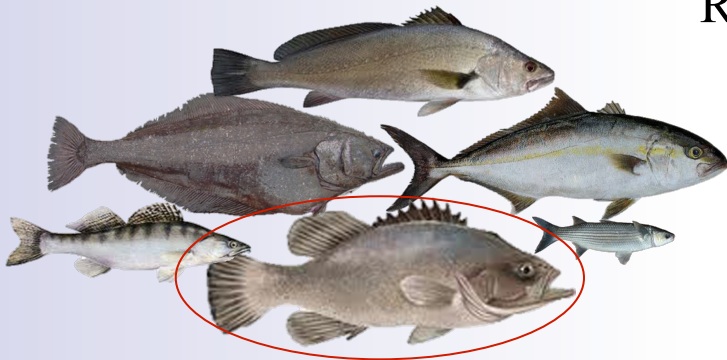




# GWP Larval husbandry WP 18.1

WRECKFISH ONTOGENY OF THE MAJOR ORGANS  
RELATED TO FEEDING AND DIGESTION.



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**Larval rearing success is the main bottleneck for the industrial-scale farming of any species.**



**The development of the digestive and visual systems is essential for the survival of larvae and is directly related to the employed rearing protocol.**

**The study focused on:**

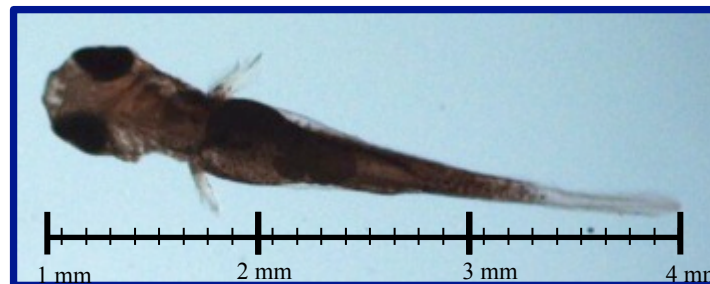
- a) the ontogeny of digestive system and eye,**
- b) the identification of critical phases during larval rearing (malnutrition periods),**
- c) the estimation of feeding preferences in accordance to the feeding protocol,**
- d) the visual ability in the different developmental stages.**

**The aim of this study was the extraction of the related information, in order to optimize the larval rearing protocol of wreckfish.**

Parameters

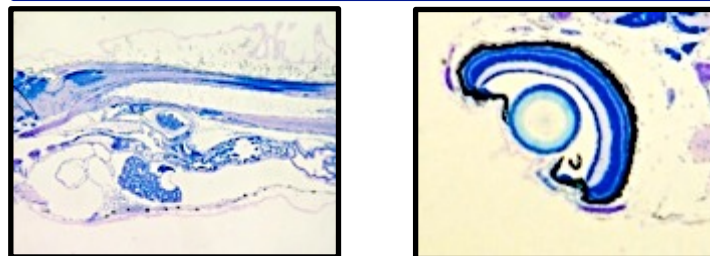
Methodology

Growth performance



Fixed larvae  
(from MC2)

Ontogeny of digestive system and eye



Histology

Feeding preferences

Stomach contents of the larvae

Histology

Estimation of malnutrition periods

Lipid deposition in the liver and the length of intestinal villi

Histology,  
image analysis

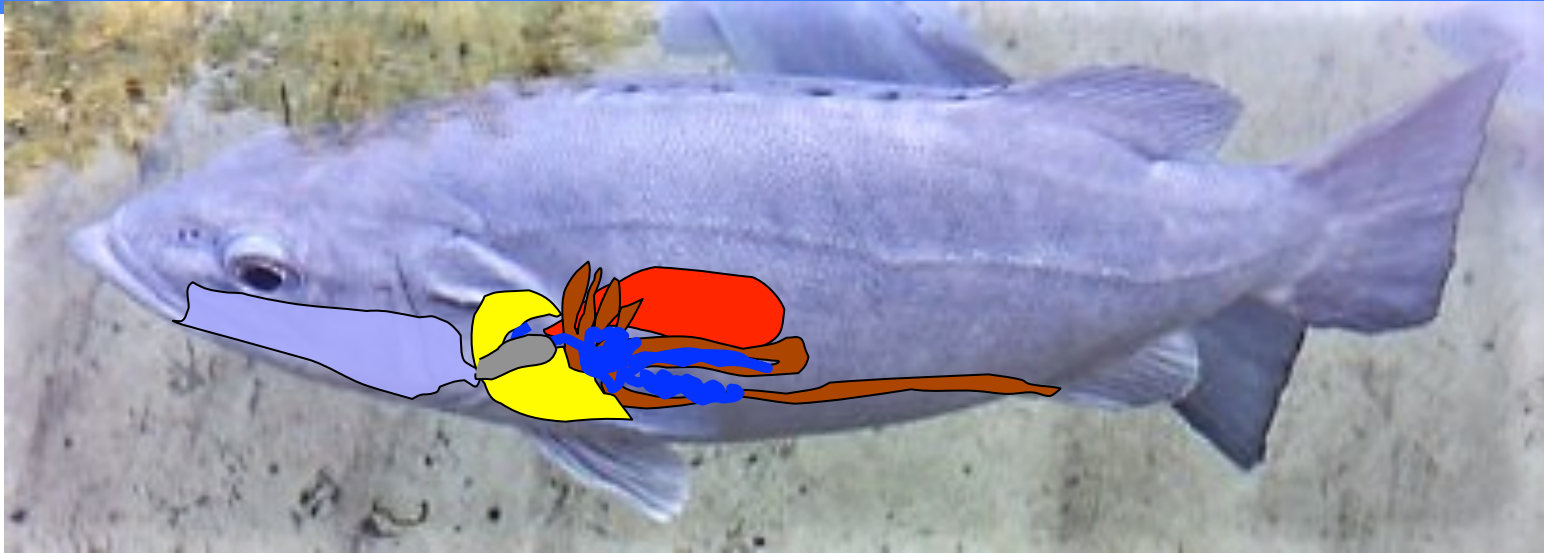
Estimation of visual acuity (visual distance)

Diameter of lens, number of cone cells in the retina

Histology,  
image analysis

# Results

## Digestive system ontogeny



Buccopharynx

Esophagus Stomach

Intestine

Accessory  
glands

Mouth opening

Pharyngeal teeth

Taste buds

Longitudinal folds

Goblet cells

Cardiac and pyloric  
sphincter

Gastric glands

Goblet cells

Pyloric caeca

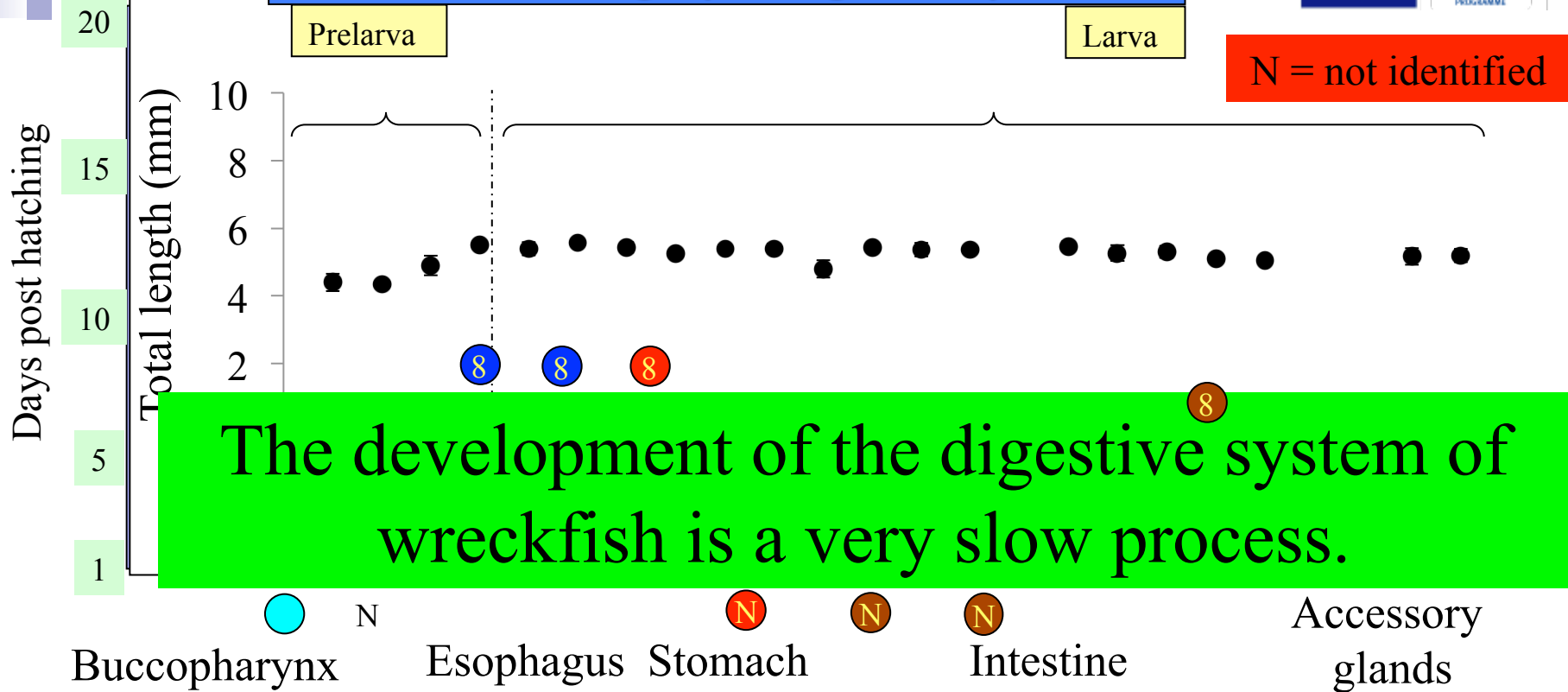
Ileo-rectal valve

Intestinal folds

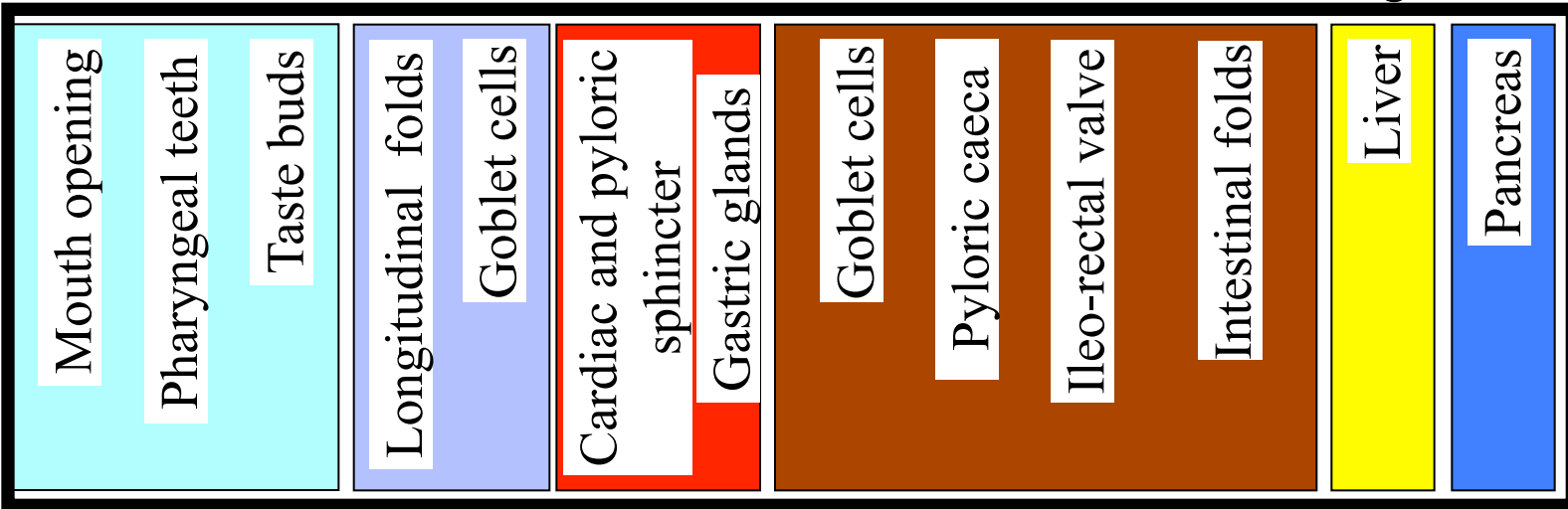
Liver

Pancreas

# Results – ontogeny of digestive system



The development of the digestive system of wreckfish is a very slow process.



23 dph

BC

- There were no lipids identified in the liver tissue during the rearing period (malnutrition period).
- There were no food items identified in the stomach contents.
- The diet of the larvae was exclusively autotrophic, based on the nutrients that were in the yolk sack.

Yolk

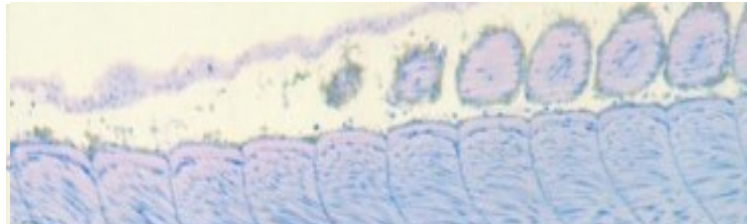
Lipids vacuoles

Liver tissue (x100)

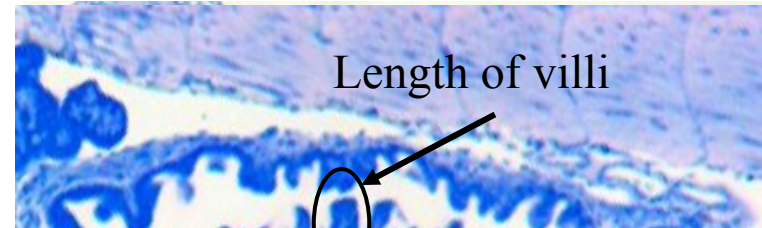


Area of the digestive canal

7 dph



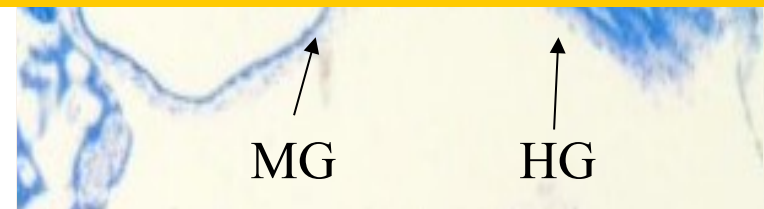
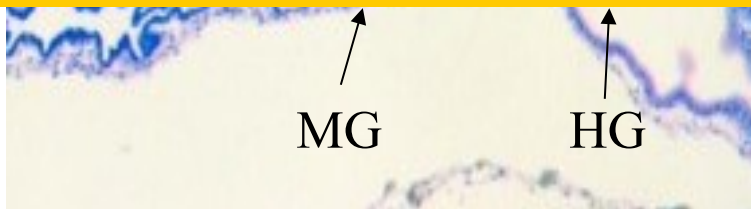
11 dph



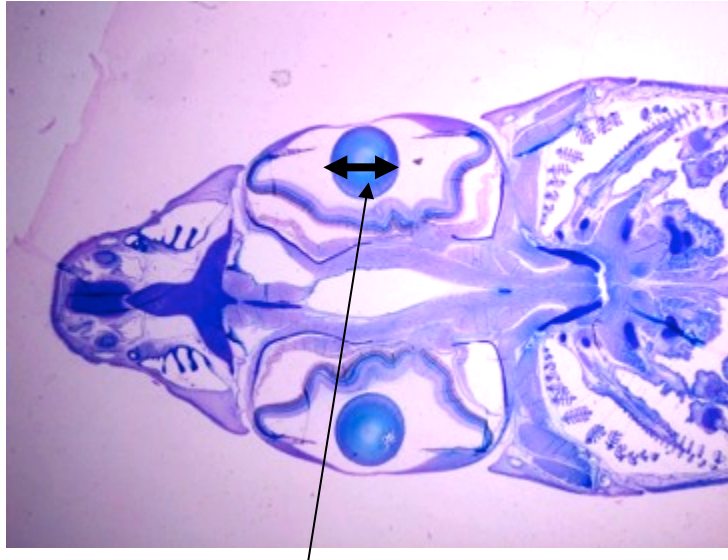
**The size of intestinal villi is a histological index that is related with the nutritional status of the fish.**

**(Hall and Bellwood 1995; McLeese and Moon 1989)**

- **Wreckfish larvae were affected by a malnutrition - starvation period (16-23 dph) that had as a result the atrophy of the intestinal structures which appeared as a reduction of villi size.**
- **The autotrophic condition that existed during this period was not adequate to cover the nutritional requirements of wreckfish larvae.**







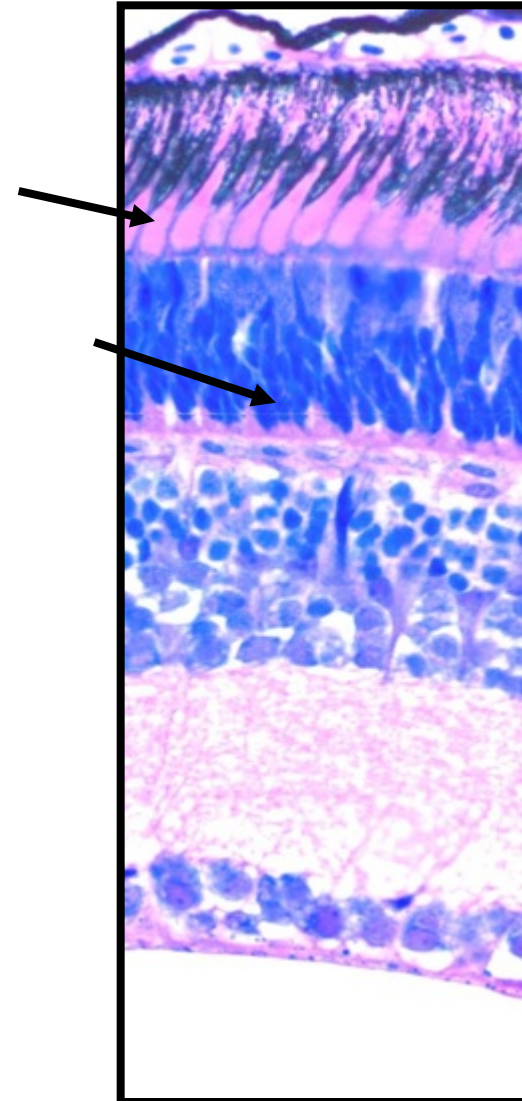
Lens diameter

Retina

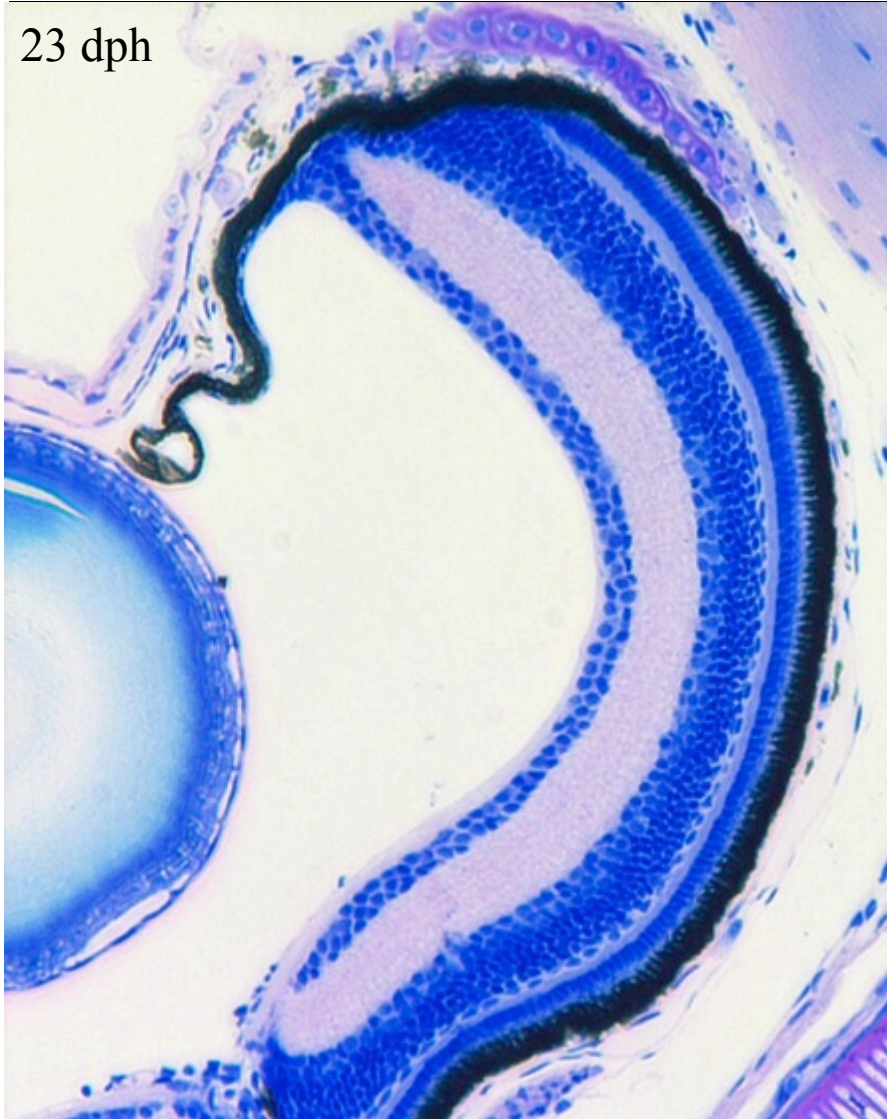
Number of:

Cone cells

Rod cells



23 dph



- ❖ Differentiation of retina layers started at 3 dph
- ❖ At 6 dph :
  - a) Cone cells (photopic vision – day vision)
  - b) Retina organization was completed
  - c) The lens transparency increased.
- **The fish were able to identify the food items in photic rearing environments.**
- ❖ Rod cells didn't appear during the first 23 dph.  
(scotopic vision – night or under low light intensities vision).
- **The fish weren't able to identify the food items in rearing environments with low light intensities.**

**Visual acuity is defined as the minimum angle, at which two parallel objects can project at the eye and still be resolved as separate.**

**Histological visual acuity was expressed as the**

**Minimum Separable Angle (MSA) =  $\alpha$ ,**

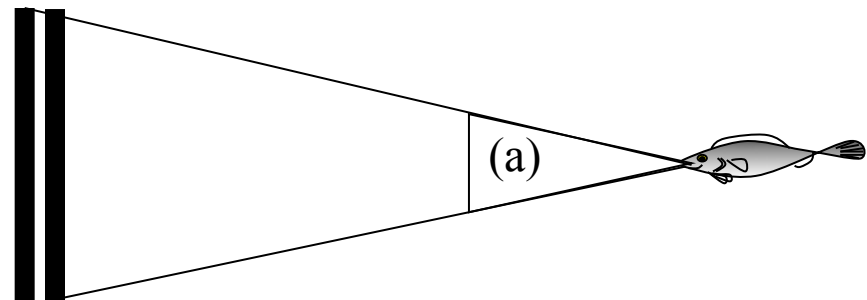
**which was calculated as:**

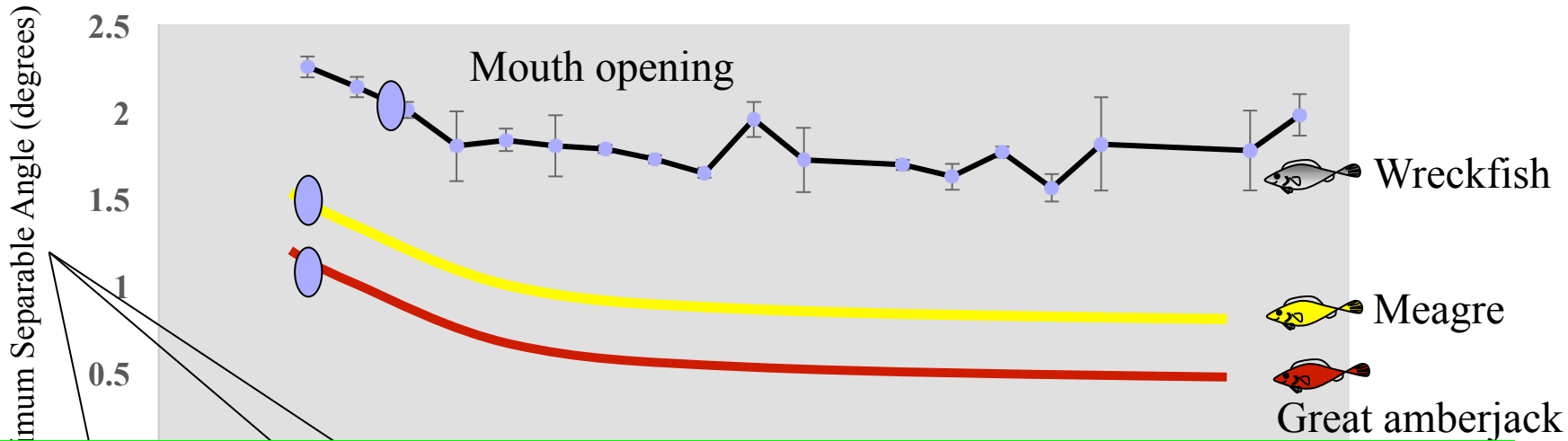
**$d$  = Number of cones**

**$r$  = Lens radius**

$$\sin(\alpha) = 1.11 / (10d * 2.55r)$$

(Neave, 1984)

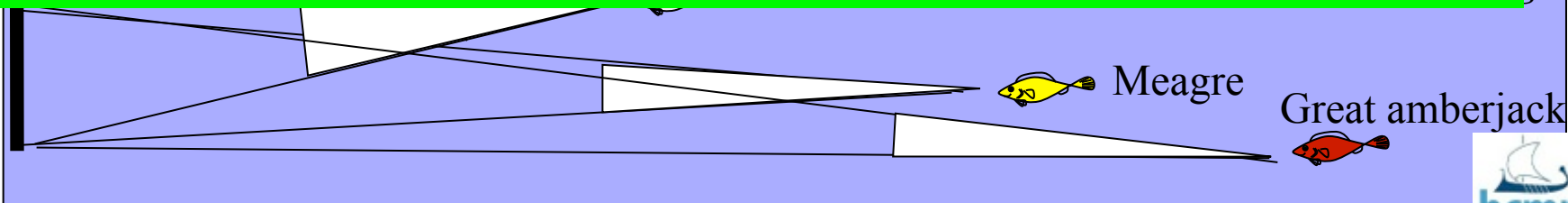


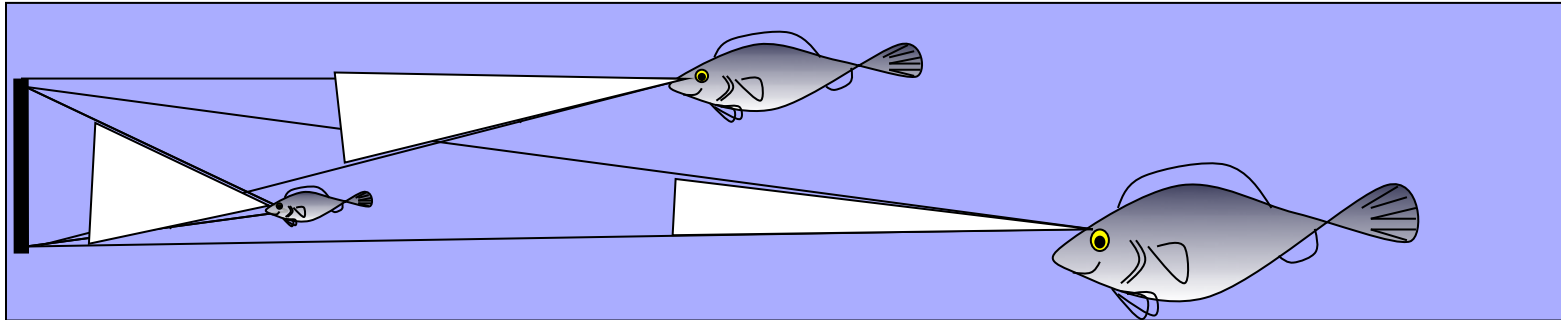


Visual acuity (visual distance) increases during development

BUT

In comparison with other species wreckfish presented lower values of visual acuity



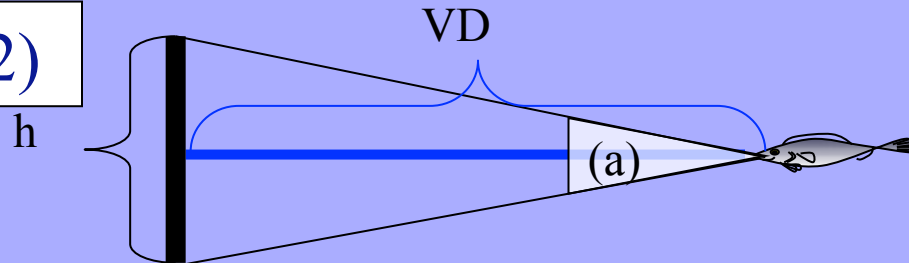


## Estimation of the Visual Distance

$$VD = 0.5 * h / \tan(a/2)$$

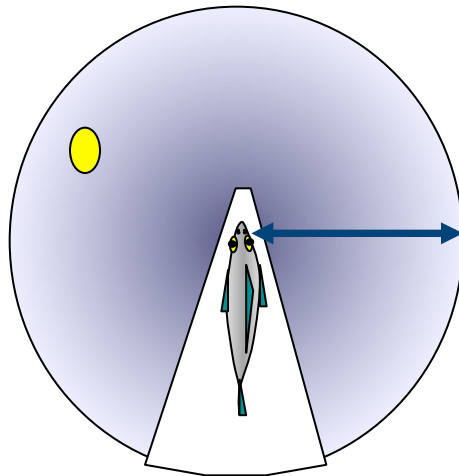
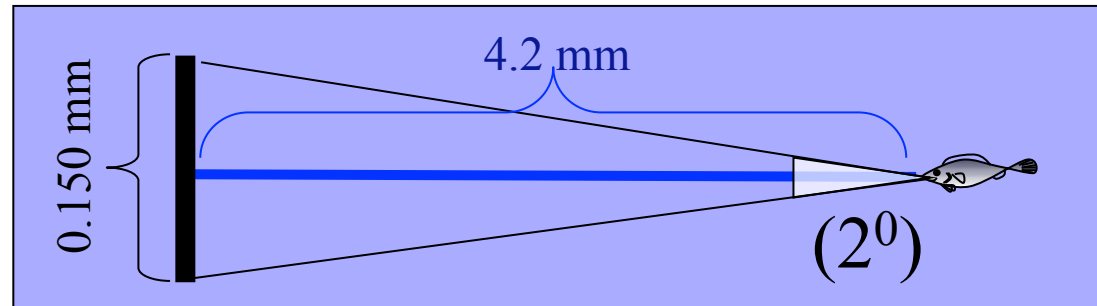
Visual Distance (VD)

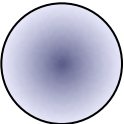

$h$  = object width (mm)



(Wanzenböck and Schiemer, 1989)

## Estimation of the Visual Distance



-  Volume 0.3 ml  
radius 4.2 mm
-  Rotifer

At the larval stage of the mouth opening, the histological visual acuity for wreckfish was estimated around  $2^{\circ}$  (degrees).

The distance or the radius of the visual field was calculated around 4.2 mm for the identification of an object size of 0.15 mm (rotifer).

This corresponds in a volume of sphere of around 0.3 ml.

So the concentration of rotifers has to be at least 1 rotifer per 0.3 ml or more than 3 rotifers per ml.

## Until the 23 dph:

- **The development of the digestive system of wreckfish is a slow process.**
- **The nutrition of larvae was exclusively autotrophic.**
- **No exogenous feeding items were identified in the stomach contents.**
- **After 16 dph larvae suffered from malnutrition - starvation.**

## ➤ **The feeding protocol needs to be defined.**

- **The wreckfish larvae present only photopic ability of vision.**
- **In comparison with other species the wreckfish larvae present lower visual acuity.**

## ➤ **The light conditions on the rearing environment have to be harmonized with the visual abilities of wreckfish larvae.**



# Thank you

## Acknowledgments

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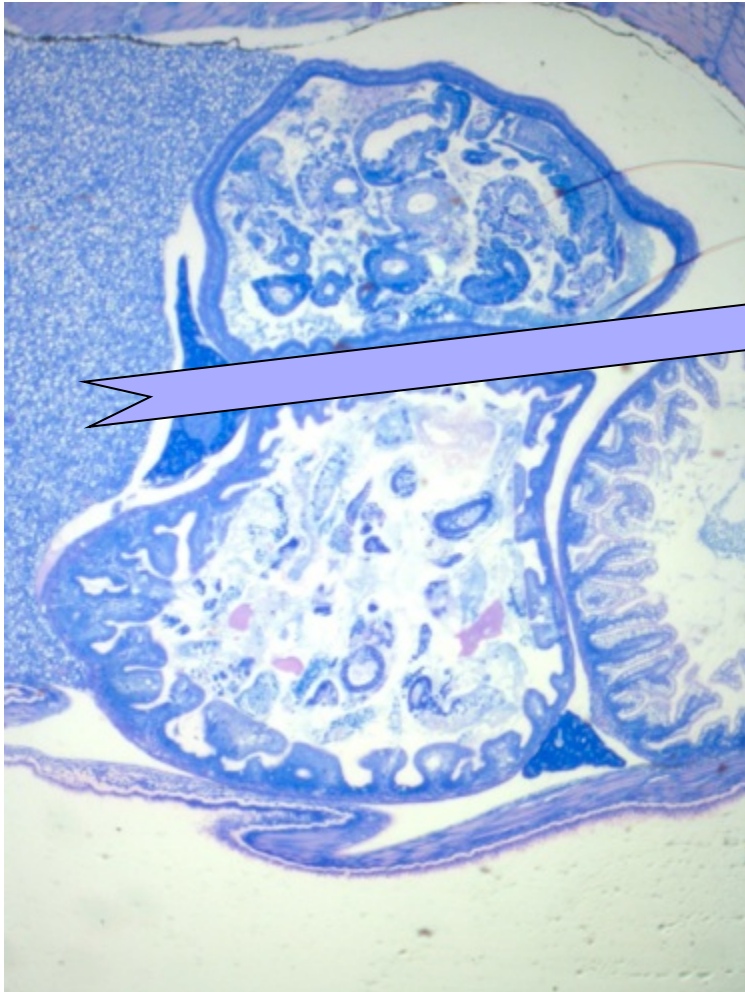
(Instituto Español de Oceanografía, Centro Oceanográfico de Vigo, Spain)





# Lipid deposition in liver

Liver



Lipid vacuoles

Lipid %

Important role in the metabolic activity. Changes in the liver lipid content are considered as precise and rapid indicators for periods of malnutrition in fish larvae.

Papadakis et al. 2009, Papadakis et al. 2013  
Aquaculture