

HAS CLIMATE CHANGE AFFECTED THE TIMING OF GROWTH IN NORTH SEA COD? AN ANALYSIS OF ANNUAL GROWTH ZONES IN OTOLITHS.

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Introduction

Cod (*Gadus morhua*) in the southern North Sea are near the southern limit of their distribution. The possibility that climate change may have affected the onset and duration of cod growth was investigated using the timing of annual growth zones in otoliths.

Methodology

- Otoliths of cod from ICES sub-area IVc (Figure 1) were examined from two time periods, with contrasting temperature regimes: 1985/86 and 1994/95 (Figure 2).
- Individuals of ages 2–4 years were selected.
- Monthly observations of the edge type (translucent or opaque) were made.
- Measurements of the width of each edge type constituting the marginal increment were taken under reflected light, using Optimas 5.0 software (Figure 3 far right; see also Stephenson and Hall, 2003).

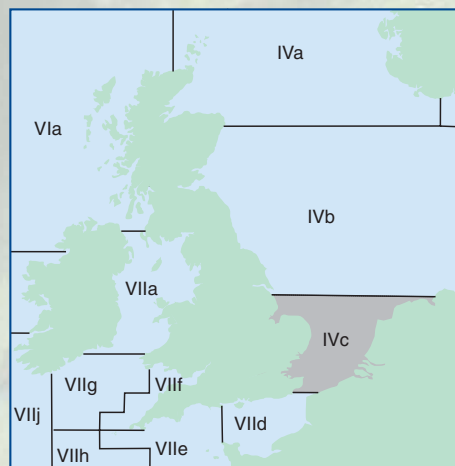


Figure 1: Location of ICES area IVc

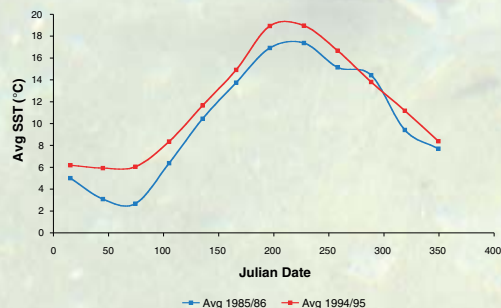


Figure 2: Average Sea Surface Temperature (°C) by month (presented as Julian Date) in the cold (1985/86) and warm (1994/95) temperature periods selected

Results

- Formation of the opaque zone usually begins in October, and is completed by June or July.
- The formation of a translucent edge began up to a month earlier in the otoliths of cod from the warmer years (1994/95) at each age (Figure 4). The completion of the translucent zone also appears to be earlier in warmer years, so the total translucent growth period does not appear to have changed.
- The rate at which the opaque zone was laid down was not different in the two temperature periods (Figure 5). However, the rate at which the translucent zone was laid down was slower in the warmer period than in the cooler period (Figure 6).

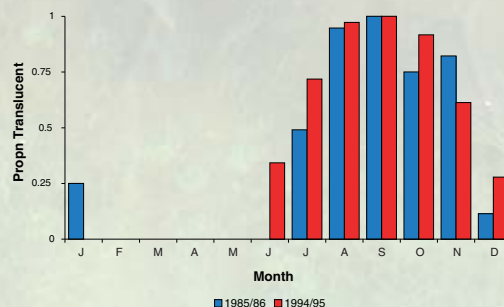


Figure 4: Proportion of North Sea cod otoliths with a translucent margin by month in two temperature periods

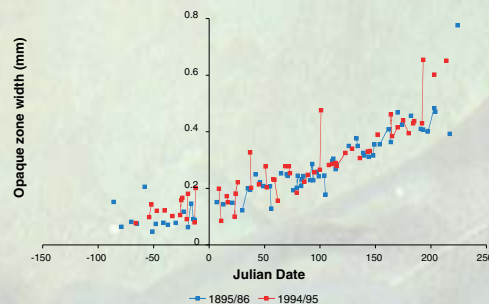


Figure 5: Rate of marginal opaque zone formation in otoliths from the two temperature periods by Julian Date

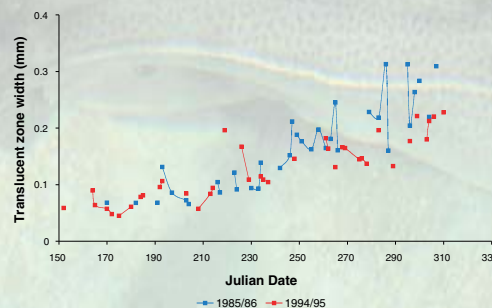


Figure 6: Rate of marginal translucent zone formation in otoliths from the two temperature periods by Julian Date

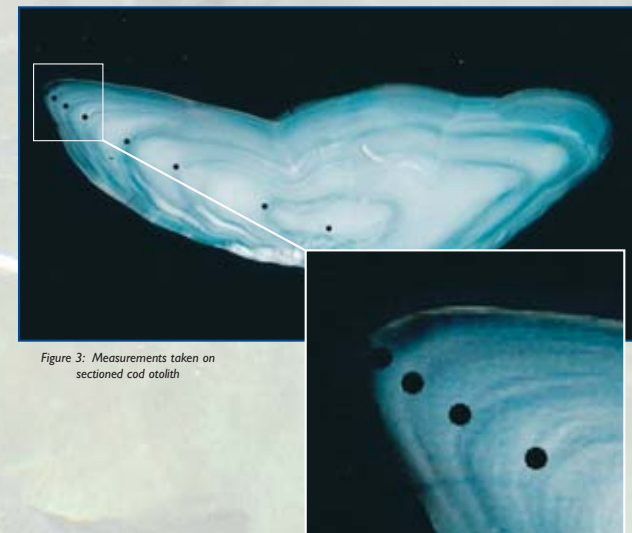


Figure 3: Measurements taken on sectioned cod otolith

Discussion

- Translucent zone formation in North Sea cod otoliths starts and finishes earlier in warmer years.
- The period of opaque growth remains about the same in both periods.
- Rate of translucent zone deposition is slower in warmer years.
- This implies that growth overall is reduced at higher temperatures.
- Cod are close to the southern limit of their range in the study area. Is there a physiological or ecological reason why growth does not continue?
- Are variations the result of changes in productivity, a mismatch in prey and the onset of growth (Beaugrand *et al.*, 2003), or the result of reduced growth rates at higher temperatures (Björnsson and Steinarsson, 2002)?

Further studies

Statistical models will be developed to examine the influence of temperature on the formation of translucent otolith increments. The study will also link with experimental studies on factors affecting otolith formation within IBACS.

Acknowledgements

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References

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