Growth of juvenile white anglerfish (*Lophius piscatorius*) in the Bay of Biscay using otolith microstructure

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IMPORTANCE OF THE STUDY

The study of the daily growth increments in otoliths of young fish is a powerful technique that provides information about important **early life history** characteristics associated with age and growth of juvenile fish, such as hatch dates, annual growth pattern, reproductive and recruitment patterns, settlement and mortality rates (Campana and Jones, 1992).

White anglerfish (*Lophius piscatorius*) is a commercially important species in Europe, but our understanding of their basic biology is far from complete. Thus, the analysis of the otolith microstructure of L. piscatorius in Atlantic waters will provide valuable information for estimating the growth rate in the first stages and it can help verify the formation of the first annual increment and, consequently, provide the basis for a more accurate annual growth pattern.

OBJECTIVES

The main objective of this work was to investigate the early life history of *L. piscatorius* in the Bay of Biscay by the analysis of otolith *(lapilli)* daily increments. Specific objectives were:

i) to estimate the **ages of juvenile** specimens through daily microincrement counts;
ii) to estimate **daily growth rates**;
iii) thus, to estimate the **hatch date distribution** of juveniles.

MATERIAL & METHODS

Juvenile *L. piscatorius* specimens (n=17) were collected in southern Bay of Biscay during a bottom trawl survey carried by the RV "Cornide de Saavedra" in October 2010.

Otolith (*lapilli*) (Fig. 1) microstructure analysis was conducted on specimens ranging from **116** to **213 mm** in total length**.** Otoliths were mounted on microscope slides using mounting wax (Cristalbond). Thin sagittal sections were produced by grinding with automated polishing wheels until core and primary growth increments were visible. Increment counts and measurements were made under a light microscope at **400× magnification** (and 1000× for analyzing the primordium zone) by means of a light microscope equipped with a digital camera. The image transmitted to a computer was examined with an **image-analyser** (Visilog 6.4/ TNPC 4.2).

Fishes were **aged** by counting the growth increments on the *lapilli* otoliths, assuming increments were laid down daily. The widths of the increments were measured along the longest radius of the *lapilli*, starting at the hatch check (Campana and Jones, 1992).

The **hatch date** distribution was estimated by subtracting the number of otolith growth increments from the date of capture.

RESULTS & DISCUSSION

Early life history events

The primordium of *lapilli* otoliths consisted of **one o two cores** surrounded by a sharply demarcated check presumed to be associated with hatching, the **hatching check (HC)** as Hislop *et al.* (2001) reported for this species in northern British waters; a second check, the possible **yolk sac absorbtion check (YSC)** was also observed **(Fig. 2a)**. The initial increment sequence observed between these two checks may reflect the period of **endogenous feeding**, providing an estimated of yolk sac duration of about **13 days** (ranged 9-19 d, SE= 0.84, n=16). Hislop *et al*. (2001) estimated a duration of around 20 days. Several studies have addressed the effects of temperature on yolk-sac duration, pointing that the rate of yolk disappearance (yolk utilization efficiency) is faster at higher temperatures (Johns and Howell, 1980). The temperature in the Bay of Biscay waters during the larval stage (between May and July) when the yolk sac is developed, is around 14-20ºC (ERIS-IEO-SANT) while the embryonic phase in northern British waters occurs at a temperature of 8-9ºC.

The *lapilli* otolith exhibited a strongly demarcated matrix-rich area that may reflect some physiological change associated with the **pelagic-demersal transition**, the presumed **settlement check (SC),** located between 75 and 107 increments (mean=87, SE=2.49, n=16) from the first check **(Fig. 2b).** Hislop *et al*. (2001) estimated this check at a mean of around 108 days and they indicate that factors such as the attainment of a treshold length, depth and the availability of a suitable substrate could determine when settlement takes place.

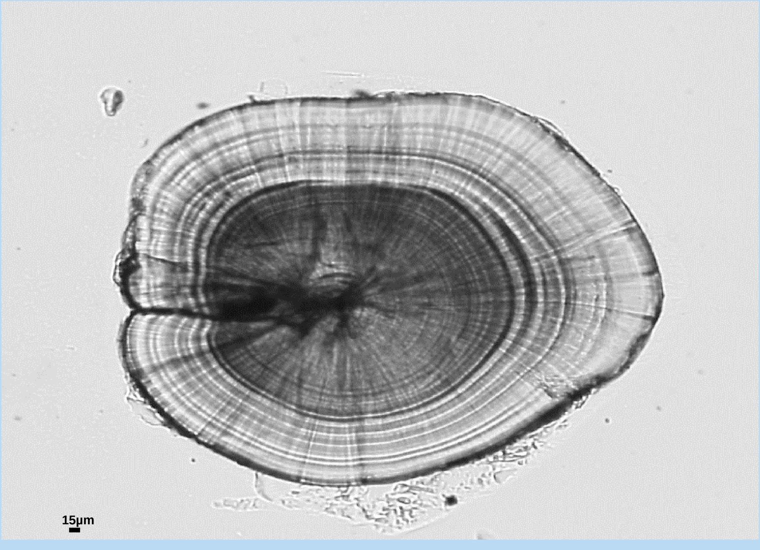


Fig.1. *Lapilli* **otolith of** *L. piscatorius*

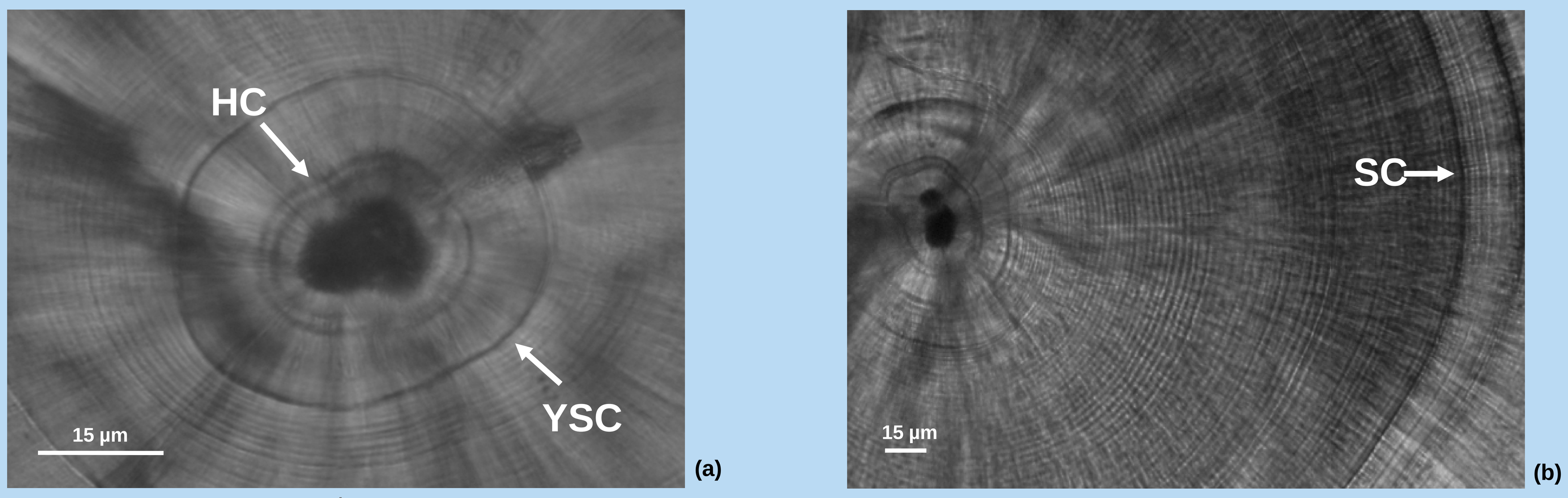
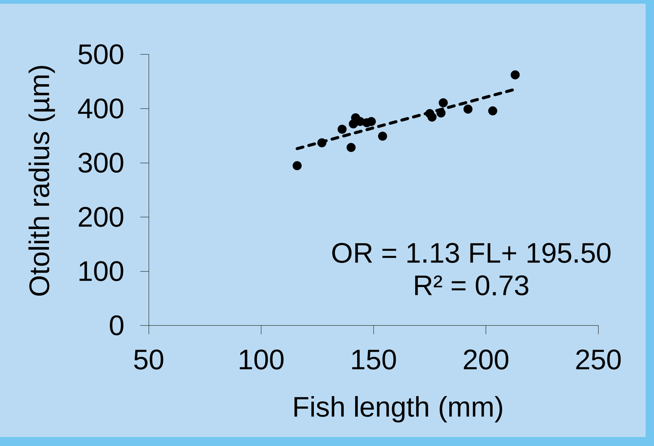


Fig. 2 . Microstructure of *lapilli* **otolith of** *L. piscatorius***: (a) the core area showing presumed hatching check (HC), the yolk sac absorbtion check (YSC); (b) the settlement check (SC).**

Otolith radius - fish length relationship

Otolith radius - fish length relationship is useful to determine the potencial use of otolith microstructure width in growth studies. When otolith size and fish size are highly correlated, and therefore this relationship is predictable, growth trajectories can be **back-calculated** based on otolith increment width (Campana and Neilson, 1985).

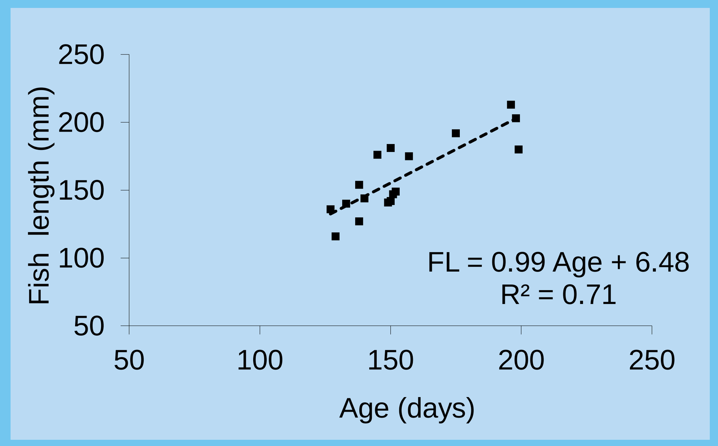
There was a linear relationship between otolith radius and fish length (R^2=0.73, $F_{1,\ 15}$=40, P<0.001, n=17) which will allow us to **back-calculate** growth trajectories.



Age - fish length relationship & growth rates

Age estimated ranged from **127 to 199 days** based on growth increment counts.

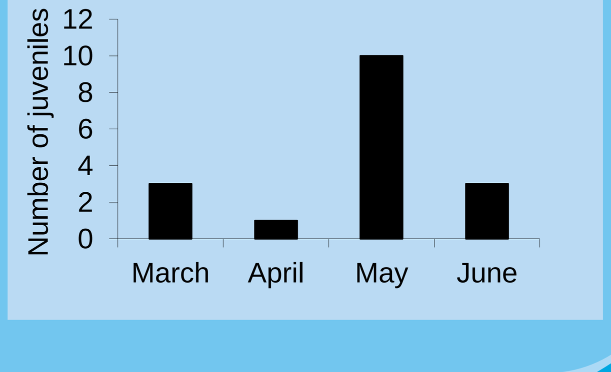
The daily growth rate of juvenile *L. piscatorius* was estimated by fitting a linear regression to the whole age length data (R^2=0.71, $F_{1,15}$=36.29, P<0.001, n=17). The **growth rate** calculated by pooling all aged fish was **0.99 mm/day** (size range 116-213 mm TL), **similar** result to that estimated for this species in northern Atlantic waters (0.91 mm/day) (Wright et al., 2002). Thus, juveniles **< 213 mm** TL collected in October were born the same year and **belong to age class 0**.



The mean lengths at age 1 estimated in studies performed during the last decades using the traditional age estimation criterion based on *illicia* (Duarte *et al*., 2002) were between 132 and 200 mm (Dupouy *et al.,* 1986; Landa *et al.,* 2001; Quincoces, 2002). Thus, at least the first apparent annual increment, which was traditionally considered as the first annulus in those studies, does not seem to correspond to a real one.

Hatch date distribution

The **hatch date** distribution was back-calculated from the date of capture. This would indicate an spawning season from **March to June.** These results agree with the spawning period (May to July) estimated in the histological study of Quincoces (2002) in northern Bay of Biscay, and they also agree with the spread period covering the previous months calculated in the macroscopic studies of Duarte *et al.* (2001) and Landa *et al.* (2012) in southern Bay of Biscay.



CONCLUSION & FURTHER ANALYSIS

- The present results corroborate a faster growth pattern than previously thought for the early stages of *L. piscatorius* in this area, and it is very similarly to what Wright *et al.* (2002) found in British waters.
- These findings have implications for estimating a more accurate annual growth pattern and annual age estimation criterion using hard parts, due to the age estimation criterion based on *illicia* (Duarte *et al.,* 2002) that was used in the assessment of the Atlantic stocks of this species was found to result in the overestimation of the true age (Azevedo *et al.,* 2008).
- For further studies, a **larger sample** should be analyzed to enable us to consolidate these results.

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