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Contribution to knowledge on age and growth of Antarctic toothfish (Dissostichus mawsoni) from Division 58.4.1

L.J. López-Abellán, M.T.G. Santamaría, R. Sarralde and S. Barreiro (Spain)

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Contribution to knowledge on age and growth of Antarctic toothfish (*Dissostichus mawsoni*) from Division 58.4.1

L.J. López-Abellán, M.T.G. Santamaría, R. Sarralde, S. Barreiro

Centro Oceanográfico de Canarias, Instituto Español de Oceanografía

Abstract

A summary of progress made regarding the ageing and growth studies for *Dissostichus mawsoni* from Division 58.4.1 is presented. It is included the methodology used in the otolith preparation and the interpretation criteria applied on age estimation, as well as the age-length key and growth parameters estimates by sex. Growth parameters obtained using length-age pair values are: L_∞: 154.4, k: 0.1399 and t_0: 1.321 for males; L_∞: 166.6, k: 0.1322 and t_0: 1.571 for females; and L_∞: 168.2, k: 0.1141 and t_0: 0.8488 all combined.

Introduction

Samples studied were obtained in the course of research experiments conducted by the Spanish flagged vessel *Tronio* in Division 58.4.1 in the fishing season 2012-13. Otoliths from 580 specimens were used in this first approach to ageing individuals of this species by experienced age readers of the Instituto Español de Oceanografía, in order to construct the age structure of fished population and to estimate the growth parameters.

This information is intended to be implemented in a robust assessment for the surveyed areas in this region, using together the simple Petersen and the Depletion methods.

Otolith preparation

We basically followed the methodology described on the Manual for age determination of Antarctic toothfish (Sutton *et al*., 2012) as “bake and embed” technique.

Sagitta otoliths removed from each selected fish were cleaned and conveniently labeled for identification. Once in the laboratory, the left otolith was selected for preparation, unless it is broken or damaged. The first step consisted in marking the distal surface of each otolith transversely through the *primordium* with a pencil, to ensure that the otolith *primordia* are correctly aligned during embedding and facilitate the four aligned otoliths sectioning with a single cut.

Figure 1.- Metallic tray.

Figure 2.- Aluminum double mould used to embed otoliths.

Marked otoliths were placed in a metallic tray (Fig. 1) and baked in a Selecta muffle until dark colored (285ºC; 15 minutes).

Once baked and cooled, the otoliths were embedded in a pre-accelerated polyester resin (Crystic 115) blocks, using an aluminum double mould (Fig. 2). Each block comprises a layer of 20 otoliths.

After cured, each block was extracted and cut in a high speed revolving saw (Fig. 3) with a diamond disk supplied by *Asahi diamond industrial Europe SAS* (Disque 1A1R Ø 152 T 0,9 E 0,9 H 13 W9, Ref 8502578A001).

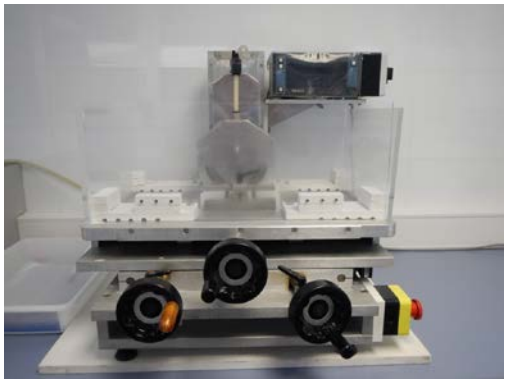

Figure 3.- High speed revolving saw.

The cut surfaces were polished with a faceting machine using a 1200 microns diamond coated disc (Fig. 4). This process removed any cutting marks that could distort the image during otolith reading. Each block was labeled with a reference number (Fig. 5) before microscope examination with incident light.

Figure 4.- Faceting machine.

Figure 5.- Sections ready to be read.

Otolith interpretation and age determination

For microscopic examination, two tests were done on the cut surface of the polished otolith section, using a thin layer of paraffin oil or water. The best contrast was obtained by using a thin layer of water over the otolith surface. The sections were illuminated with incident white light, with the option of using different illumination angles and intensities and examined using a stereo microscope (Fig. 6) with two binocular heads (at around 40x magnification).

Figure 6.- Stereo microscope used in this process.

In this initial phase on ageing *D. mawsoni* from Division 58.4.1, the protocol adopted consisted of:

- Individual readings at the same time (same image) by two experienced people on otolith interpretation.
- Discussions and adoption of interpretation pattern
- Final personal age assignment, maintaining single readings when there were disagreements.
- Graphical analysis of progress achieved.

After 165 readings it was detected that the pattern followed was not correct because there was a tendency on readers to consider several annual rings as one single year in the outer part of the otolith. These readings were discarded and the process started again from this point (specimen 166) applying this new approach. The criteria concerning the first ring proposed by La Mesa (2007) was taken into account although not always it was observed.

Due to the complexity in the reading process, the protocol of conjoint interpretation was maintained for the rest of the whole collection (580 otoliths), although discrepancies were recorded.

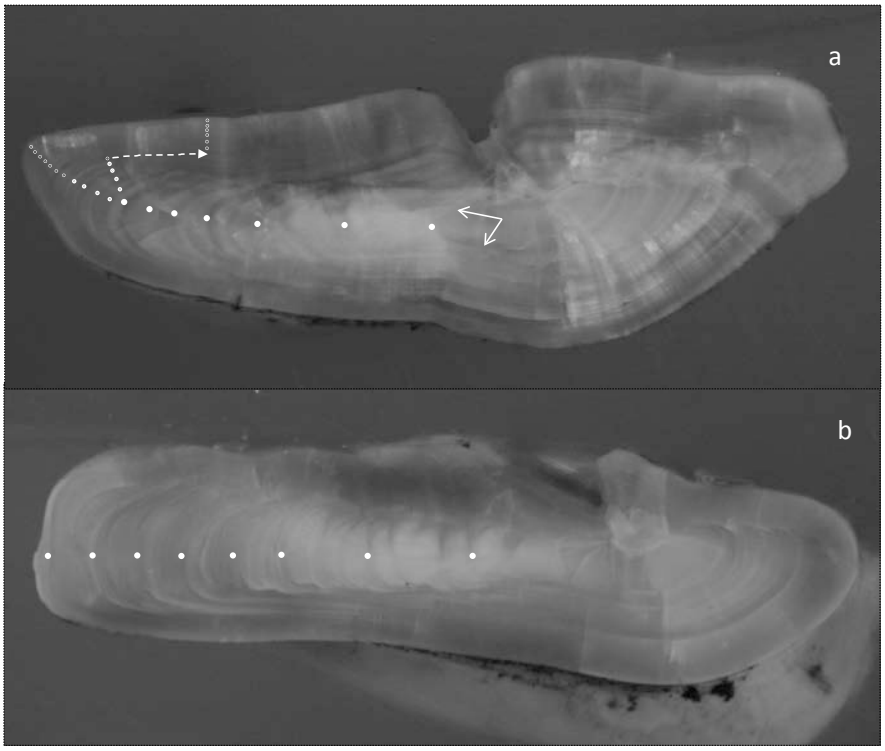

Figure 7.- Transverse otolith sections from *D. mawsoni* specimens. a) nº 366 (18+) showing arrows indicating the annulus estimated as the first year and the two most common reading paths used; b) nº 556 (younger fish, 8+) with year marks adopted, showing in the margin a clear translucent zone in the process of forming.

In Figure 7a the transverse otolith section of a *D. mawsoni* specimen is presented

(142 cm; 18+). White dots mark the interpreted annual growth regarding the annuli, including the two most common paths used on reading process. Arrows show what we consider the first annulus. Figure 7b belongs to a younger fish otolith (109 cm; 8+) where we can realize the difficulties on interpret the three first rings and the new translucent zone in formation in the margin.

Most of otolith features described by authors in Sutton *et al*. (2012) were clearly identified in collection and difficulties on interpretation were verified (plane for readings, false checks, split zones, deficient burning, etc.), thus 11%-15% of otoliths were considered unreadable. Also reliability on reading were low, only 3.3%-10.9% of otoliths was considered easy to read, 41.2%-54.3% readable and 40.5%-23.6% readable with difficulty (Table 1).

Table 1. Readability of otolith.

Reader A	n	%
Difficult to read	235	40.5%
Readable	239	41.2%
Easy to read	19	3.3%
Rejected	87	15.0%
Total	580	

Reader B	n	%
Difficult to read	137	23.6%
Readable	315	54.3%
Easy to read	63	10.9%
Rejected	65	11.2%
Total	580	

Diagnostics in interpreting age comparisons is unnecessary in this case, considering the protocol followed by the readers. However, figure 8 also shows some disagreements after comparing both interpretations. We follow this procedure to reach a unique consensual criterion. Although readings from both readers were very close (Figure 9), for posterior analysis it was decided to use the readings that obtained the best fitting.

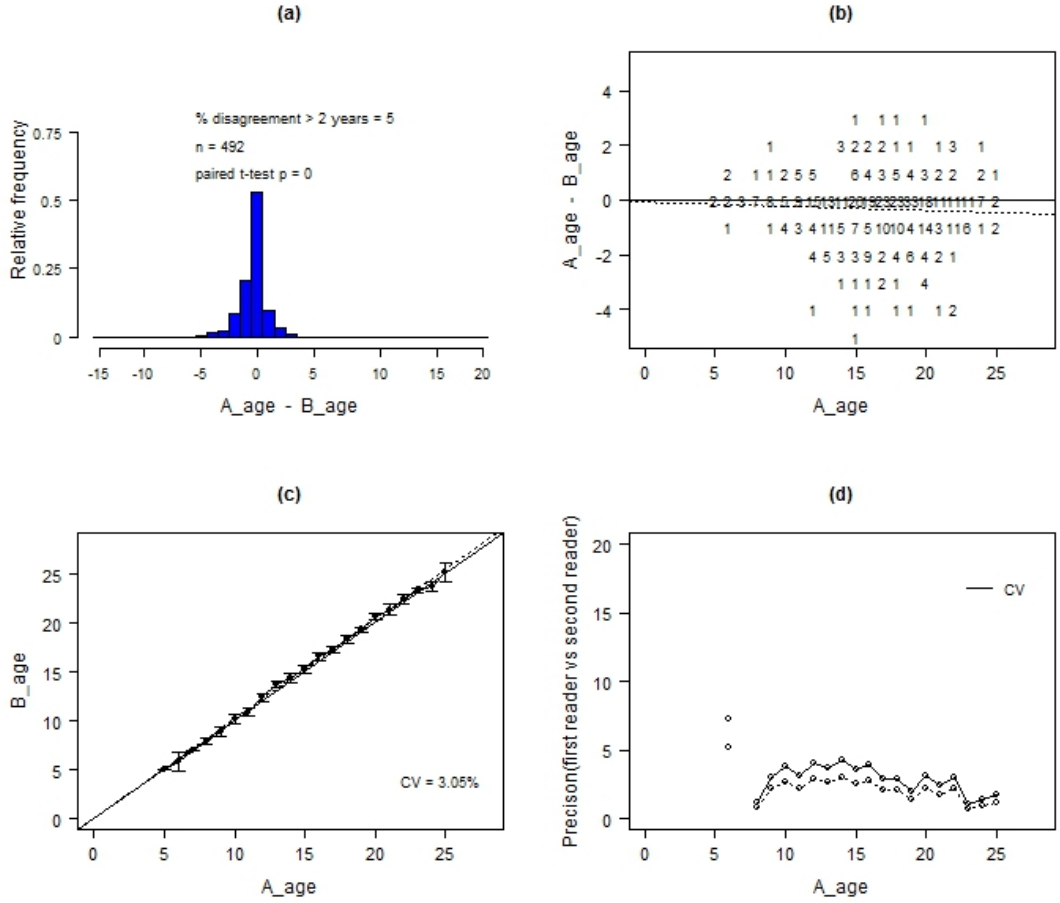

Figure 8.- Comparison of estimated ages by two readers including exchange of information between them using the NIWA R code AgeCompare library.

Age-length key and mean length analysis

Table 2 shows the age-length key for all individuals adopted where the length ranged from 5 cm to 175 cm total length and ages ranged from 5+ to 26+. Few individuals with less than 7 years and greater than 24 years were in the whole sample analyzed. The evolution of mean length at age from keys from two readers are in figure 9 and the comparison of results from reader B with a similar length range in Horn (2003) is in figure 10.

Table 2. Age-length key for *D. mawsoni* from Division 58.4.1, fishing season 2012-13.

Length (cm)/ Age Class (years)	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
60	2	1																				
65	1																					
70	1		1																			
75		1																				
80																						
85			3	2																		
90			1	2	2	1	1															
95			1	1	1	2	1															
100					3	3	2															
105				3	3	3	4	4														
110					1	1	1	3	3	2	2											
115					1	3	8	3	4	5	2	1		1								
120							2	5	4	7	7		2	1	1		1					
125								3	4	10	5	4	4	1	2	2	2		1			
130								2	2	2	9	2	4	4	5	7	1	1	1			
135								2	2	5	5	4	4	6	3	2	7	1	3	2		
140									1	2	6	7	14	10	11	4	4	4	2	1		
145										1	5	8	3	9	4	5	2	3	2	3		
150									1	1	2	4	4	2	7	8	6	7	2	4	2	1
155										1	1	4	2	3	12	5	5	1	7	2		1
160											1	1	6	7	4	2	4		7	1		
165														2	1		1	1	2	1	1	1
170														1	2	1	4	1	5		1	
175														1		1	1	1		1		1
n	4	2	6	8	11	13	19	22	21	36	45	35	43	48	52	37	38	20	32	15	4	4
Mean length (cm)	66.3	70.0	87.5	97.5	103.9	106.3	111.7	120.7	125.8	128.9	134.5	143.5	143.5	147.4	148.7	147.2	150.7	151.3	156.1	152.8	161.3	163.8
SD	4.79	10.61	8.37	8.86	7.78	8.20	8.54	9.58	10.53	10.66	11.75	10.42	11.42	12.98	11.70	12.19	14.16	11.11	12.52	10.77	10.31	11.09

Figure 9.- Evolution of mean lengths at age from two readers.

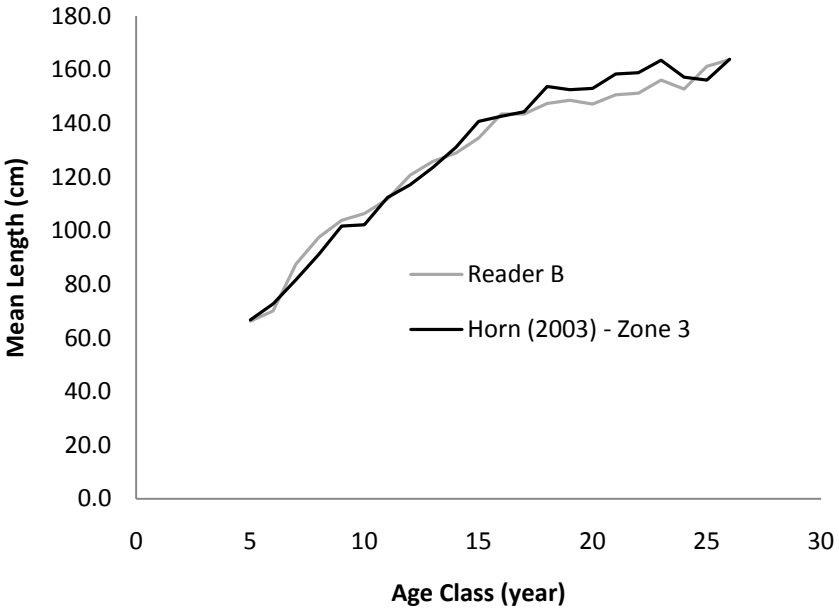

Figure 10.- Evolution of mean lengths at age from readings selected in this study and Horn (2003).

Growth parameters

A von Bertalanffy growth function based on a least-square approach from length-age pair values had been estimated. Growth parameters by sex and combined are presented in Table 3. Figure 11 shows pair values by sex and growth curve fitted for males, females and all data.

Table 3. Parameters of von Bertalanffy growth fitting by sex and all data combined, for *D. mawsoni* from Division 58.4.1 and the results of the likelihood ratio of between-sex differences in growth.

Sex	*n*	L_∞ (cm)	k (y^{-1})	t_0 (y)	*P*
Male	235	154.4	0.1399	1.321	
Female	279	166.6	0.1322	1.571	
Combined	514	168.2	0.1141	0.8488	<0.0001

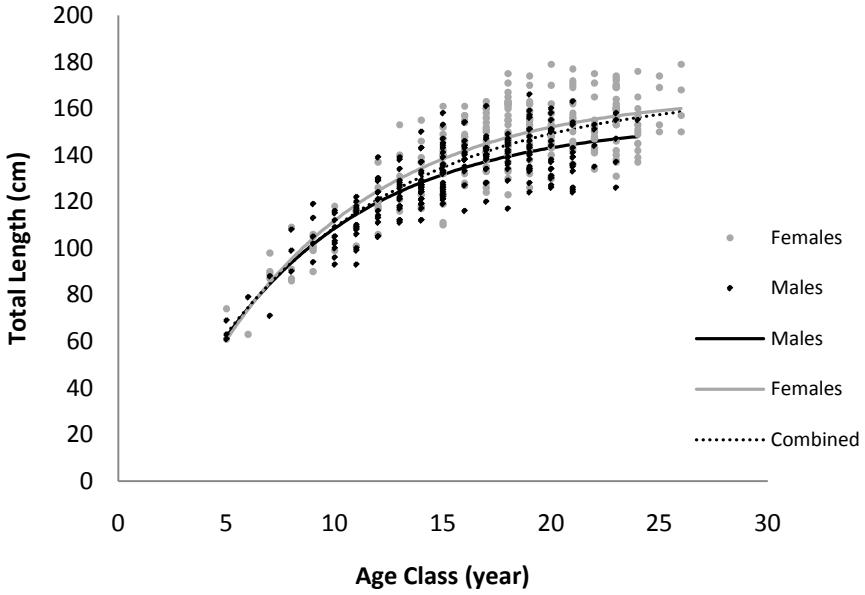

Figure 11.- Pairs values of length-age used to estimate growth parameters and growth curves fitted for males, females and all combined.

Work in progress

Once reached this practical status, the annually age estimation of Antarctic toothfish samples has continued incorporating two new readers for 2014 samples readings, to transfer the criteria followed and practical issues of process.

References

Horn, P.L. (2003). An examination of latitudinal variation in the growth rates of antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea. *Document WG-FSA-03/30. CCAMLR*, Hobart: 11 pp.

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