

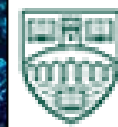
The background of the slide is a deep blue underwater photograph. In the foreground, there is a large, flat, fan-shaped coral structure. Above it, a large, flat, light-colored object, possibly a piece of coral or a rock, is visible. The water is filled with many small, dark fish swimming in various directions. The overall scene is a vibrant underwater ecosystem.

EFFECTS OF LIGHT ON THE EARLY DEVELOPMENT OF CULTURED FISH SPECIES: European seabass (*Dicentrarchus labrax* L.), and Atlantic cod (*Gadus morhua* L.)

Villamizar, N., Davie, A., Migaud H., Treasurer J. and Sánchez-Vázquez, F.J.



**UNIVERSIDAD DE
MURCIA**



**UNIVERSITY OF
STIRLING**

TIME STRUCTURE IN NATURE: CRONOBIOLOGY

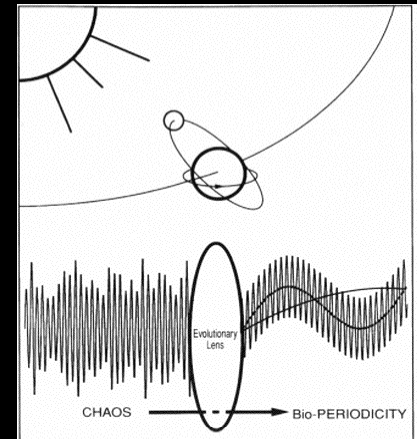


Why is light so important?

Daily cyclic environment ... Earth's axial rotation



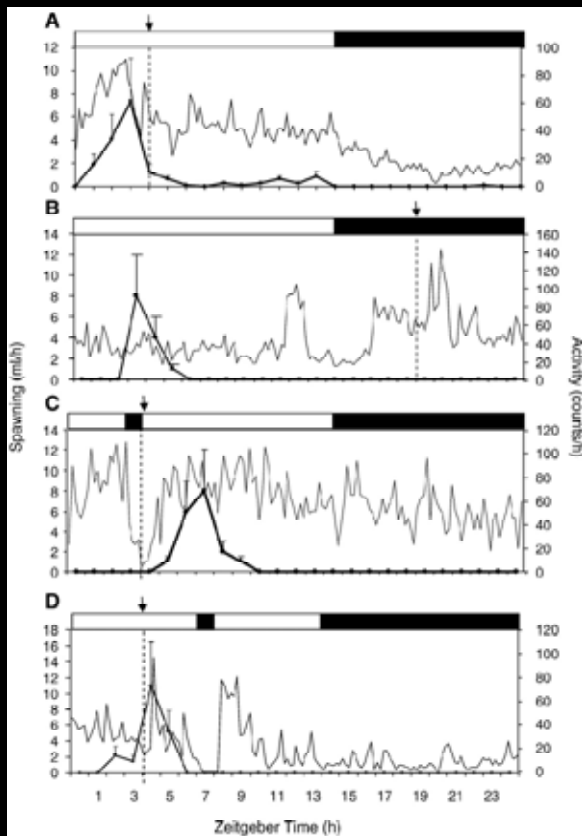
Biological rhythms



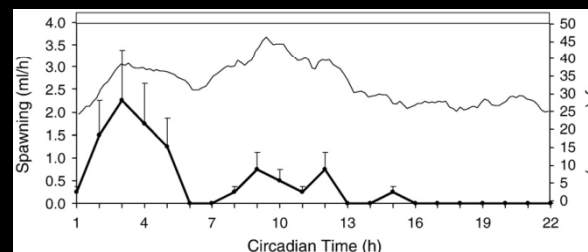
TIME STRUCTURE IN NATURE: CRONOBIOLOGY



Larvae production is rhythmic...



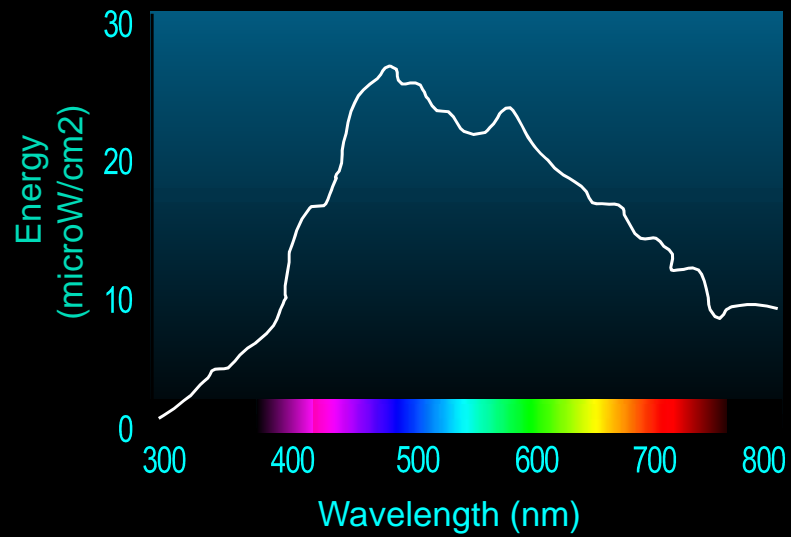
... synchronised to light, but endogenous



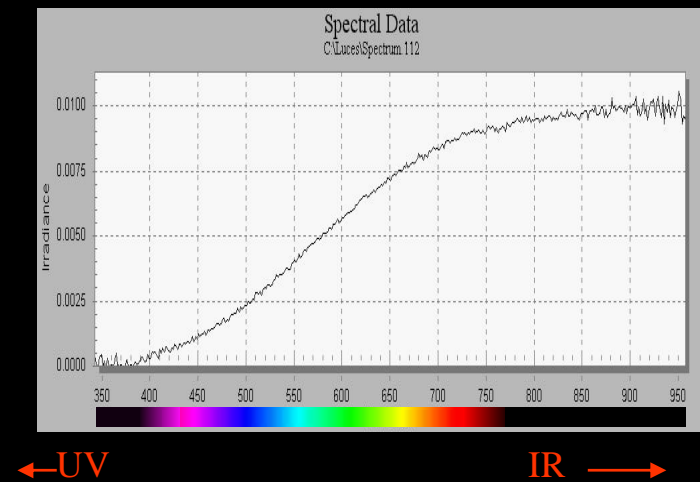
UNDERWATER PHOTOENVIRONMENT: PHOTOPERIOD AND SPECTRUM



Spectrum at the Earth's surface



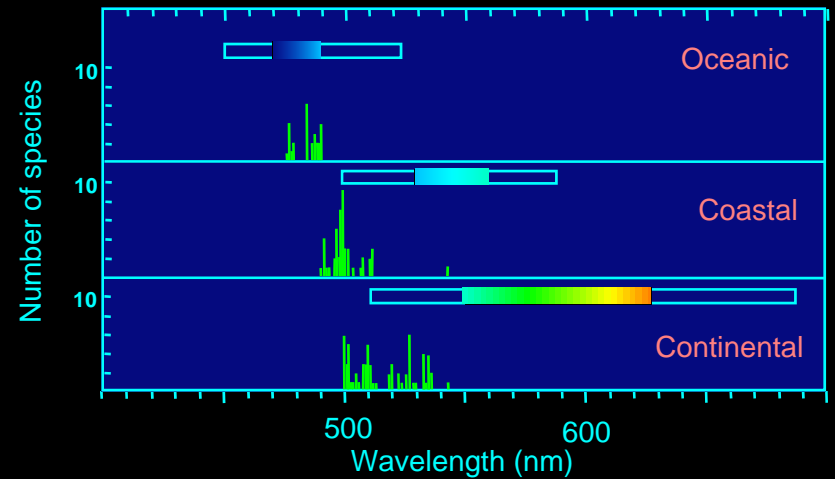
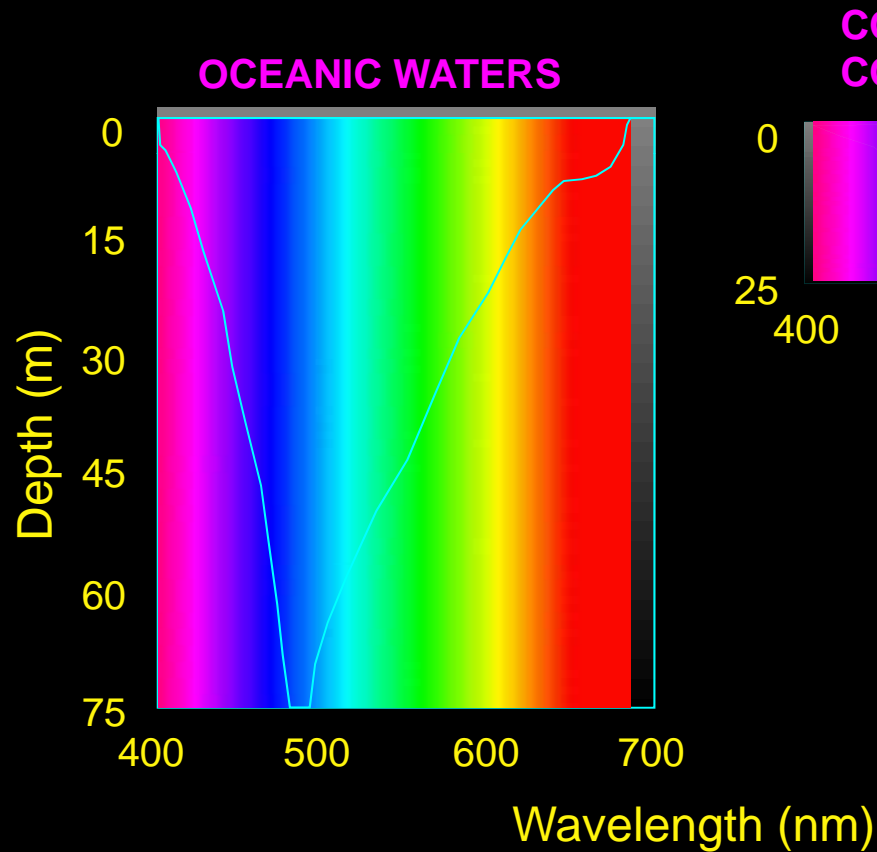
Spectrum of a light bulb



←UV

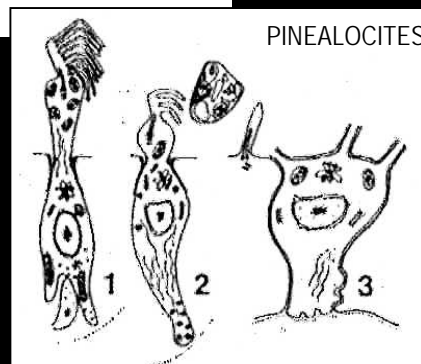
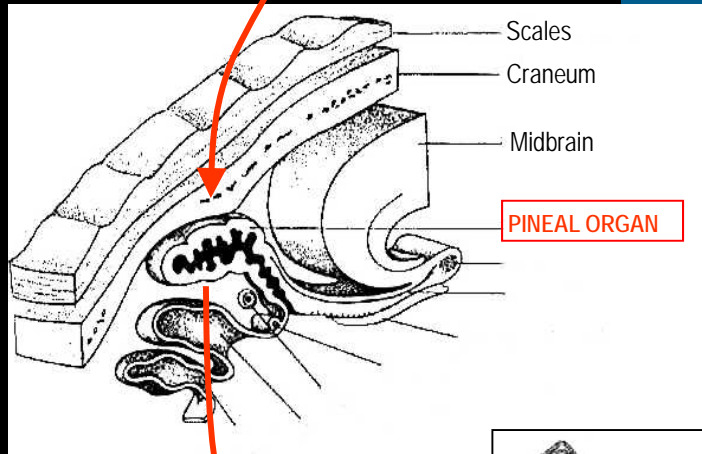
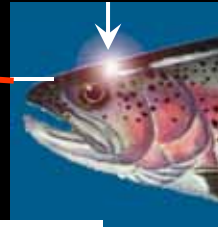
IR →

UNDERWATER PHOTOENVIRONMENT: PHOTOPERIOD AND SPECTRUM

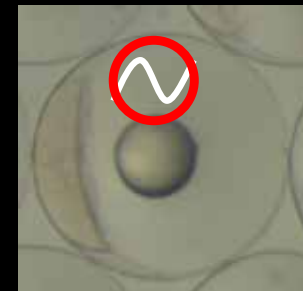


*UNDERWATER PHOTOENVIRONMENT:
PHOTOTRANSDUCTION SYSTEM*

Photoreception in fish...

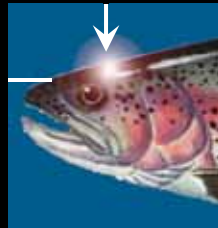


Early development of pineal...

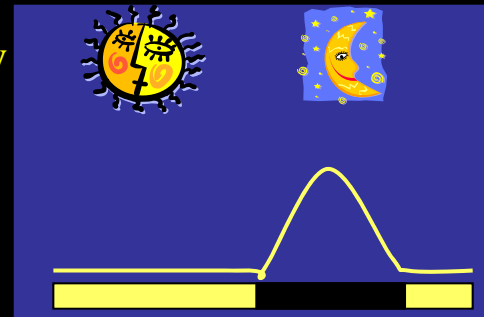


*UNDERWATER PHOTOENVIRONMENT:
PHOTOTRANSDUCTION SYSTEM*

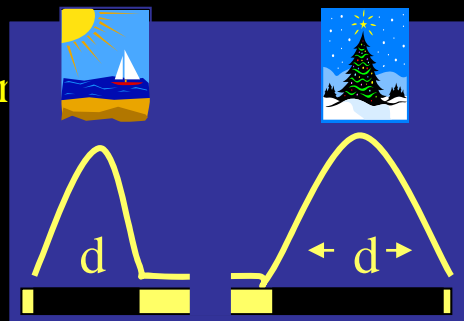
Melatonin rhythms...



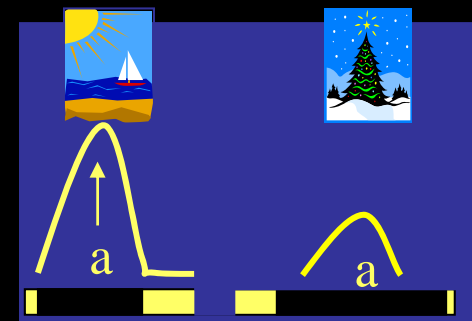
Time of day



Time of year



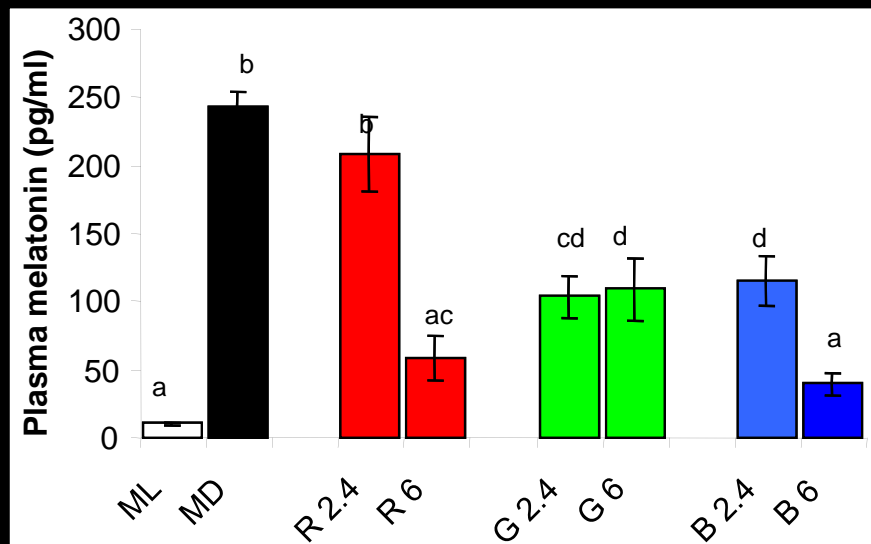
DURATION



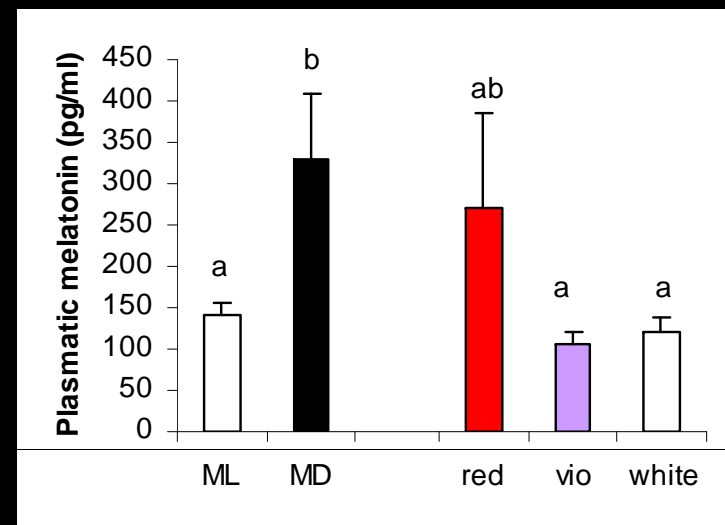
AMPLITUDE

UNDERWATER PHOTOENVIRONMENT: PHOTOTRANSDUCTION SYSTEM

Melatonin and light spectrum...



Bayarri et al. *J. Pineal Res.* 32:32-44; 2002



Oliveira et al. *Chronobiol. Int.* 24:1-13; 2007

I. OBJECTIVES



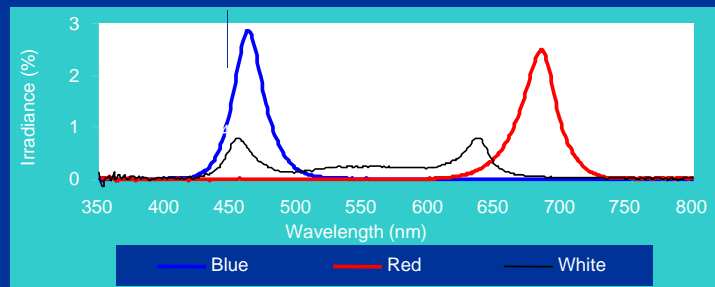
Photoperiod



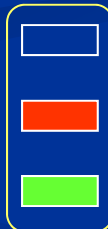
- Constant light (LL)
- Constant darkness (DD)
- Light-dark cycle (LD)



Light spectrum



- White LD (LD_W)
- Blue LD (LD_B)
- Red LD (LD_R)
- Green light (LL)

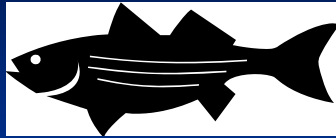


Light intensity



- 1.39 W m⁻² (LED)
- 0.5 W m⁻² (CCL)
- 0.25 W m⁻² (CCL)

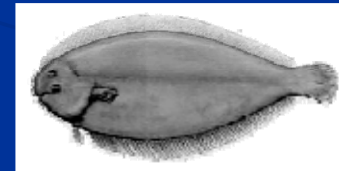
FISH SPECIES



European sea bass (*Dicentrarchus labrax*)



Cod (*Gadus morhua*)



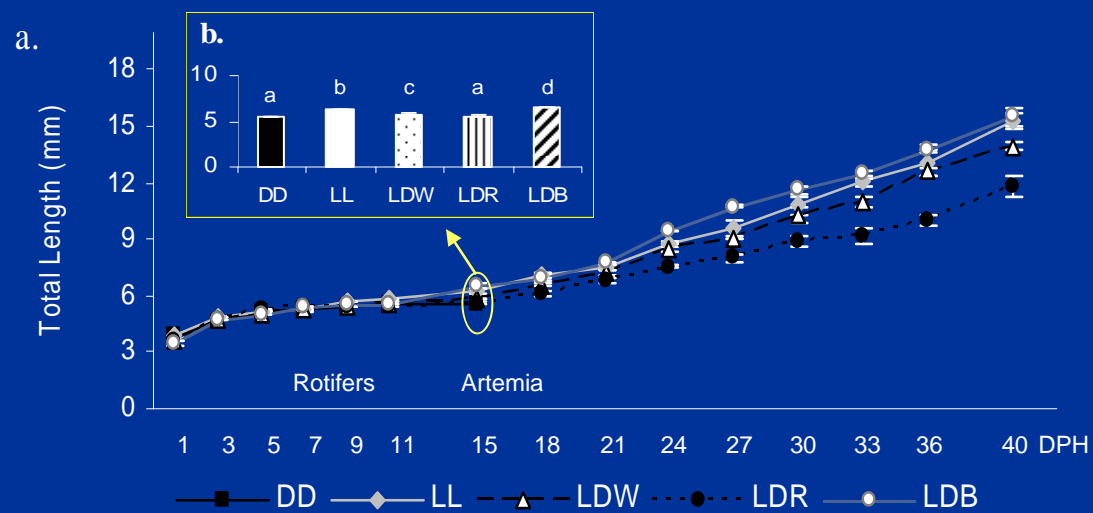
Senegal sole (*Solea senegalensis*)





RESULTS AND DISCUSSION

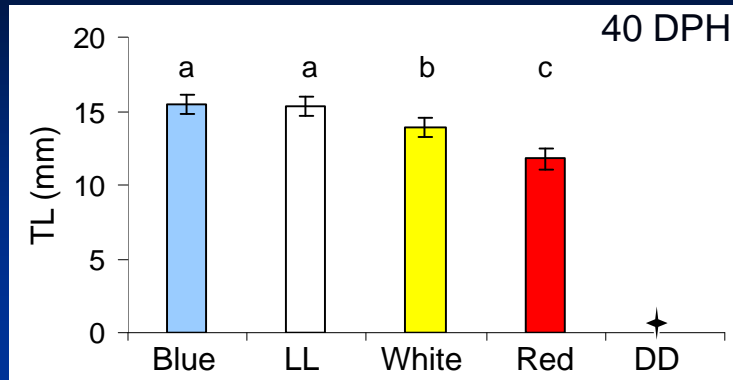
GROWTH



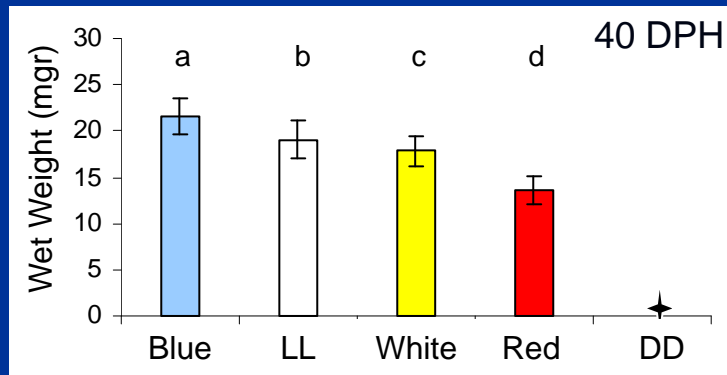
Delayed growth under DD and LDred



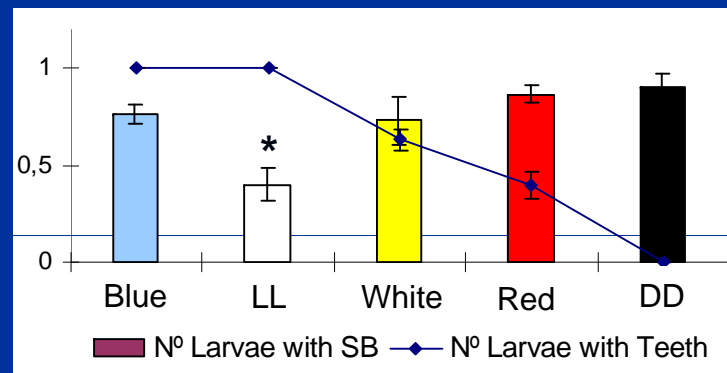
RESULTS AND DISCUSSION



Greatest TL under LDBlue and LL



Highest total wet weight under LDBlue



- DPH 33: 100% of larvae showed teeth in LL and LDBlue.
- DPH 15: proportion of larvae with swim bladder significantly lower in the LL.



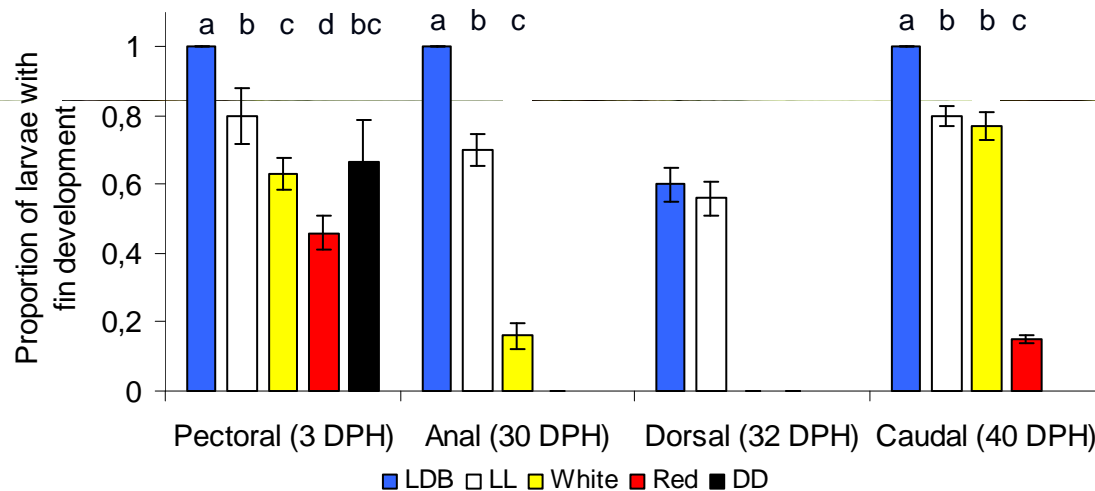
III. Results and Discussion

Red

White

LL

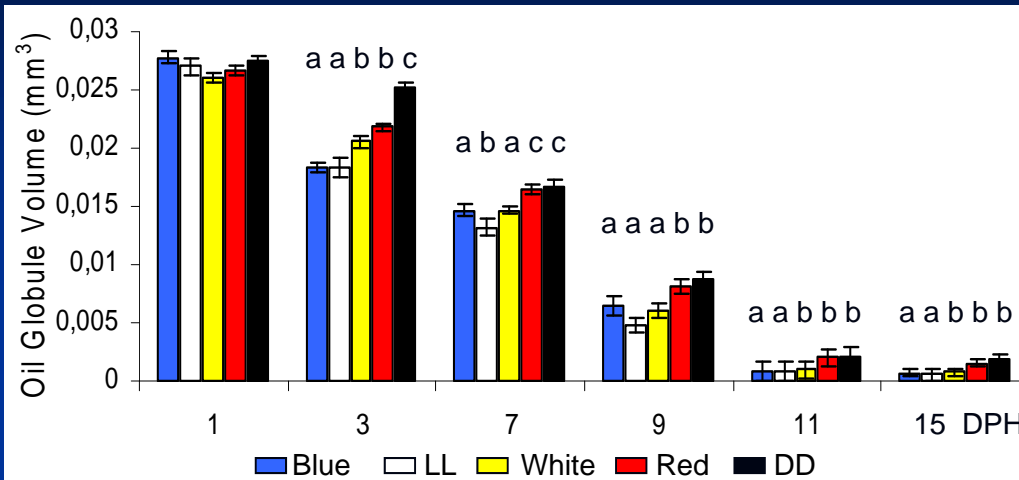
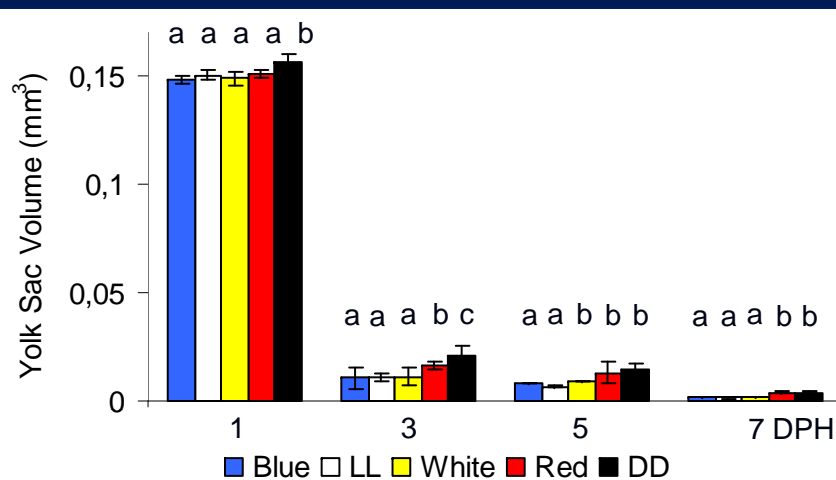
Blue



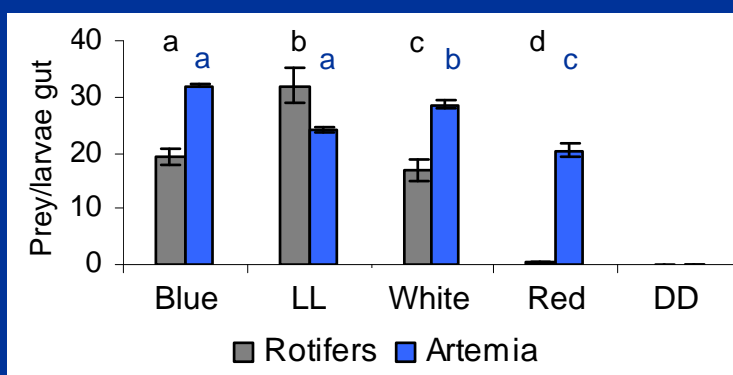
Fastest fin development under LDBBlue



III. Results and Discussion



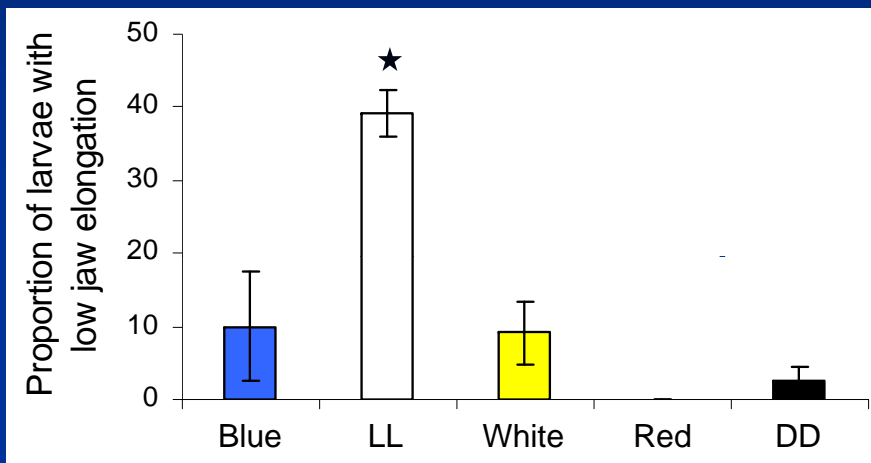
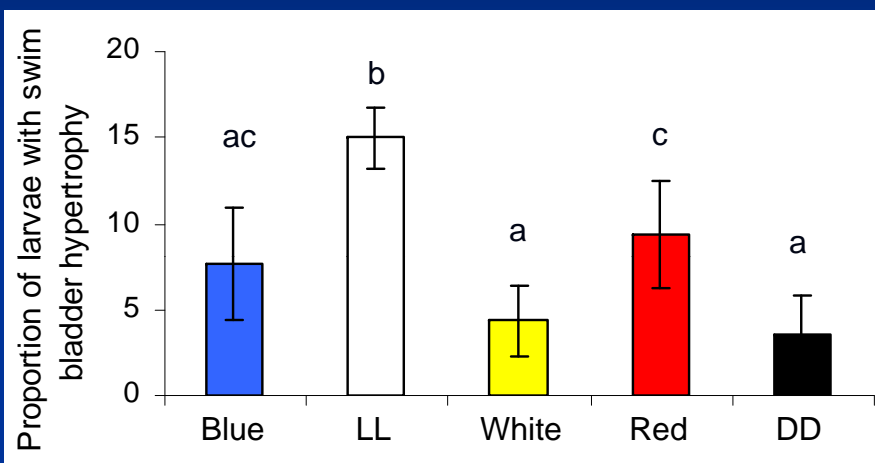
Delayed absorption of endogenous reserves under DD and LDRed



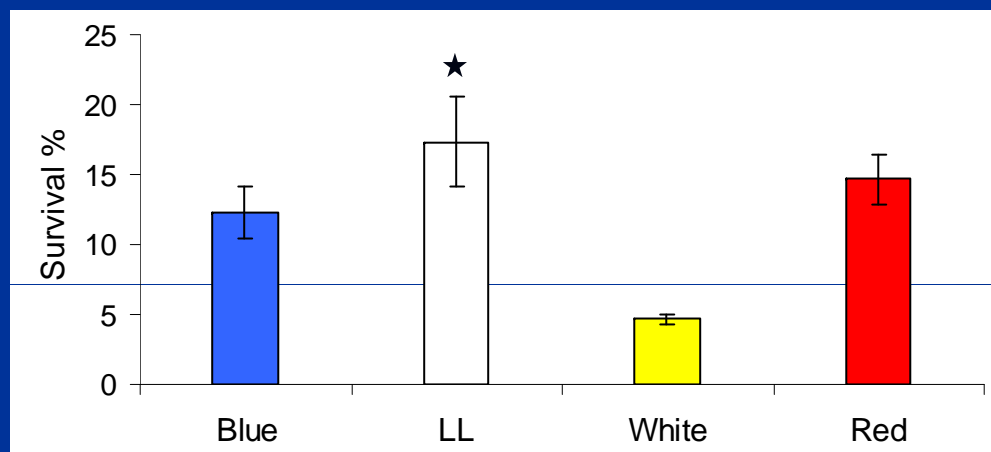
- Poor rotifer intake under DD and LDRed.
- Larvae under red LDRed fed actively on artemia.



III. Results and Discussion



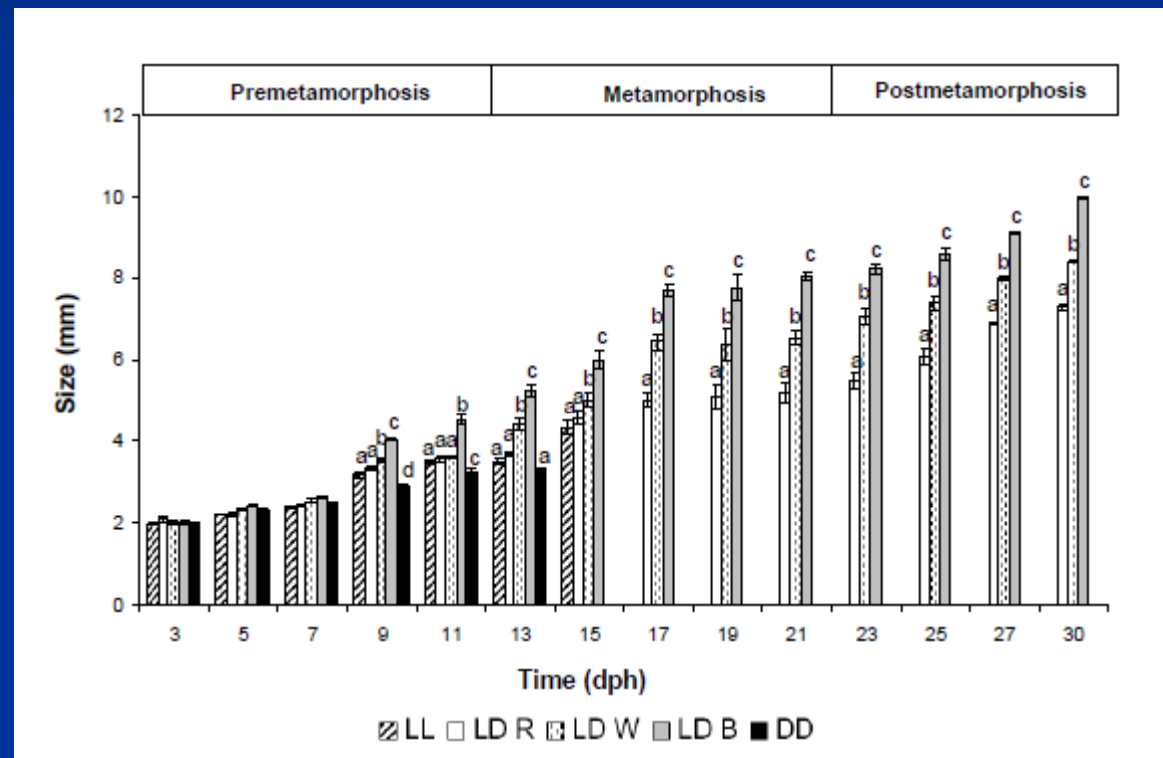
Higher proportion of malformations under LL



Best survival under LL



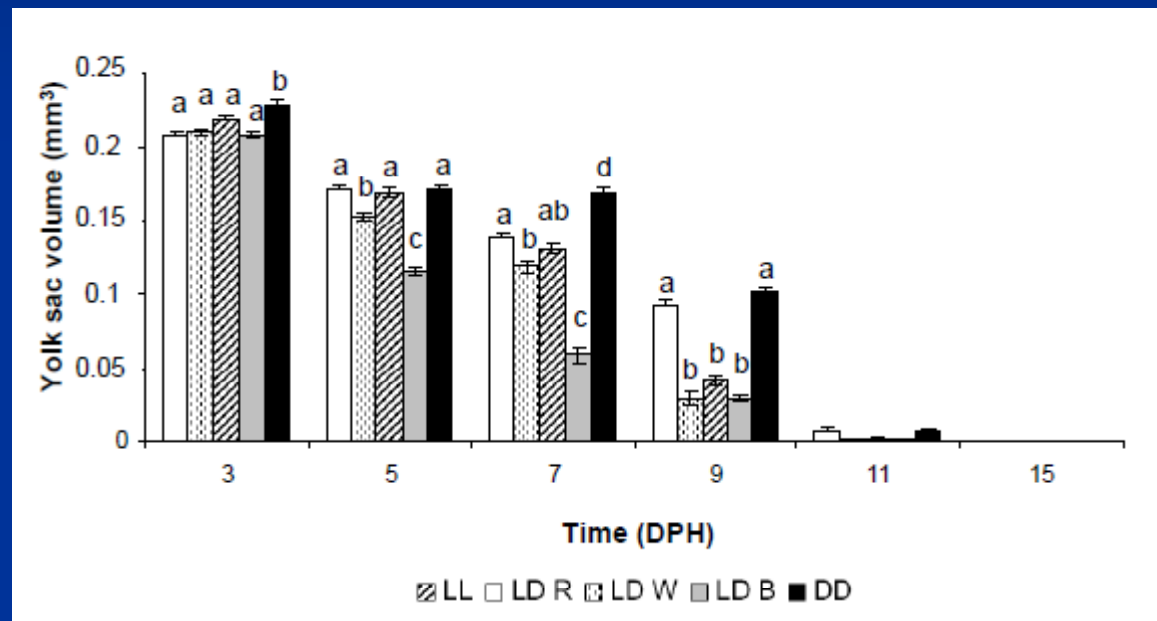
III. Results and Discussion



Fastest growth under LDBlue



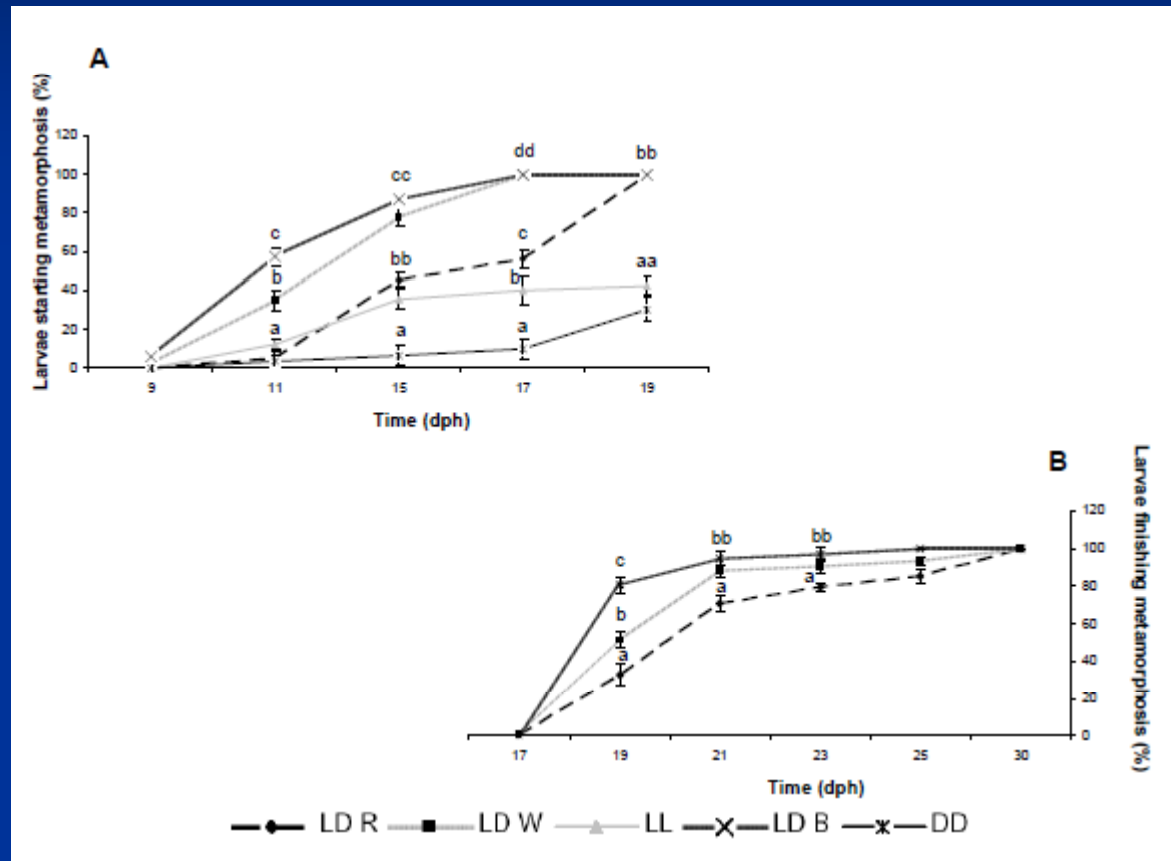
III. Results and Discussion



Delayed yolk sac absorption under DD and LDRed



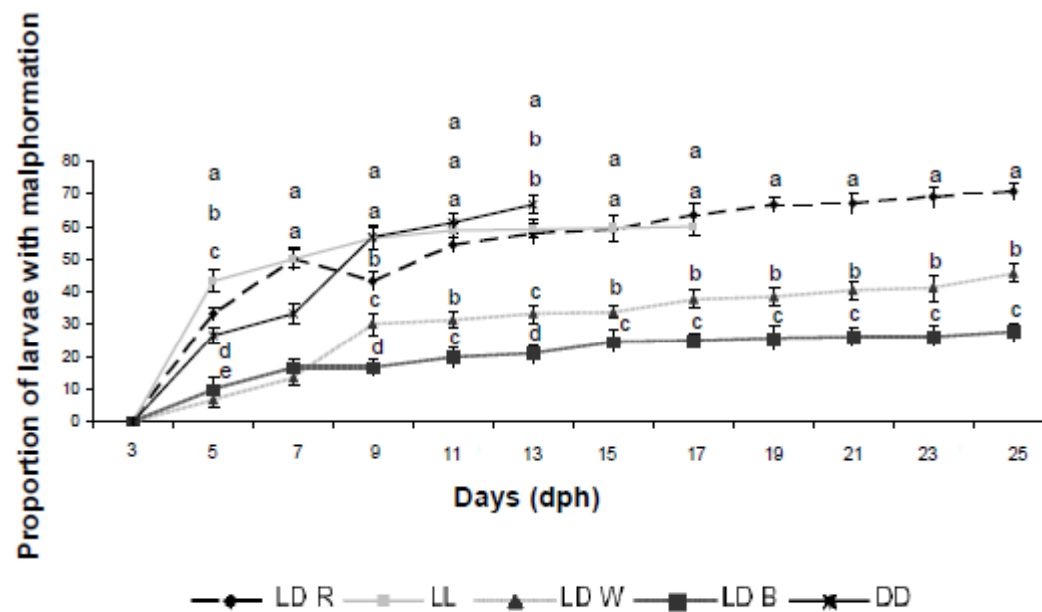
III. Results and Discussion



Earlier metamorphosis under LDBlue and LDWhite



III. Results and Discussion

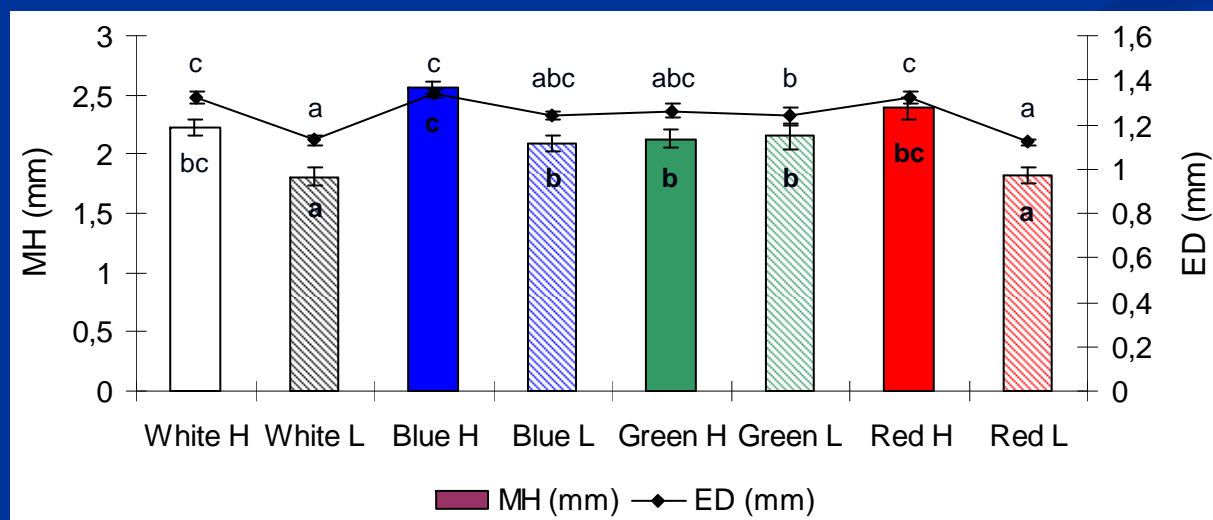
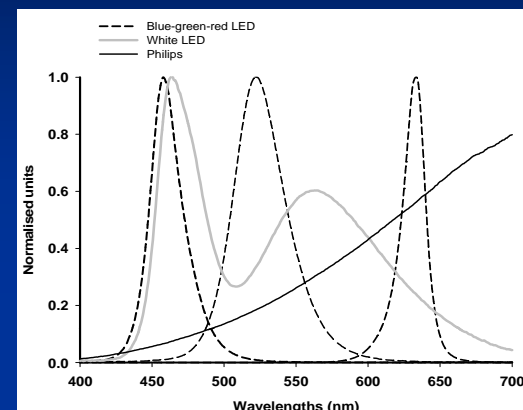
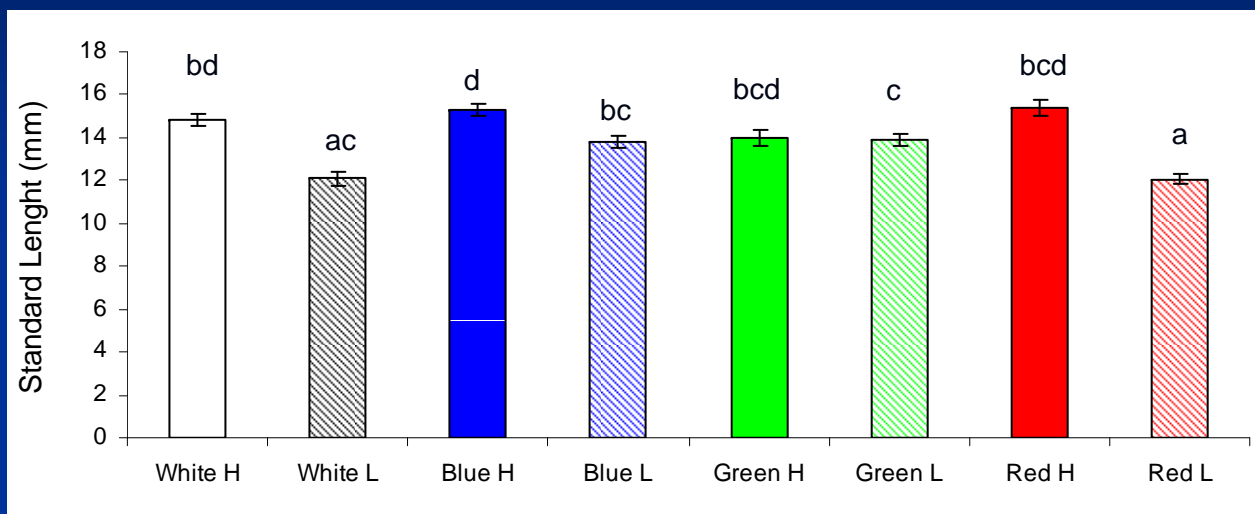


Lowest malformations under LDBlue and LDWhite



III. Results and Discussion

- Trial 1: CCL. Effects of light spectrum at high (0.50W/m^2) and low (0.25W/m^2) intensities

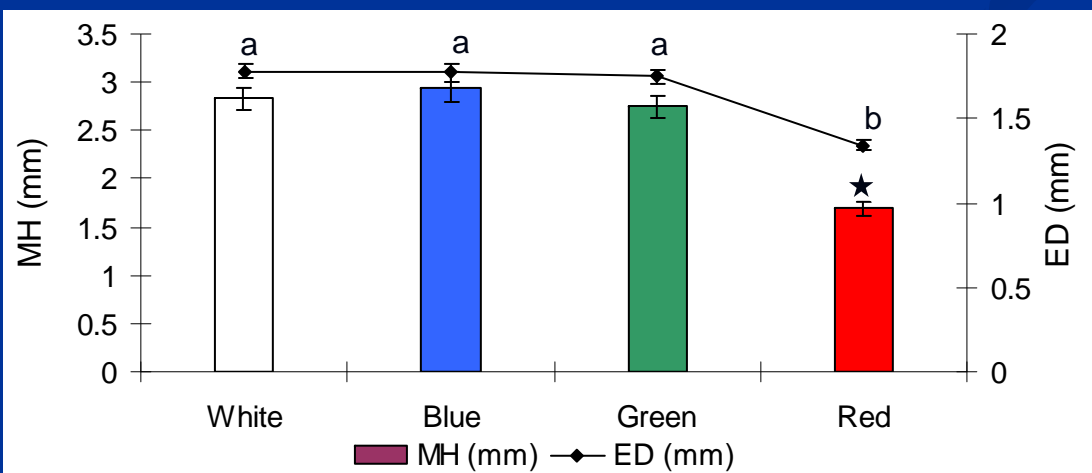
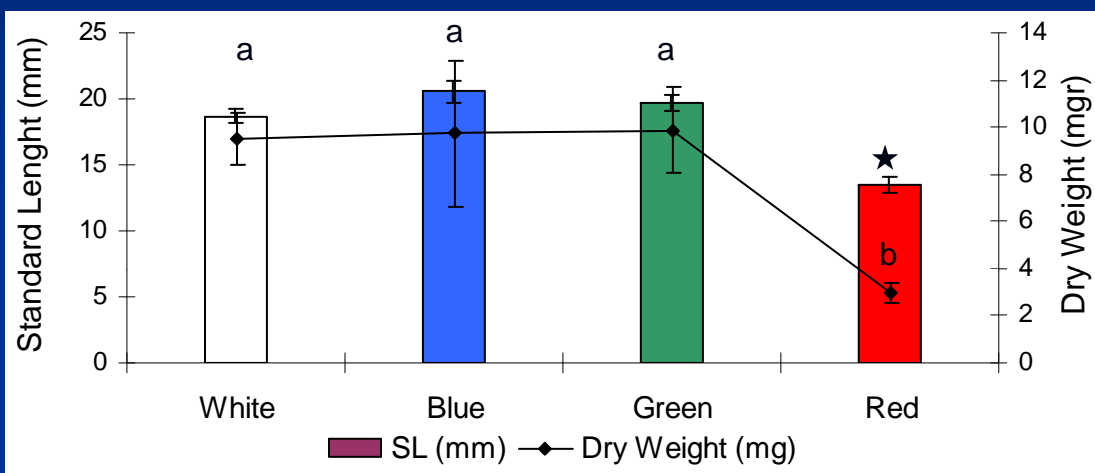


Best performance under high light intensities regardless spectrum!



III. Results and Discussion

- Trial 2 (LED): Effects of light spectrum on cod larvae performance at higher light intensity (1.39W/m^2)



Worst performance under red light

CONCLUSIONS

- The early development of European sea bass, Atlantic cod and Senegal sole were strongly affected by light conditions.
- Constant darkness (DD) and red light delayed larvae development and led to poor performance.
- In cod, low light intensities reduced larvae performance and masked spectrum effects.
- Constant light (LL) improved growth and survival in cod, though in sea bass and sole, this “unnatural” condition seriously compromised larvae welfare.
- Light conditions approaching the UW light environment (LDblue) produced the best results.

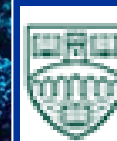
PERSPECTIVES

- Behavioural responses of larvi (and preys)...
- Developments of the circadian systems (clock genes and photoreceptors)...
- Long-term effects (reproduction)...
- Light and thermocycles...

Thank you for your attention!



UNIVERSIDAD DE
MURCIA



UNIVERSITY OF
STIRLING