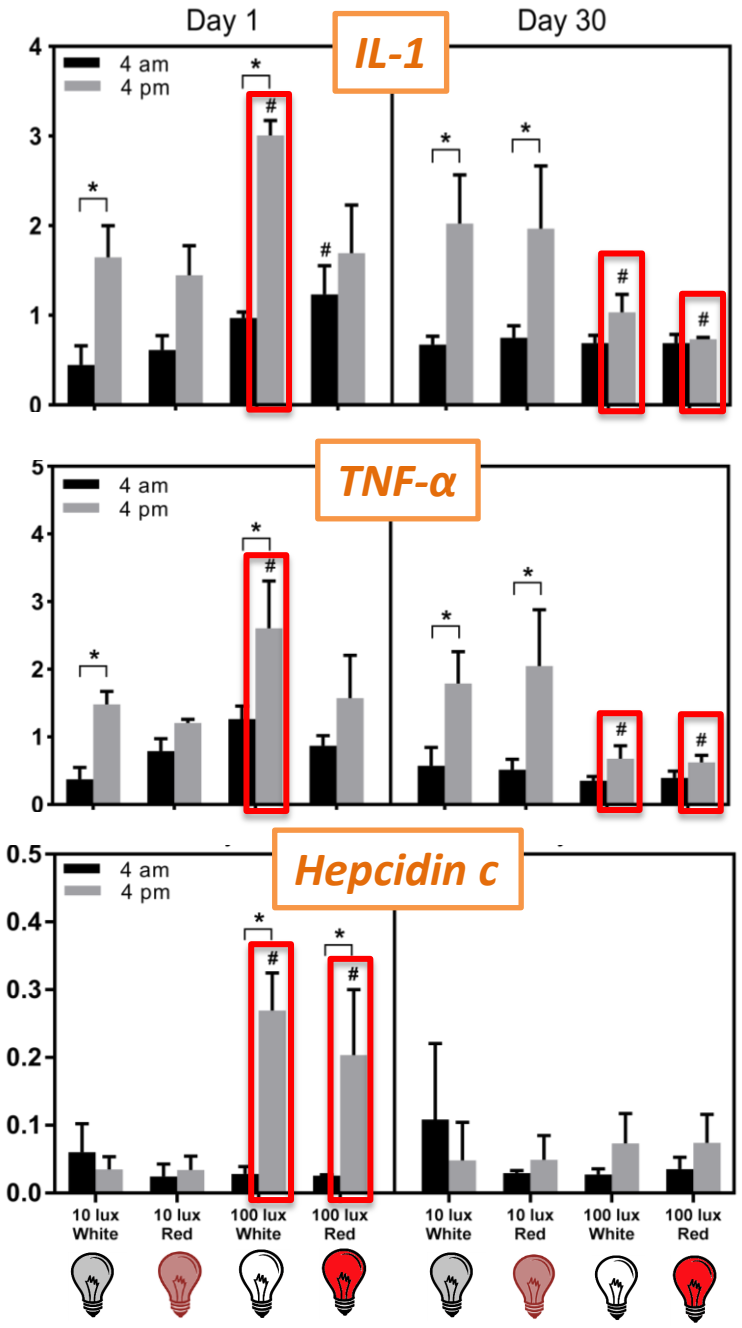
No effect

- Change of light environment induced a short-term stress
- High light intensities perceived as a long-term stressor

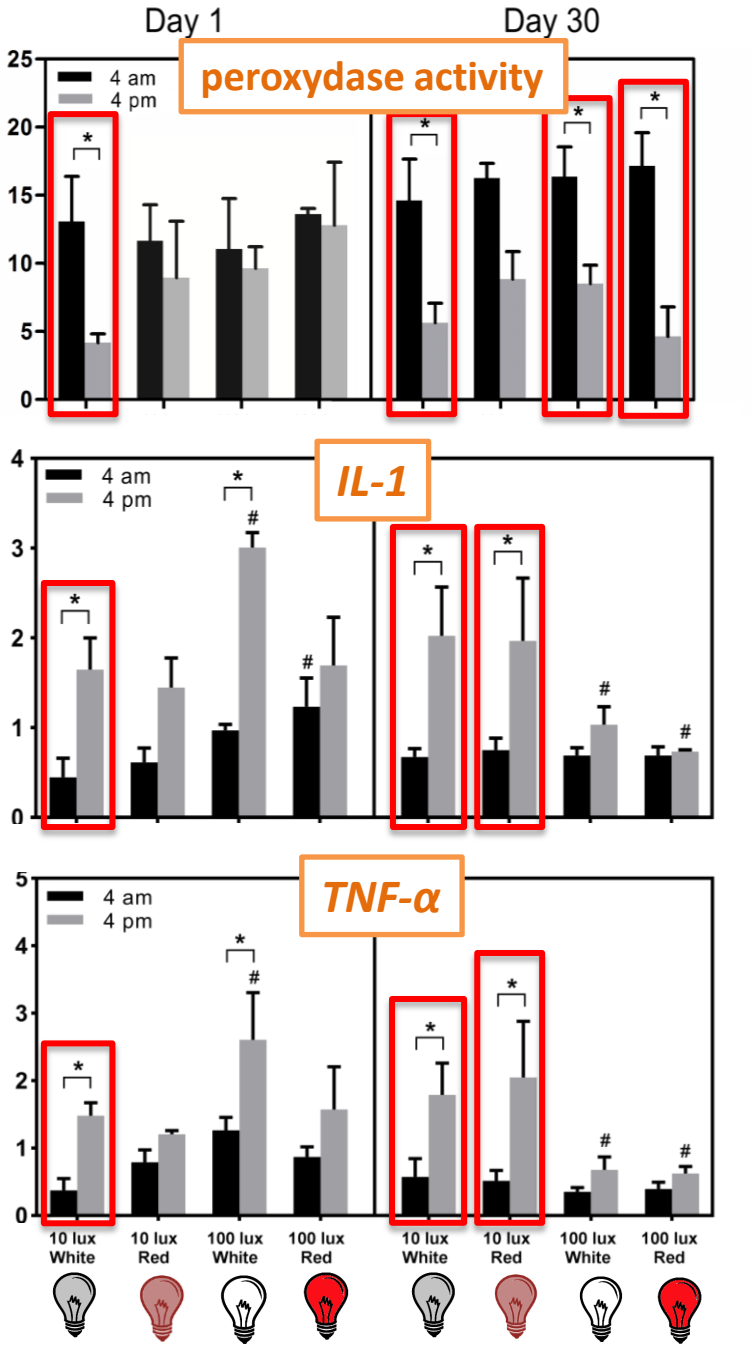
Immunity


Day 1
Day 30
Lysozyme activity
4 am
4 pm
4000
3000
2000
1000
0
*
*
#
#
10 lux White
10 lux Red
100 lux White
100 lux Red
10 lux White
10 lux Red
100 lux White
100 lux Red


Day 1
Day 30
peroxydase activity
4 am
4 pm
25
20
15
10
5
0
*
*
*
*
10 lux White
10 lux Red
100 lux White
100 lux Red
10 lux White
10 lux Red
100 lux White
100 lux Red



- D1 : immune stimulation
- D30 : immune suppression at 100 lux



- Circadian activities of some immune markers : effect of the melatonin hormone through a direct or indirect action
  - Melatonin (MEL): integration of light information -> drives circadian rhythms according to the light-darkness cycle

- Is this MEL an important immune regulator?
- Effects of light conditions on MEL production?

-> MEL levels still under analyses

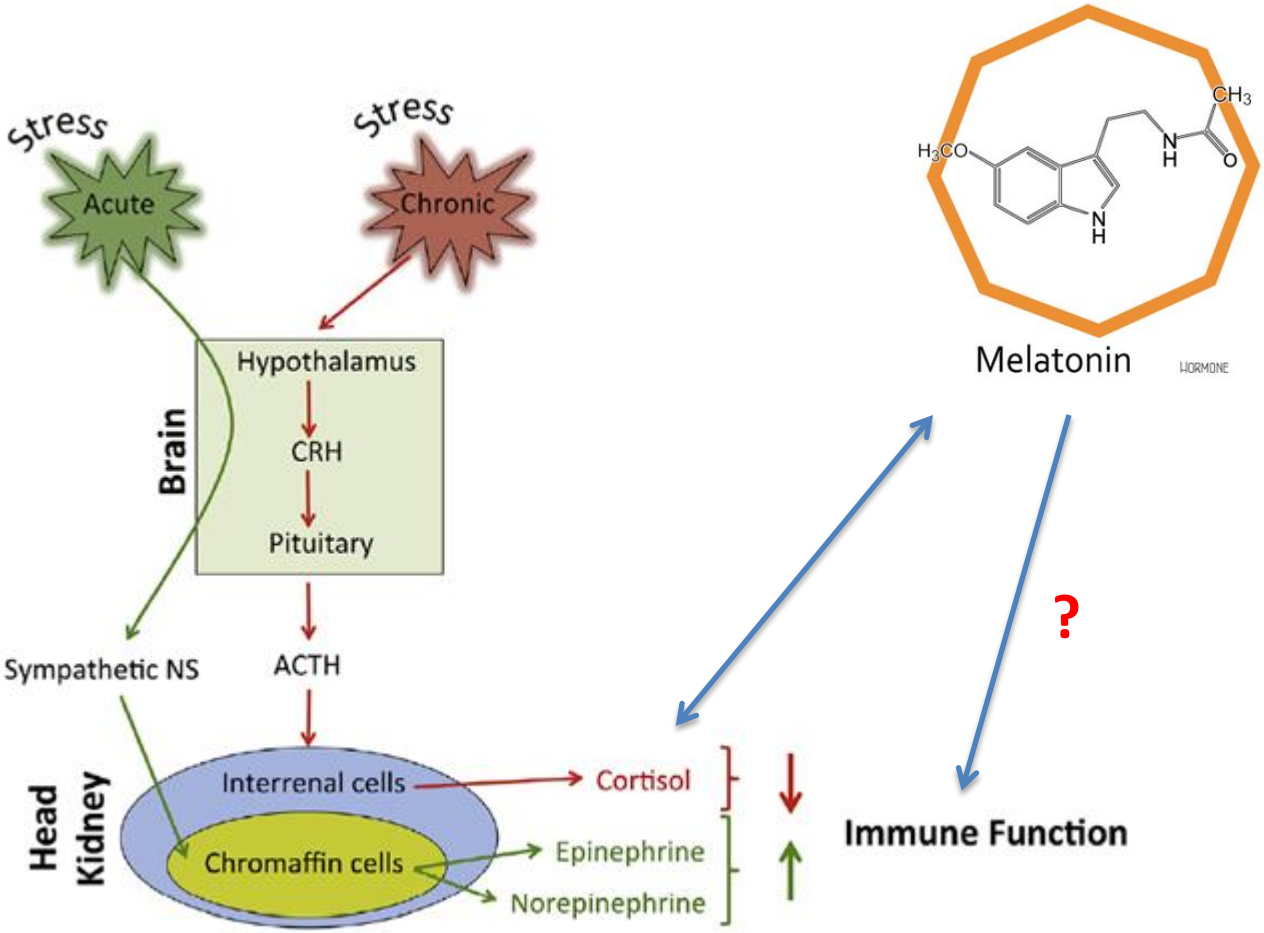
Immunomodulation by MEL

Well established in ***mammals*** :

> Melatonin appears to regulate cell dynamics […] of all […] cells lineages involved in host defense – not only NK cells but also T and B lymphocytes, granulocytes and monocytes – in both bone marrow and tissues (Miller et al, 2006).

Few evidences in ***fishes*** :

> Circadian activities of some immune variables
>
> Exogeneous MEL induces increases of immune gene expression
>
> Severe immune depression following pinealectomy



Melatonin would play a central role in this process by being an intermediate between the light, the stress axis and the immune system

Conclusions & perspectives

- Light is a directive environmental factor for pikeperch welfare
- Low light intensity is less stressful / no effect of light spectrum (red vs white)
- No clear effect on HPI axis but clear immune modulation : would suggest the involvement of other mechanisms (melatonin hormone?)

- Keyrole of **melatonin** in the stress response?
- Immunomodulation by melatonin?

Thanks for your attention