Larval herring otoliths: Coping with reality

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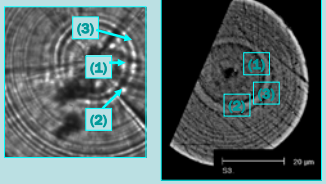
FEATURES OF LARVAL HERRING OTOLITHS

Early Increment Formation

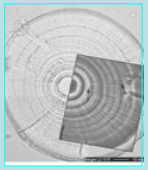
The earliest increments in herring larvae are formed irregularly, and their structure is different from that of later increments.



Three features usually constitute the early increments.

1) the first check, a distinct D-zone up to 1 um in width, often followed by
2) a wide (1 – 5 um), heavily mineralized increment (wide L-zone), often followed by
3) a smaller check

The accepted notion is that once increment formation begins, it continues at a regular rate. A zone usually referred to as an 'area of low contrast' has been assumed to contain many narrow increments. However, the wide D-zone which follows the first increment is a single increment, and it may take several days to form.



This may also happen later, for example here, where wide increments are seen with both SEM and LM

Experimental studies of otolith growth consistently reveal discrepancies between increment counts and known age.

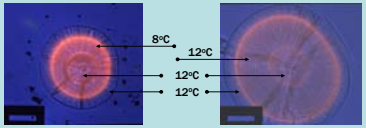
Field studies of larval herring ecology consistently ignore these discrepancies which add unknown errors to the estimates of larval age, hatching date, and growth.

Larval herring otoliths do not represent a reliable record of the entire larval period, because

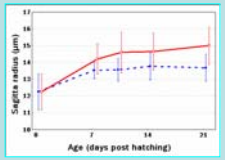
1) Early features are related to development rather than age

2) Wide L- and D- zones can be formed over several days, especially early in life and in slow growth conditions

Is it realistic to assume that herring larvae in the wild differ substantially from those observed in mesocosms? Do all herring larvae with missing rings die in the wild?



We need a temperature dependent otolith growth model to help explain the relationship between otolith radius growth and increment width

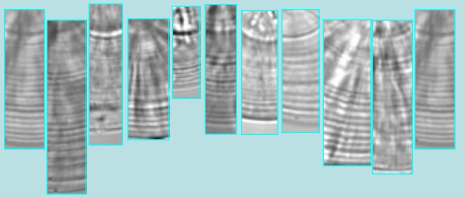


Larvae starved from hatching at 8ºC or 12º C

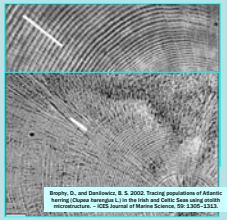
In starved herring larvae, for example, otolith growth continues for a week after hatching, and then virtually ceases.

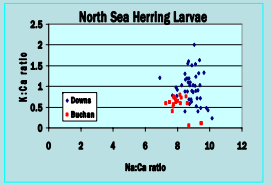
How do we study herring larval growth when we can't use otolith increments for straight-forward age estimation?

It is important to evaluate what can accurately be determined about herring larvae from their otoliths, acknowledging the uncertainty of age estimation in the first weeks of life.

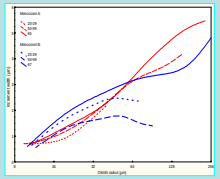


Pattern-recognition techniques could be developed to identify otoliths as coming from good growth or poor growth areas or seasons.

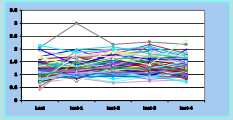




Stock differentiation can be accomplish effectively using increment patterns and composition (microchemistry)



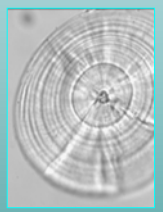
A model of size dependent otolith growth could be used to identify areas of poor growth. Wider than "expected" increments could be used as an indicator of problems with age estimations.

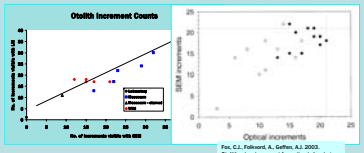


Increments in older larvae are more regular, and events and comparisons can be tracked backwards from time of capture. The combination of otolith size and increment count may reveal growth differences, not apparent in average measures of increment widths.

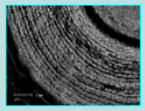
ARE HERRING UNIQUE ?

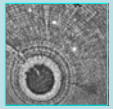
In a number of species, uncertainty in age estimation occurs because the timing of the first increment is controlled by developmental events (in this case, EYS). This makes it difficult to calculate hatching curves without detailed information on the temperature regime and egg size, both of which influence development rates.





Fox, C.J., Folkvord, A., Geffen, A.J. 2003. Otolith micro-increment formation in herring Clupea harengus larvae in relation to growth rate. Mar Ecol Prog Ser 264: 83–94.





Is this an artefact?

Light microscope (LM) and scanning electron microscope (SEM) examination of herring otoliths reveals similar patterns, and 'missing' increments cannot be explained solely by poor resolution

Is there a biological explanation?

Some species have very quiescent larvae during early developmental stages, or may have protracted development due to low temperatures. It is likely that circadian patterns will also be slow to develop in these cases, and metabolic processes will follow internal rhythms

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