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An illustrated manual for age reading of ling *Molva molva* L and tusk *Brosme brosme* L. by otoliths

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1. Introduction

The stocks of ling *Molva molva* L., blue ling *Molva dipterygia* (Pennant, 1784) and tusk *Brosme brosme* L. in the northeastern Atlantic support significant coastal and offshore bank and slope fisheries in several countries. In 1992, Iceland, the Faroes and Norway initiated a three-year project which should provide improved knowledge of the biology of the three species (Bergstad and Hareide 1996; Magnusson *et al.* 1997). In that project it was focused specifically on age determination methods which could form a basis for future stock assessments and further studies of biology.

For all the three species there was a need for reconsidering the ageing methods applied in earlier studies, and on that basis, perform further technical development and inter-calibration of age readings. This manual summarises results of efforts made for two of the species, ling and tusk, in the period 1993-1996. The manual illustrates the agreed practices which should provide reasonably precise age estimates. Data from several inter-calibration exercises carried out during the nordic project were presented by Bergstad *et al.* (1997).

The only structure useful for determining the age of ling and tusk are the sagittal otoliths, and the otoliths are extracted by the same procedures as used for other gadoids (e.g. Williams and Bedford 1974). This manual aims at assisting age readers who are inexperienced with the reading of ling and tusk otoliths. It should be used as an initial guideline and reference only. In order to achieve precise and stable age determination, there is a need for inter-calibrations of readings by different readers, and repeated reading by the same reader.

2. LING

2.1 Methods

Molander (1956) described and illustrated methods for reading whole ling otoliths, and his or very similar methods and interpretations were used in later studies.

The otoliths could be kept dry or in ethanol or water after collection. If kept dry, soaking in water may be necessary to re-expose the annuli.

The otoliths from ling of TL<90 cm may be read whole after removal of all tissues by a needle or brush. They should be submerged in water or glycerol and viewed *sulcus-side down* by bright transmitted light, or by reflected light against a black background (Figure 1).

Otoliths from ling of total length (TL) greater than around 90 cm become very robust and cannot usually be read whole. Sectioning has been attempted (transverse sections through the nucleus), but with limited success. We recommend breaking or preferably sawing the otolith into two halves through the nucleus. Annuli can be read from the transverse surfaces when applying sidewise illumination and shading as used for e.g. cod (*Gadus morhua*) otoliths. Even with this technique many of the largest specimens cannot be aged with confidence.

2.2 Interpretation of annuli

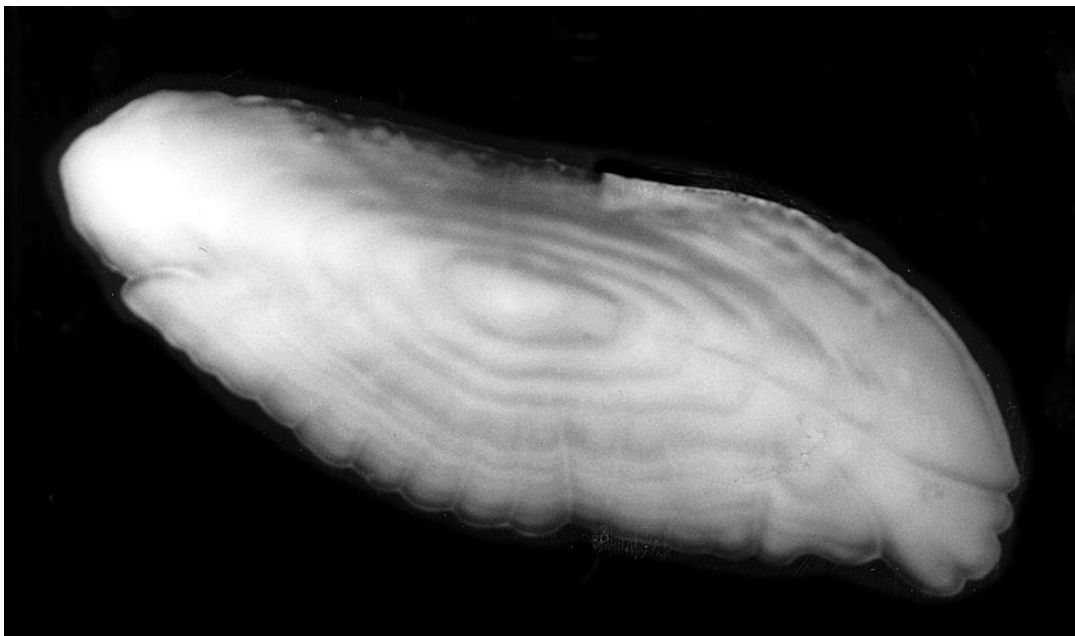
The interpretation of annuli are illustrated by photographs (Figure 1). In all cases, 1 January is assumed as the birthdate. A source of some inconsistency in the

interpretation is the definition of the first fast-growth zone, i.e. the nucleus and the opaque area deposited during the 0-group stage. Due to the prolonged spawning season of ling, this zone may be of very variable size and may sometimes seem very small compared with the subsequent opaque zones which also, however, may be of variable width.

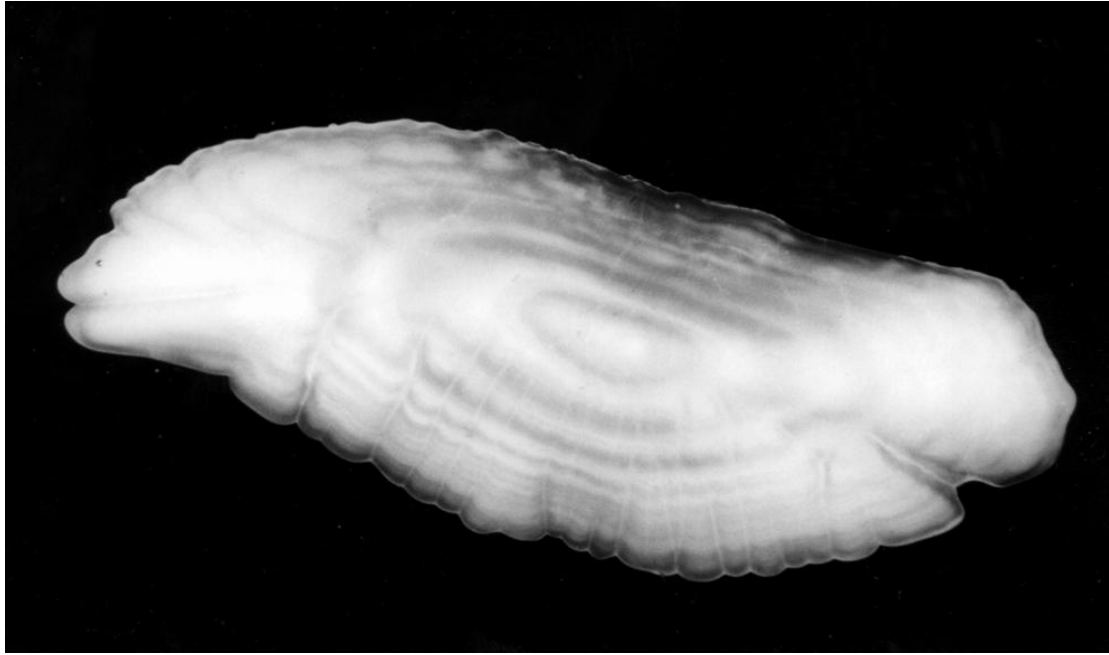
FIGURE 1. Ling otoliths submerged in glycerol and viewed sulcus-side down by reflected light against a black background.



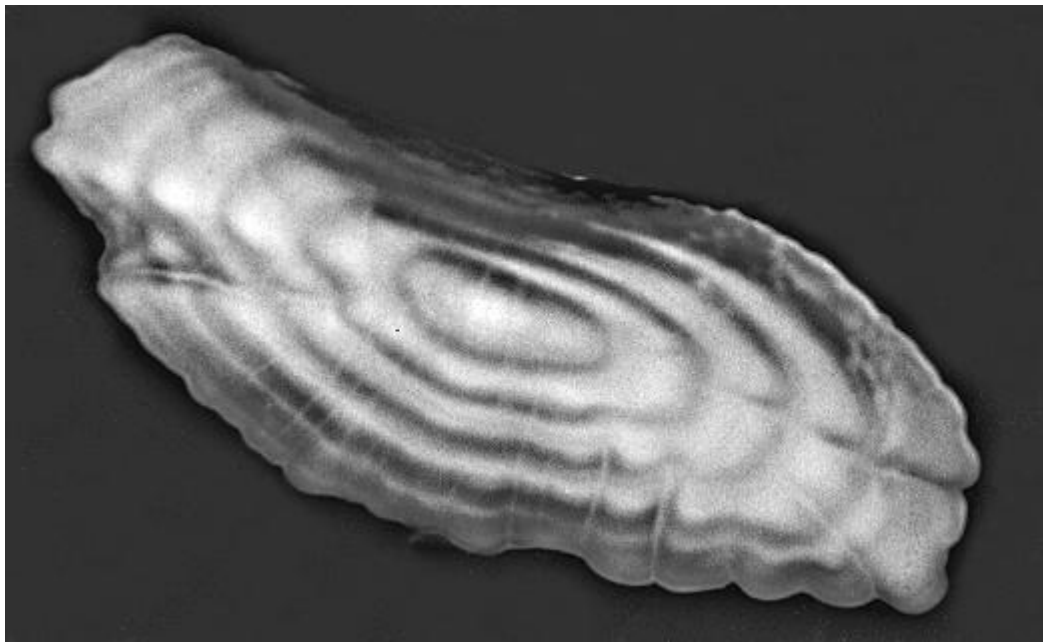
a) **Specimen 132.** *TL:* 69 cm. *Locality:* ICES area VIa. *Date of capture:* 21 June 1995. *Interpretation:* Hyaline edge, except in the generally opaque anterior and posterior sectors. Clear first annulus. 5 years (hyaline edge included).



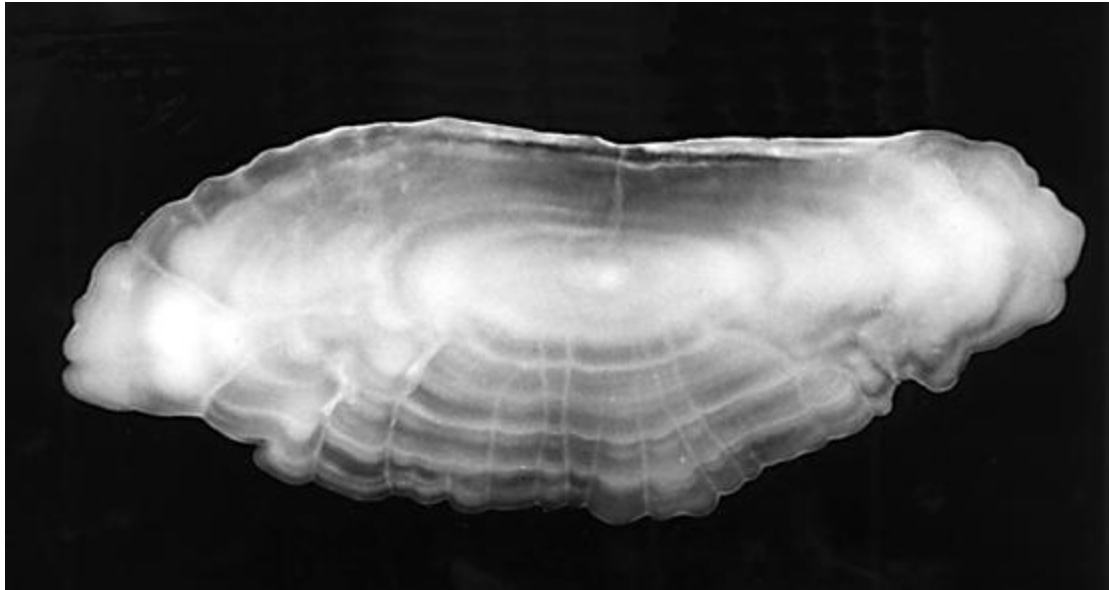
b) **Specimen 57.** *TL:* 63 cm. *Locality:* ICES area VIa. *Date of capture:* 21 June 1995. *Interpretation:* First four annuli clear, the fourth unusually wide. Interpretation of further annuli unclear. Most readers agreed on 7 years.



c) **Specimen 86.** *TL:* 86 cm. *Locality:* ICES area VIa. *Date of capture:* 21 June 1995. *Interpretation:* First three annuli clear, others unclear. 6-8 years old. Unreadable.



d) **Specimen 160.** *TL:* 60 cm. *Locality:* ICES area VIa. *Date of capture:* 21 June 1995. *Interpretation:* Very clear otolith. Only the 5th annulus indistinct. 6 years.



- e) **Specimen H94,33.** *TL:* 76 cm, *Locality:* ICES area IIIa. *Date of capture:* Nov. 1994. *Interpretation:* Nuclear area either unusually large or first annulus unclear. Assuming large nuclear area, 6 years.



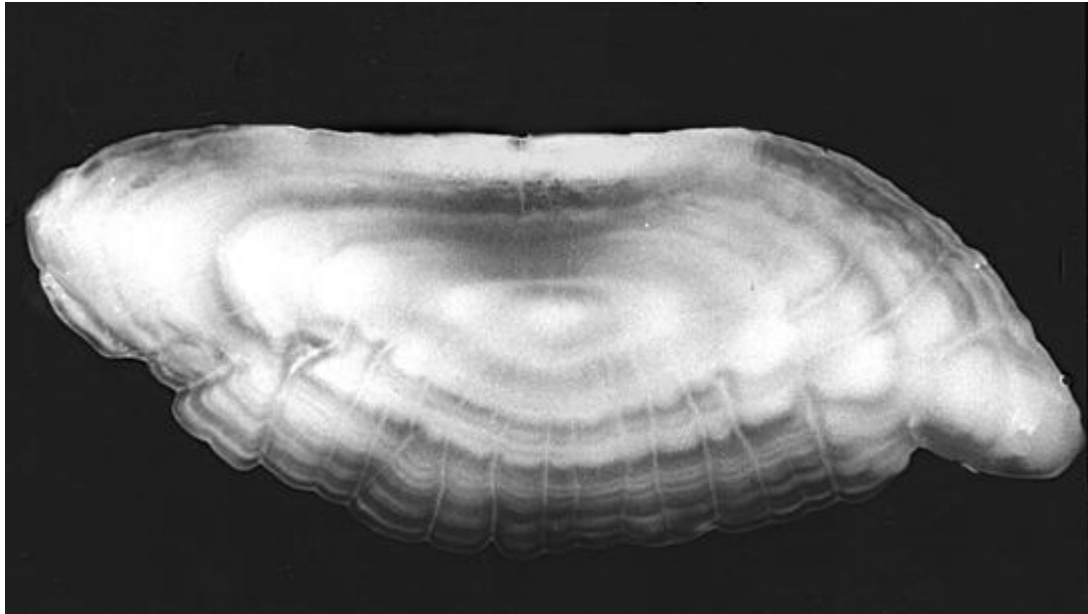
- f) **Specimen H94, 2.** *TL:* 83 cm, *Locality:* ICES area IIIa. *Date of capture:* Nov. 1994. *Interpretation:* Clear and large nuclear area. All annuli distinct. If including the margin which appears opaque (fast-growth zone not completed), 7 years.



g) **Specimen H94, 3.** *TL:* 87 cm. *Locality:* ICES area IIIa. *Date of capture:* Nov. 1994. *Interpretation:* Large nuclear area. Second annulus unclear. Variable widths. 6 or 7 years, probably 6.



h) **Specimen FM-94,3.** *TL:* 69 cm. *Locality:* ICES area IIIa. *Date of capture:* Feb-Mar 1994. *Interpretation:* Opaque margin is wide and must be the fast-growth zone from previous year. Margin should be incl. in count despite absence of hyaline edge. 6 years.



- i) **Specimen 6/9,22.** *TL:* 92 cm. *Locality:* ICES area IIIa. *Date of capture:* 6 Sept 1994. *Interpretation:* Nuclear area small. Margin unclear. 8(7) years.

3. TUSK

3.1 Methods

Pre-reading processing of the otoliths are the same as for ling (see above). Otoliths of tusk of TL<70 cm may be read whole. This technique had also been used previously by Norwegian, Icelandic and Faroese readers. The tusk otolith was best viewed *sulcus-side up* by reflected light against a black background (Figure 2).

The otoliths from specimens of TL>70 cm are often unreadable. In the nordic project transverse sections were produced by the double-blade ISOMET saw and mounted in clear plastic on microscope slides, but few sections were readable.

3.2 Interpretation of the annuli

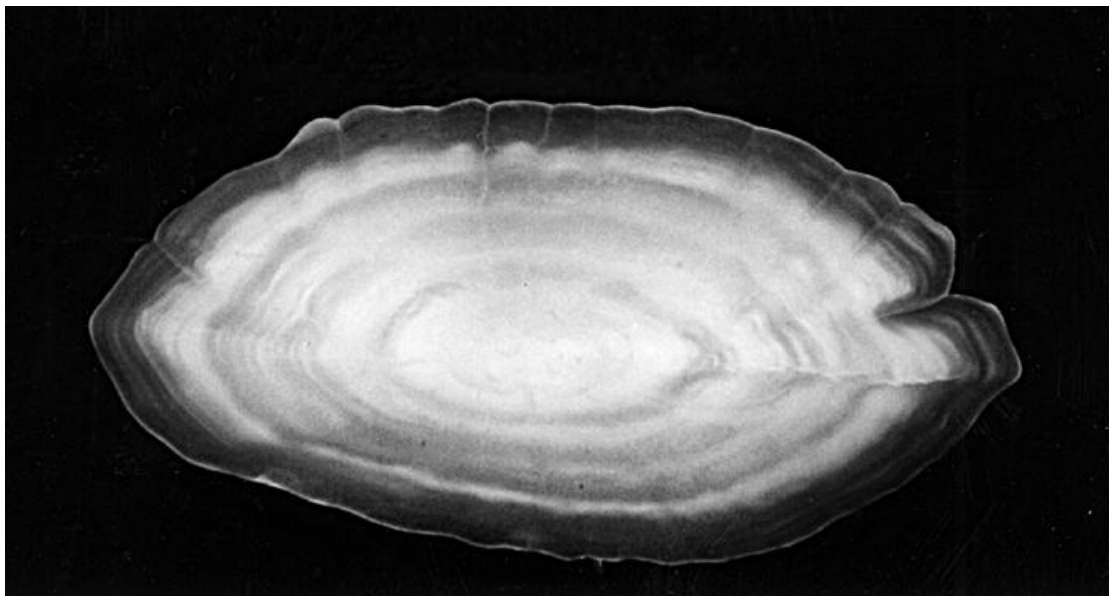
The interpretation problems are generally greater than for ling. Examples of both good and difficult otoliths are shown in Figure 2. The opaque fast-growth zones are seldom homogeneous but appear as bands split by thin but sometimes distinct hyaline zones which may be wrongly considered as annuli. The 0-group growth may be variable and hence the nuclear region of the otolith may be of variable size.

In most tusk samples a relatively high fraction of the fish in the length range 40 - 70 cm had otoliths which were considered unreadable, sometimes as much as 30 % of the specimens were excluded.

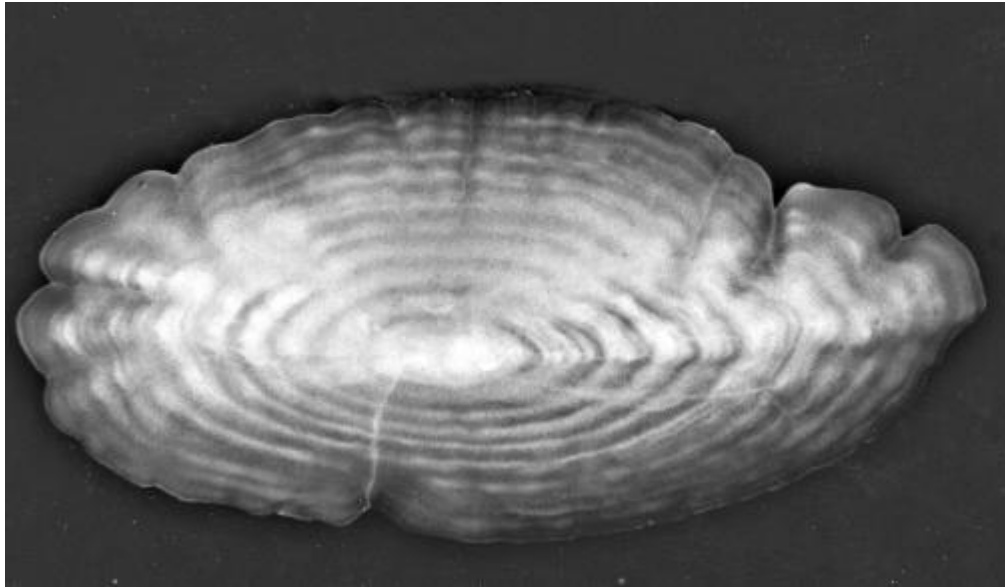
FIGURE 2. Tusk otoliths submerged in glycerol and viewed sulcus-side down against a black background.



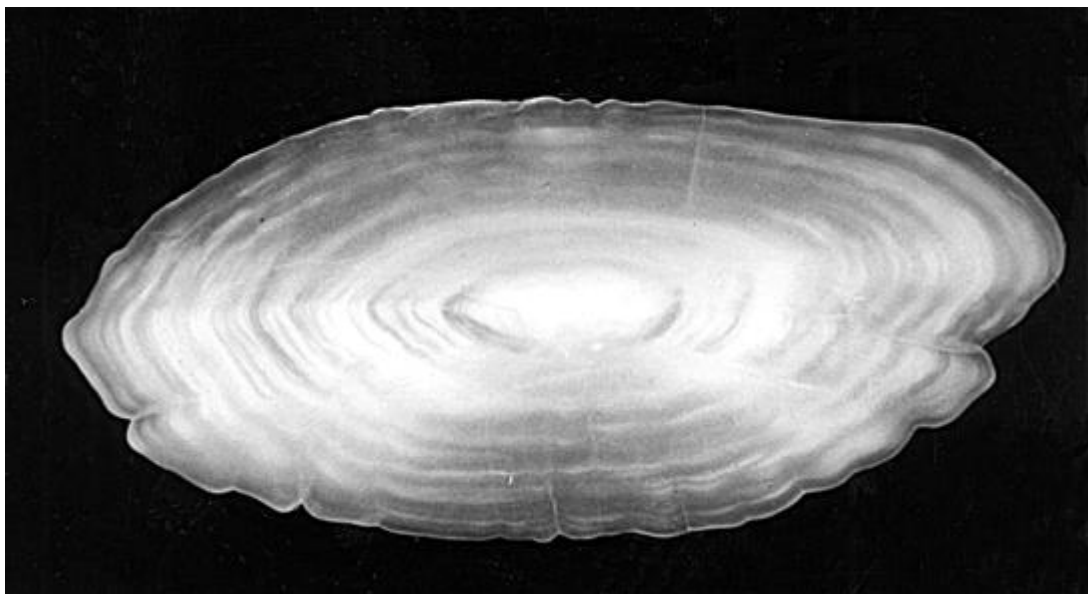
a) **Specimen b182.** *TL:* 28 cm. *Locality:* ICES area VIa. *Date of capture:* 21 June 1995. *Interpretation:* Margin opaque, at least at anterior and posterior sectors. Assumed to represent current year and should not be incl. in count. Nuclear area slightly unclear with a comparatively thin hyaline zone not accepted as annulus. 5 years.



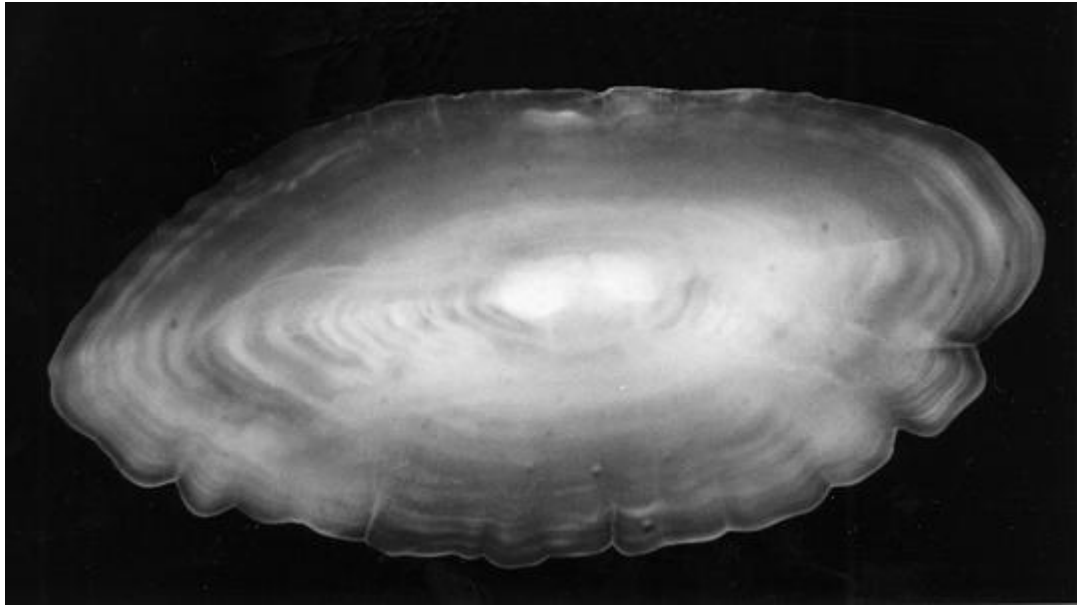
b) **Specimen b183.** *TL:* 31 cm. *Locality:* ICES area VIa. *Date of capture:* 21 June 1995. *Interpretation:* First 3 annuli very clear. Edge problematic. Probably 5 years.



c) **Specimen b161.** *TL:* 65 cm. *Locality:* ICES area area VIa. *Date of capture:* 21 June 1995. *Interpretation:* Almost all annuli very distinct. 11 years.



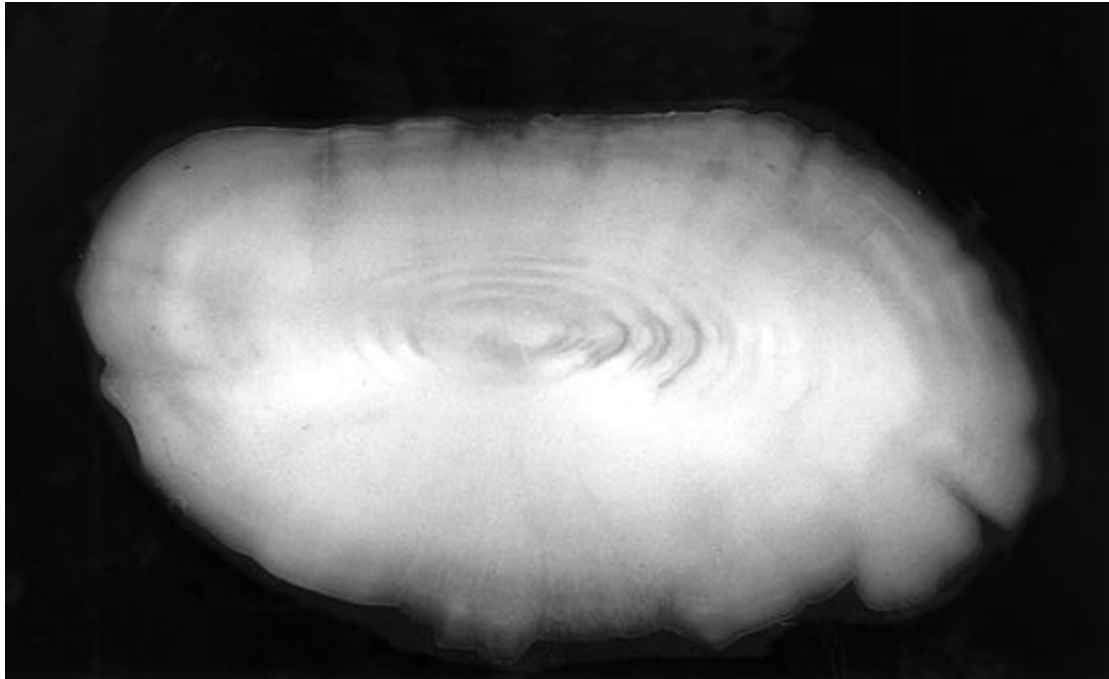
d) **Specimen b178.** *TL:* 50 cm. *Locality:* ICES area area VIa. *Date of capture:* 21 June 1995. *Interpretation:* First annulus clear, many opaque zones split by thin hyaline zones, but rather clear annuli. 8(9) years.



e) **Specimen b170.** *TL:* 52 cm. *Locality:* ICES area area VIa. *Date of capture:* 21 June 1995. *Interpretation:* First annulus relatively clear, but subsequent ones unclear. Great danger of overestimation. Should be considered unreadable.



f) **Specimen b167.** *TL:* 66 cm. *Locality:* ICES area area VIa. *Date of capture:* 21 June 1995. *Interpretation:* First annulus rather unclear, but consistent counting possible. 11 years.



g) **Specimen b162.** *TL:* 69 cm. *Locality:* ICES area area VIa. *Date of capture:* 21 June 1995. *Interpretation:* First three annuli clear, otherwise blurred. Unreadable.

Acknowledgements

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