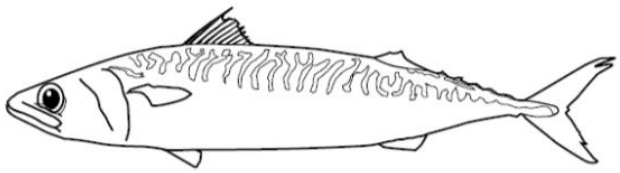
Report of the Small-Scale Otolith Exchange of Northeast Atlantic Mackerel (*Scomber scombrus*) 2020-2021 (SmartDots event 280)

by María Rosario Navarro (National Centre IEO-CSIC, CO Santander, Spain)

and Jens Ulleweit (TI-SF Bremerhaven, Germany)



1. INTRODUCTION.

Atlantic mackerel (*Scomber scombrus*) is a pelagic species of high commercial importance in European waters. Living on both sides of the North Atlantic, ICES currently uses the term "Northeast Atlantic (NEA) mackerel" to define the mackerel present in the Northeast Atlantic with a distribution range from the Iberian Peninsula in the South to the Nordic Sea, including Icelandic and Greenland waters and the Western Baltic. Recent ICES stock advice based on an age-based analytical assessment model shows that the stock of NEA mackerel is still on a high level but decreasing the last years.

Age readings on mackerel are important input data for the assessment and carried out by a number of laboratories using international agreed ageing criteria.

The first reported workshop on mackerel ageing was held in Lowestoft in 1987, preceded by a first otolith exchange in 1986, and followed by another workshop in 1995 in Spain and one exchange in 2002. A third exchange was performed in 2008, followed by a workshop that was held in 2010 in Lowestoft again, and a small exchange in 2014, which was the first one using images only (via WebGR). All previous workshops and exchanges have had outcome stating the overall agreement to be low but fair but skewed towards having a higher agreement on the younger ages. All workshops discussed and tried to standardize age reading methods by preparing a manual and a reference collection of agreed age otoliths.

The last exchange and workshop held in San Sebastian in 2018 were the first ones performed via SmartDots. Quite a lot in terms of ironing out was achieved, through on-screen discussion of difficult and/or old otoliths and calibration, some of the differences in age interpretation between readers. The participants agreed to employ the revised ageing guidelines in their age estimation. The overall results of the workshop exercise showed an improvement in the agreement between all readers and especially expert readers, regarding the exchange carried out before the workshop exercise. However, the agreement between readers for otoliths with older ages (from age 6) continued to be very low.

During the last workshop ageing protocol/guidelines were revised and completed with the aim to employ these guidelines to eliminate some of the problems with e.g., split rings in the otolith structures. In conclusion, the participants to the workshop recommended that exchanges and workshops on age reading of NEA mackerel should be held regularly and the next exchange was scheduled for 2020. However, due to the pandemic, the start of the exchange was delayed until the beginning of 2021. This report represents the results of this exchange.

2. MATERIAL AND METHODS.

A total of 37 readers from 12 European countries (13 laboratories) participated in the exchange. Two more readers (one from The Netherlands and another from Norway) were originally included in the exchange although in the end they did not participate in the exercise. The reader´s number of each participant was assigned based on the new protocol to weight the experience of readers in reading exchanges. Thus, an experience ranking number was obtained for each reader from the information provided by the participants in the Excel table "Scheme for ranking SmartDots Users" (Table 2.1).

Table 2.1. Experience ranking number and other readers' information of the participants of the small-scale exchange of NEA mackerel otoliths.

Exp. rank. N	Reader Id	Readers name	Laboratory	Country	Readings in assessment
1	R1	Jane Mills	Marine Lab	Scotland-UK	YES
2	R2	Guðrún Finnbogadóttir	MFRI	Iceland	YES
3	R3	Eilert Hermansen	IMR	Norway	YES
4	R4	Anne-Liv Johnsen	IMR	Norway	YES
5	R5	Iñaki Rico	AZTI	Spain	YES
6	R6	Charo Navarro	IEO	Spain	YES
7	R7	Deirdre Lynch	Marine Institute	Ireland	YES
8	R8	Maria Jarnum	DTU-Aqua	Denmark	YES
9	R9	Clara Dueñas-Liaño	IEO	Spain	NO
10	R10	Andre Dijkman-Dulkes	WMR	Netherlands	YES
11	R11	Selene Hoey	Marine Institute	Ireland	YES
12	R12	Jens Arni Thomassen	FMRI	Faroes	YES
13	R13	Poul Vestergaard	FMRI	Faroes	YES
14	R14	Tim Huijer	WMR	Netherlands	YES
15	R15	Merete Kvalsund	IMR	Norway	YES
16	R16	Delfina Morais	IPMA	Portugal	YES
17	R17	Gertrud Delfs	Thünen-Institut	Germany	YES
18	R18	Stine Karlson	IMR	Norway	YES
19	R19	Orjan Sorensen	IMR	Norway	YES
20	R20	Eugene Mullins	Marine Institute	Ireland	YES
21	R21	Naiara Serrano	AZTI	Spain	YES
22	R22	Gitta Hemken	Thünen-Institut	Germany	YES
23	R23	Michelle Inglis	Marine-Lab	Scotland-UK	NO
24	R24	Froidis T. Rist	IMR	Norway	YES
25	R25	Adam Custer	IMR	Norway	YES
26	R26	Andreia Silva	IPMA	Portugal	NO
27	R27	Ana Antolínez Boj	IEO	Spain	NO
28	R28	Athanasios Spetsiotis	FRI	Greece	NO
29	R29	Gina correia	IPMA	Portugal	NO
30	R30	Papantoniou Vasiliki	FRI	Greece	NO
31	R31	Geoffrey Bled Defruit	IFREMER	France	NO
32	R32	Tom Svoldgaard	DTU-Aqua	Denmark	YES
33	R33	Telliez Solène	IFREMER	France	NO
34	R34	Antoine Dussuel	IFREMER	France	NO
35	R35	Erling Boge	IMR	Norway	NO
36	R36	Lea Marie Hellenbrecht	IMR	Norway	NO
37	R37	Susanne Tonheim	IMR	Norway	NO

The exchange was carried out via SmartDots, the web application developed by ICES to facilitate the setup of exchanges, workshops and training events (http://www.ices.dk/marine-data/tools/Pages/smartdots.aspx). A total of 237 otolith images from the main areas of mackerel distribution were included in the exchange. Following the recommendations of WKMACQI (Workshop on Mackerel biological parameter Quality Indicators) (ICES, 2018), it was attempted that the spatial and temporal coverage, as well as the length and age range, of the mackerel otoliths of the exchange corresponded with the coverage in the assessment (Table 2.2).

Table 2.2. Spatial and temporal coverage of the otoliths used in the small-scale exchange of NEA mackerel otoliths.

Component	ICES Area	subarea	N images			Length range (cm)	Image origin
			Sem 1	Sem 2	Total		
South component	8c	8cE	5	5	10	29-43	IEO (Spain)
		8cW	5	5	10		
	9a	9aN	5	5	10	20-42	IPMA (Portugal)
		9aCN	14	13	27		
		9aC					
		9aCS					
		9aS					
West component	6	6a	3	7	10	27-37	WMR (The Netherlands)
	7	7b	5		5	31-39	IMR (Norway)
		7c	5		5	34-38	TI-SF (Germany)
		7g	5		5	19-33	
		7d		5	5	26-35	
		7f		5	5	21-29	IFREMER (France)
		7h		5	5	16-30	
		7j		5	5	17-33	
	8abde	8a		10	10	19-30	
		8b	10		10	32-39	AZTI (Spain)
North Sea component	4	4a	5	15	20	19-43	TI-SF (Germany)
		4b	6	14	20	19-39	WMR (The Netherlands)
		4c	5		5	19-24	
North distribution	2	2a	20		20	16-39	DTU-Aqua (Denmark)
		2b		20	20	33-42	IMR (Norway)
	5	5b	10		30	26-40	
			7	13			FMRI (Faroe Islands)
	Total		110	127	237		

Although SmartDots application can generate an automatic analysis of the results, it was necessary to apply some nuances to the results that were impossible to perform with the program. Also all the annotations of reader R29 were not included in the automatic analysis, probably because one or more steps were missed during the annotation process. Hence, the exchange results were analysed using the spreadsheet of GuusEltink (Eltink, 2000) instead.

3. RESULTS.

A table with the participants' readings can be found in Table 3.1. In addition to the estimation of the age of the exchange otoliths, readers were asked to assign the quality to each reading according to the "3 point grading system" (AQ1, AQ2, AQ3) recommended by WKNARC (ICES, 2011), shown in the table in blue (AQ1 annotations) and brown (AQ2 annotations). Readings with AQ3 were not included in the analyses.

Two analyses were performed for the total of areas: i) all readers, and ii) advanced readers (readers whose age estimations are used in the NEA mackerel assessment).

Table 3.1. Overall readings (Small scale otolith exchange NEA mackerel). (L: fish length; M: landing month; MA: modal age; ad: advanced; *: advanced readers; blue annotations: Q1, brown annotations: Q2, black annotations: no Q1/Q2 information).

Area	Sample code	L (cm)	M	R1*	R2*	R3*	R4*	R5*	R6*	R7*	R8*	R9	R10*	R11*	R12*	R13*	R14*	R15*	R16*	R17*	R18*	R19*	R20*	R21*	R22*	R23	R24*	R25*	R26	R27	R28	R29	R30	R31	R32*	R33	R34	R35	R36	R37	MA all	MA ad
8.c	MAC001	401	3	9	10	12	11	10	11	11	8	10	11	10	10	13	10	10	6	10	12	10	11	-	12	10	10	12	-	10	9	5	-	7	9	6	7	10	10	10	10	10
8.c	MAC002	353	4	5	5	5	5	6	5	5	5	5	5	7	6	5	5	6	5	5	5	5	5	4	5	6	6	5	4	5	5	4	-	5	6	4	5	5	5	5	5	5
8.c	MAC003	340	4	5	5	6	5	5	5	5	5	5	5	6	5	4	5	5	4	5	5	5	5	4	5	5	6	5	4	5	4	4	-	5	4	4	5	5	5	5	5	5
8.c	MAC004	311	6	3	3	4	3	4	4	3	3	4	3	4	3	3	4	4	3	3	3	3	4	2	3	2	4	2	3	3	3	4	-	3	3	2	1	3	3	3	3	3
8.c	MAC005	290	6	2	1	2	1	1	2	1	2	2	2	2	2	2	1	2	2	1	1	1	2	1	2	1	2	2	2	2	1	3	-	2	3	1	1	2	1	1	2	2
8.c	MAC006	390	7	5	6	7	9	7	7	7	6	5	6	9	6	8	7	8	4	7	9	7	5	8	8	6	8	8	-	6	-	5	-	-	9	5	4	8	9	6	6	7
8.c	MAC007	337	7	3	3	4	4	4	3	4	3	3	4	5	5	4	4	4	3	4	4	4	3	4	4	3	4	4	3	3	4	3	-	-	3	3	3	3	4	3	4	4
8.c	MAC008	340	7	4	5	5	4	5	5	4	4	4	5	6	5	5	5	6	4	5	5	5	5	4	5	4	5	5	2	3	5	3	-	-	4	3	3	5	5	5	5	5
8.c	MAC009	379	7	-	6	9	6	8	7	7	4	5	7	7	7	7	8	6	5	-	9	8	7	8	-	5	7	9	-	5	-	4	-	-	6	5	5	9	-	6	7	7
8.c	MAC010	318	7	2	1	1	2	2	2	1	1	2	1	2	3	2	2	2	2	-	3	2	3	2	2	2	2	2	1	2	-	3	-	-	2	1	1	1	1	2	2	2
8.c	MAC011	348	3	5	5	6	6	6	6	5	5	5	6	6	5	6	5	6	4	5	6	5	6	4	6	6	6	6	4	6	5	4	-	6	4	5	5	6	6	6	6	6
8.c	MAC012	329	3	2	2	2	2	2	2	3	2	2	3	3	3	3	2	2	2	3	2	2	3	1	3	3	2	2	-	2	-	4	-	2	3	2	2	1	2	2	2	2
8.c	MAC013	365	3	-	7	8	6	7	7	7	6	7	7	8	7	11	7	7	5	8	8	7	7	6	8	6	7	9	-	6	6	6	-	6	7	5	5	7	7	7	7	7
8.c	MAC014	435	3	10	11	11	11	10	11	10	7	10	10	11	12	8	10	10	5	-	10	-	10	9	-	9	11	13	-	10	9	9	-	6	13	6	6	9	9	10	10	10
8.c	MAC015	382	3	9	11	12	10	11	10	10	6	10	9	12	10	10	9	11	6	-	11	11	11	7	11	9	11	13	-	10	8	7	-	8	8	7	5	10	-	11	11	11
8.c	MAC016	311	7	3	3	3	3	3	3	3	3	3	2	4	3	3	3	4	2	3	3	3	3	3	3	3	3	3	2	3	3	2	-	-	3	3	3	3	3	3	3	3
8.c	MAC017	377	7	6	6	7	7	7	7	6	5	5	6	8	7	7	6	6	5	6	7	6	6	7	7	7	6	6	6	6	7	6	-	-	6	5	5	6	7	8	6	6
8.c	MAC018	339	7	2	2	5	2	3	3	4	1	2	2	4	5	2	3	2	2	-	2	2	3	2	3	3	2	2	1	2	-	3	-	-	2	1	1	2	2	2	2	2
8.c	MAC019	292	7	1	1	1	1	1	2	1	1	1	1	2	1	1	2	2	1	1	1	2	1	2	2	1	1	1	1	1	2	3	-	-	2	1	1	1	1	1	1	1
8.c	MAC020	353	7	2	2	3	3	4	3	3	1	2	2	3	4	2	3	2	2	-	2	2	3	2	3	3	2	2	1	2	-	-	-	-	2	2	1	2	2	2	2	2
9.a	MAC021	295	1	3	3	3	3	3	3	3	3	3	3	3	3	4	2	3	2	3	3	3	3	2	3	3	3	3	2	3	3	-	-	3	3	2	2	3	3	3	3	3
9.a	MAC022	315	1	3	3	3	3	4	3	3	3	4	3	5	3	4	4	3	3	3	3	3	4	2	3	3	4	-	3	4	5	4	-	3	3	3	3	3	4	3	3	3
9.a	MAC023	361	1	3	3	3	3	5	4	3	3	3	3	3	3	3	3	3	4	3	3	6	2	4	4	4	4	3	3	3	4	3	-	3	4	3	3	3	3	3	3	3
9.a	MAC024	420	5	11	11	12	12	11	12	11	8	11	9	13	12	12	11	10	7	11	12	12	12	10	12	8	11	11	9	11	9	9	-	-	10	7	8	12	12	10	12	12
9.a	MAC025	389	5	-	9	10	9	10	10	9	8	9	9	12	10	10	9	10	6	8	10	9	10	9	10	8	10	10	9	8	-	7	-	8	9	7	5	10	11	8	10	10
9.a	MAC026	287	7	1	1	2	1	1	1	1	1	1	1	2	1	2	2	2	1	2	1	2	1	2	2	1	1	2	1	1	2	2	-	2	2	1	1	1	1	1	1	1
9.a	MAC027	293	7	1	1	2	1	1	2	1	1	1	1	2	1	2	2	2	1	2	1	2	2	2	2	2	1	2	1	1	-	2	-	2	2	1	1	1	1	1	1	2
9.a	MAC028	315	10	1	1	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	4	-	-	2	1	1	2	1	2	2	2
9.a	MAC029	297	10	1	1	2	1	2	2	1	1	2	1	2	1	2	2	-	1	2	2	2	2	2	2	2	2	2	1	1	-	3	-	-	1	1	1	1	1	1	1	2
9.a	MAC030	208	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	-	-	1	0	0	0	1	0	0	0
7.b	MAC031	345	5	4	6	5	5	5	6	5	5	5	5	6	5	5	4	5	3	6	6	5	3	4	6	5	5	5	4	4	-	5	-	5	3	3	2	7	6	6	5	5
7.b	MAC032	340	5	4	4	4	5	4	5	3	4	4	4	4	4	3	4	4	3	5	4	4	4	4	4	3	4	4	4	4	4	5	-	4	4	3	4	4	4	4	4	4
7.b	MAC033	390	5	10	12	12	11	12	14	11	11	11	10	13	11	12	9	10	10	12	12	11	11	9	12	12	12	11	10	9	-	8	-	8	7	11	7	11	11	12	11	12
7.b	MAC034	315	5	3	3	3	3	3	3	2	3	3	3	3	3	2	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	-	3	2	2	3	3	3	3	3	3
7.b	MAC035	365	5	6	7	6	6	6	6	5	6	6	6	7	5	6	6	6	5	6	7	6	6	6	7	6	6	6	5	6	6	6	-	6	4	6	5	6	7	6	6	6
5.b	MAC036	380	1	8	10	10	10	11	9	10	9	9	9	10	11	11	8	9	8	10	10	11	10	8	11	9	12	11	9	9	8	8	-	4	4	10	9	10	11	10	10	10
5.b	MAC037	313	1	4	4	4	4	4	4	4	4	4	4	4	3	3	3	4	3	4	4	4	4	3	4	4	4	4	3	4	3	3	-	3	3	3	3	4	3	4	4	4
5.b	MAC038	330	1	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4	3	4	4	4	4	3	4	4	4	4	3	4	4	4	-	4	3	3	4	4	4	4	4	4
5.b	MAC039	405	1	11	14	15	13	13	10	14	13	12	13	15	14	13	14	13	8	14	14	15	-	13	15	12	14	12	6	11	14	8	-	7	6	12	6	14	15	15	14	14
5.b	MAC040	355	1	6	6	6	6	6	6	6	6	6	6	6	6	6	5	6	5	6	6	6	5	6	6	6	6	6	6	6	6	5	-	6	5	6	6	6	6	6	6	6
5.b	MAC041	350	1	6	7	7	7	7	7	6	6	7	7	7	8	7	6	7	6	7	7	7	7	5	7	7	7	6	6	7	6	5	-	6	3	6	6	7	7	7	7	7
5.b	MAC042	330	1	5	4	4	5	4	4	4	4	3	5	6	4	5	4	4	3	4	4	4	4	2	4	4	4	4	3	3	3	3	-	3	2	3	3	4	3	4	4	4
5.b	MAC043	375	1	6	6	6	6	6	6	6	6	6	7	6	6	6	6	6	6	6	7	6	6	5	6	6	6	6	5	6	6	6	-	6	4	6	6	6	6	6	6	6
5.b	MAC044	395	1	9	10	10	10	10	10	10	9	10	10	11	10	11	10	10	9	10	11	11	10	8	10	10	10	10	9	10	10	9	-	8	9	9	8	10	10	10	10	10
5.b	MAC045	355	1	6	6	6	6	6	6	6	6	6	7	7	7	6	5	6	6	6	7	6	6	5	6	6	6	7	6	6	6	5	-	6	5	6	6	6	7	7	6	6
2.b	MAC046	395	7	10	11	10	10	11	9	10	9	10	-	11	11	10	10	10	9	13	11	12	9	9	13	9	12	12	10	9	-	8	-	10	6	9	8	10	10	11	10	10
2.b	MAC047	370	7	5	6	6	6	6	6	5	4	5	5	6	6	6	5	6	5	6	6	6	5	6	6	6	6	6	5	5	6	4	-	6	4	4	4	6	7	6	6	6
2.b	MAC048	395	7	6	10	10	10	10	9	8	9	8	6	10	9	9	9	9	7	9	10	10	10	10	10	8	10	11	8	8	9	6	-	8	6	7	5	10	8	10	10	10
2.b	MAC049	370	7	5	6	6	6	6	6	4	4	5	6	5	6	6	5	4	6	6	6	7	6	6	6	5	6	6	4	5	5	4	-	5	5	4	4	5	5	5	6	6
2.b	MAC050	385	7	8	9	9	9	9	9	11	7	8	9	9	10	10	7	9	7	9	9	9	11	9	9	9	9	9	-	7	9	6	-	8	4	6	4	9	9	10	9	9
2.b	MAC051	385	7	8	9	10	8	9	9	9	8	7	8	10	8	10	9	10	7	9	9	10	9	9	10	9	9	8	8	7	8	4	-	5	4	8	4	10	8	10	9	9
2.b	MAC052	385	7	8	9	9	9	8	10	6	8	8	12	8	11	9	9	8	9	9	11	9	9	11	9	11	9	7	8	8	9	7	-	9	5	8	8	9	8	9	9	9
2.b	MAC053	365	7	5	6	6	6	6	5	5	5	6	6	6	7	7	6	7	5	7	7	6	6	6	7	5	6	7	5	5	6	4	-	6	3	4	5	7	6	7	6	6
2.b	MAC054	370	7	5	6	7	6	6	6	6	5	5	6	7	6	8	6	7	6	6	6	6	8	6	6	7	6	6	6	6	6	5	-	6	5	5	6	6	6	7	6	6
2.b	MAC055	410	7	10	19	19	15	14	13	18	15	-	17	19	14	19	16	18	10	19	17	15	18	10	19	10	19	19	11	11	-	8	-	10	7	10	11	19	18	19	19	19
2.b	MAC056	380	7	7	9	9	9	9	8	8	7	8	10	10	10	9	9	7	12	9	10	12	9	10	10	9	10	8	8	9	7	-	8	4	6	8	10	9	11	9	9	9
2.b	MAC057	365	7	5	6	6	6	6	5	5	5	5	5	6	6	6	5	6	5	6	6	6	5	6	6	6	6	6	5	5	5	6	-	6	3	5	5	6	6	5	6	6
2.b	MAC058	380	7	7	10	9	9	8	9	9	8	7	8	10	9	9	7	9	5	7	10	10	9	8	10	7	10	10	8	7	7	6	-	7	6	6	6	10	10	10	10	9
2.b	MAC059	330	7	3	4	4	4	4	4	3	3	3	3	4	4	3	4	4	3	4	4	4	3	4	4	4	3	4	3	3	4	3	-	4	3	3	3	4	4	4	4	4
2.b	MAC060	400	7	5	7	9	7	7	6	7	5	7	5	8	6	7	7	6	3	8	7	7	7	6	8	7	7	7	3	6	6	5	-	4	6	3	3	7	6	7	7	7
2.b	MAC061	370	7	6	8	8	7	8	7	7	6	6	8	7	9	6	7	6	7	6	7	8	7	7	7	8	9	8	8	7	7	6	5	-	7	5	7	6	7	7	8	7
2.b	MAC062	415	7	13	17	17	14	14	14	13	14	16	12	17	-	16	16	16	12	16	17	15	18	14	17	14	16	16	-	13	-	-	-	11	13	12	11	17	16	16	16	16
2.b	MAC063	420	7	10	13	15	14	13	10	14	12	11	10	13	13	13	14	12	8	13	14	12	14	12	14	11	13	14	-	11	11	9	-	8	10	8	9	12	12	15	13	13
2.b	MAC064	395	7	7	9	9	9	9	8	9	6	8	7	10	9	11	9	9	8	9	10	9	9	8	10	7	10	9	7	8	7	6	-	9	8	9	8	9	10	9	9	9
2.b	MAC065	385	7	8	10	10	10	9	9	9	7	9	7	11	11	10	10	10	8	8	9	10	9	8	10	8	10	10	8	8	6	5	-	8	7	8	6	9	10	10	10	10
2.a	MAC066	270	5	3	3	3	3	3	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	-	3	3	2	2	2	3	3	3	3
2.a	MAC067	370	5	-	11	10	9	9	9	11	6	9	10	12	11	10	9	9	4	12	13	13	10	7	10	9	12	10	8	8	-	7	-	5	-	9	8	9	13	10	9	10
2.a	MAC068	240	5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-	1	2	2	2	1	2	2	3	2	2	2	2	1	2	3	2	2	1	1	2	2	2	2	2
2.a	MAC069	280	5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	4	3	3	3	3	2	3	-	3	3	2	2	3	3	3	3	3
2.a	MAC070	310	5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3	-	3	3	3	3	3	3	3	3	3
2.a	MAC071	300	5	3	3	3	3	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	-	3	3	2	3	3	3	3	3	3
2.a	MAC072	230	5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	2	2	1	1	2	2	2	2	2
2.a	MAC073	290	5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3	3	3	3	3
2.a	MAC074	280	5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	-	2	3	2	3	3	3	3	3	3
2.a	MAC075	250	5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	2	2	2	2	2	2	2	2
2.a	MAC076	260	5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-	1	2	2	1	2	2	2	2	2
2.a	MAC077	340	5	7	8	7	7	7	7	8	5	7	8	8	7	8	8	9	6	10	8	8	8	4	7	6	8	7	6	7	7	6	-	6	5	6	6	8	8	8	8	8
2.a	MAC078	360	5	5	6	6	6	5	5	6	5	5	5	6	5	6	7	5	5	6	7	6	6	5	6	6	5	5	6	6	5	5	-	4	7	5	5	5	6	5	5	5
2.a	MAC079	240	5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	2	2	2	2	2	2	2	2
2.a	MAC080	220	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	2	1	1	1	1	0	2	1	1	2	1	1	1	1	1	1	1
2.a	MAC081	280	5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3	3	3	3	3
2.a	MAC082	160	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	0	1	1	1	1	1
2.a	MAC083	390	5	7	7	9	9	8	8	8	6	7	8	8	8	8	8	8	6	9	9	8	8	8	8	9	9	8	7	8	8	8	-	6	5	6	6	8	9	7	8	8
2.a	MAC084	360	5	7	8	8	7	7	-	8	6	7	8	8	7	8	7	8	7	8	9	-	8	-	8	8	7	8	-	7	-	6	-	6	6	6	6	8	-	7	8	8
2.a	MAC085	330	5	5	5	4	5	5	4	5	5	5	5	4	5	5	5	4	4	4	5	5	5	3	5	5	5	5	3	4	5	3	-	3	4	4	4	5	5	5	5	5
4.a	MAC086	245	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2
4.a	MAC087	295	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	-	3	2	3	3	3	3	3	3	3
4.a	MAC088	255	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	3	2	2	-	2	2	2	2	2	2	2	2	2
4.a	MAC089	195	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	0	1	2	0	1	0	1	1	1	1
4.a	MAC090	335	2	5	5	5	5	5	5	5	5	6	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	4	5	5	5	-	5	5	5	5	5	5	5	5	5

Table 3.1. (cont.)

Area	Sample code	L (cm)	M	R1*	R2*	R3*	R4*	R5*	R6*	R7*	R8*	R9	R10*	R11*	R12*	R13*	R14*	R15*	R16*	R17*	R18*	R19*	R20*	R21*	R22*	R23	R24*	R25*	R26	R27	R28	R29	R30	R31	R32*	R33	R34	R35	R36	R37	MA all	MA ad
4.a	MAC103	305	11	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	4	-	2	3	2	2	2	2	3	2	2
4.a	MAC104	325	11	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	5	4	4	4	4	4	4	4	4	-	4	5	4	4	4	4	4	4	4
4.a	MAC105	345	11	8	9	8	8	8	8	8	7	7	7	9	8	8	8	8	8	8	9	8	8	8	8	8	11	8	9	7	8	6	-	8	7	8	7	8	10	11	8	8
27.c	MAC106	365	1	5	5	4	6	5	5	5	5	4	6	5	5	4	5	5	4	4	6	5	5	3	5	5	5	5	4	5	4	5	-	5	4	4	5	5	6	4	5	5
27.c	MAC107	355	1	5	6	6	6	6	6	6	5	6	6	6	6	6	6	6	5	6	6	6	6	5	6	6	6	6	4	6	5	5	-	6	5	5	6	6	6	5	6	6
27.c	MAC108	355	1	6	7	7	8	7	7	7	6	6	7	9	7	6	7	7	6	7	8	6	7	5	7	7	7	7	5	7	6	5	-	6	6	6	7	8	8	6	7	7
27.c	MAC109	345	1	6	7	7	7	7	7	6	7	6	7	7	7	7	7	7	6	7	7	7	7	6	7	7	7	7	6	7	6	6	-	6	6	7	7	7	7	7	7	7
27.c	MAC110	385	1	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	5	8	8	8	8	7	8	7	8	8	5	8	7	7	-	8	7	6	6	8	8	8	8	8
7.d	MAC111	265	12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	2	2	-	1	2	1	1	1	1	1	1	1
7.d	MAC112	295	12	2	1	2	2	2	2	2	2	2	2	2	2	2	2	1	2	3	2	2	2	3	2	2	2	2	1	2	2	4	-	2	2	1	1	2	2	2	2	2
7.d	MAC113	335	12	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	3	2	2	3	3	3	-	3	4	3	3	3	3	3	3	3
7.d	MAC114	345	12	5	4	4	5	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	5	4	4	4	4	2	4	4	4	-	4	4	3	4	4	4	4	4	4
7.d	MAC115	355	12	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3	4	3	-	3	3	3	3	3	3	3	3	3
7.g	MAC116	291	4	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	2	3	3	3	3	2	3	3	2	3	3	3	2	3	-	3	2	2	3	3	3	3	3	3
7.g	MAC117	270	4	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	1	2	2	4	2	2	2	2	2	-	2	2	1	2	2	2	2	2	2
7.g	MAC118	332	4	6	6	6	6	6	6	5	5	6	6	7	6	6	5	6	5	6	7	6	6	5	6	6	7	6	5	6	5	6	-	6	4	5	6	6	6	6	6	6
7.g	MAC119	333	4	5	5	5	5	5	4	4	5	5	5	6	4	5	4	5	4	5	5	5	5	4	5	5	5	5	5	5	4	5	-	4	4	4	5	5	5	5	5	5
7.g	MAC120	192	4	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	-	1	1	0	1	0	1	1	1	1
8.b	MAC121	321	3	3	3	4	3	3	2	3	3	3	3	3	3	3	3	2	2	3	4	3	3	2	3	3	4	4	2	3	-	4	-	3	2	2	2	6	1	3	3	3
8.b	MAC122	335	3	-	9	9	7	6	5	6	6	9	9	7	6	8	5	7	5	6	8	5	5	2	4	6	7	9	-	6	-	6	-	6	4	6	6	10	3	5	6	6
8.b	MAC123	382	3	-	10	12	8	9	8	10	8	9	11	11	7	7	8	8	7	11	10	10	8	7	10	8	12	10	6	9	9	6	-	7	6	7	6	9	10	8	8	10
8.b	MAC124	371	3	-	9	9	9	7	-	9	8	-	6	11	7	10	6	-	5	-	9	7	8	-	9	9	9	10	7	5	-	4	-	4	5	4	4	9	9	10	9	9
8.b	MAC125	360	3	6	6	6	6	6	6	6	6	6	6	6	7	6	6	6	6	6	6	6	6	5	6	6	7	6	5	6	4	5	-	6	6	6	6	6	6	6	6	6
8.b	MAC126	391	3	-	-	10	9	11	-	7	8	9	7	10	9	12	7	9	8	-	10	11	9	8	10	9	12	11	9	-	-	7	-	7	10	8	3	10	11	10	10	10
8.b	MAC127	383	3	6	7	6	7	7	7	6	6	7	8	7	7	6	7	6	6	7	7	7	6	6	7	7	7	8	7	7	4	6	-	6	7	6	6	7	8	7	7	7
8.b	MAC128	374	3	-	13	14	11	8	9	12	11	9	7	13	13	13	7	11	7	13	13	13	9	7	13	12	14	-	8	-	6	6	-	6	9	7	6	9	13	13	13	13
8.b	MAC129	341	3	6	7	6	6	6	6	6	6	6	7	9	6	6	6	7	4	7	7	7	7	5	6	7	7	7	-	5	3	3	-	5	6	5	4	6	7	7	6	6
8.b	MAC130	357	3	5	6	6	5	6	6	5	5	6	6	5	6	6	5	7	6	7	7	7	6	4	6	8	6	6	7	5	-	4	-	5	6	4	4	6	7	7	6	6
7.j	MAC131	177	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
7.j	MAC132	285	11	1	2	3	1	1	2	3	1	1	3	1	1	2	1	2	2	2	1	1	2	1	1	2	3	1	1	1	2	4	-	1	1	1	1	1	1	1	1	1
7.j	MAC133	337	11	3	3	5	3	3	4	4	2	2	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	2	4	-	3	3	2	3	3	3	3	3	3
7.j	MAC134	274	11	1	1	1	1	1	1	2	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	2	1	1	1	1	1	3	-	1	1	1	1	1	-	1	1	1
7.j	MAC135	291	11	1	1	2	1	1	1	4	1	1	1	2	1	1	2	1	1	2	1	1	1	1	1	3	1	1	2	1	2	4	-	1	1	1	1	1	1	1	1	1
7.f	MAC136	273	12	1	1	1	1	1	1	1	1	1	1	2	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	-	2	1	1	1	1	1	1	1	1
7.f	MAC137	260	12	1	1	1	1	1	2	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	2	2	-	2	1	1	1	1	1	1	1	1
7.f	MAC138	216	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	1	1	0	0	0	-	0	0	0
7.f	MAC139	236	12	0	0	0	0	0	0	0	0	0	0	-	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	-	-	1	1	0	0	0	0	0	0	0
7.f	MAC140	292	12	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-	4	-	2	1	1	1	1	2	1	1	1
7.h	MAC141	309	11	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	-	2	3	2	2	2	3	2	2	2
7.h	MAC142	292	11	1	1	-	1	1	2	4	1	1	1	2	2	1	2	1	1	2	2	-	2	1	2	2	1	2	1	1	2	3	-	1	1	1	1	1	-	2	1	1
7.h	MAC143	207	11	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	-	0	0	1	0	0	0	0	0	0	0
7.h	MAC144	161	11	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.h	MAC145	170	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.a	MAC146	305	10	2	2	3	2	1	2	3	2	3	2	2	2	2	2	1	2	2	2	2	2	1	1	3	2	-	2	2	2	4	-	-	2	2	1	4	3	1	2	2
8.a	MAC147	297	10	2	1	2	1	1	2	2	1	2	1	2	2	2	2	1	2	2	2	2	2	1	2	2	2	2	1	1	-	3	-	-	2	1	1	1	2	1	2	2
8.a	MAC148	239	10	1	3	-	2	1	2	3	1	-	3	4	2	3	2	1	1	-	4	4	3	1	1	3	3	4	1	2	2	2	2	-	2	2	1	4	5	1	1	1
8.a	MAC149	306	10	2	2	3	2	1	2	2	1	2	1	2	1	2	3	1	2	2	2	1	2	1	2	2	1	2	3	1	-	3	-	-	1	1	1	1	1	1	2	2
8.a	MAC150	282	10	1	3	3	3	1	2	-	1	3	1	4	1	2	3	1	1	2	3	2	3	1	1	2	3	-	1	1	-	3	-	-	2	2	1	1	1	1	1	1
8.a	MAC151	276	10	1	5	-	4	1	2	4	1	5	1	5	1	1	2	1	1	2	-	-	2	1	1	3	5	5	1	2	-	2	-	-	2	1	1	1	1	1	1	1
8.a	MAC152	249	10	1	1	2	1	1	2	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	2	1	-	1	1	1	1	1	1	1	1
8.a	MAC153	256	10	1	1	3	2	1	1	3	1	3	2	4	1	2	2	1	1	1	1	1	1	1	1	1	2	-	1	2	2	2	-	-	1	1	1	1	1	1	1	1
8.a	MAC154	199	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	-	0	0	0	0	0	0	0	0
8.a	MAC155	214	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	-	-	0	0	0	0	0	0	0	0
9.a	MAC156	299	1	3	2	2	3	3	3	3	3	3	3	3	3	3	3	2	3	3	2	2	3	2	3	3	3	3	2	3	2	3	-	2	1	2	2	2	2	3	3	3
9.a	MAC157	305	1	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3	4	3	-	3	3	3	3	5	3	3	3	3
9.a	MAC158	325	1	2	3	3	2	2	3	2	3	2	2	3	3	3	3	2	3	-	3	3	3	2	3	3	3	-	2	3	3	3	-	2	3	2	2	3	3	3	3	3
9.a	MAC159	266	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	-	2	2	2	2	2	2	2	2	2
9.a	MAC160	295	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3	3	3	3	3
9.a	MAC161	362	2	5	5	5	5	6	5	6	5	5	5	8	6	5	6	5	5	6	7	7	5	5	6	6	7	5	6	6	6	5	-	5	4	5	5	7	7	6	5	5
9.a	MAC162	392	2	-	9	9	9	8	9	9	6	5	6	10	7	6	5	8	6	9	9	9	6	8	9	9	9	-	7	7	5	5	-	5	5	5	4	6	10	-	9	9
9.a	MAC163	410	2	-	-	11	11	10	-	11	6	9	8	14	7	7	8	-	8	-	12	-	11	10	13	9	-	11	8	9	-	9	-	7	8	6	3	10	-	-	11	11
9.a	MAC164	325	1	3	3	3	3	3	2	3	5	3	3	3	4	3	3	2	4	6	3	6	5	3	4	3	6	3	4	3	-	4	-	2	4	2	2	5	3	-	3	3
9.a	MAC165	365	4	3	2	5	3	3	5	3	5	3	3	3	5	2	3	3	3	3	5	3	5	5	6	5	5	3	3	4	-	5	-	3	2	2	3	5	5	3	3	3
9.a	MAC166	378	4	-	-	8	7	8	-	10	6	7	6	-	7	9	6	-	7	-	8	8	9	8	-	8	9	10	7	-	-	4	-	-	3	5	3	6	-	-	8	8
9.a	MAC167	377	4	-	7	7	7	7	7	7	6	-	8	6	7	7	7	5	7	7	6	7	7	8	8	7	8	8	4	6	-	5	-	3	4	5	2	7	7	7	7	7
9.a	MAC168	387	4	6	-	8	8	9	8	8	7	7	-	8	7	9	8	7	7	-	9	8	8	8	8	8	9	8	6	8	-	5	-	5	4	7	4	8	9	8	8	8
9.a	MAC169	401	4	-	10	10	10	11	-	11	6	9	-	13	10	11	9	-	7	-	11	9	10	-	-	8	11	10	8	9	-	6	-	4	6	6	3	9	11	11	11	10
9.a	MAC170	365	7	5	8	8	7	8	6	8	5	6	7	9	8	8	8	8	5	8	8	9	8	7	8	8	8	9	5	6	7	6	-	6	7	4	2	8	8	9	8	8
9.a	MAC171	371	7	-	5	7	6	7	5	6	3	4	4	5	6	6	4	5	3	4	6	-	8	-	-	7	6	6	-	4	-	3	-	4	2	2	1	6	5	8	6	6
9.a	MAC172	386	7	-	8	8	6	8	7	6	5	6	7	9	6	8	8	8	6	7	8	-	8	8	8	10	8	8	6	7	-	5	-	4	4	3	3	7	8	8	8	8
9.a	MAC173	385	7	-	5	6	5	5	5	5	4	4	5	6	5	6	5	5	4	6	6	6	5	5	-	6	8	6	4	5	5	4	-	4	3	3	3	5	6	6	5	5
9.a	MAC174	312	7	2	2	2	3	2	2	3	2	2	2	2	3	3	3	3	2	2	2	2	2	2	2	2	3	2	2	2	2	3	-	2	2	1	2	3	3	2	2	2
9.a	MAC175	316	9	1	1	1	2	1	1	1	1	1	1	1	1	2	1	1	1	1	2	1	2	1	1	1	1	1	1	1	-	2	-	-	2	1	1	1	1	1	1	1
9.a	MAC176	325	9	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	3	2	2	2	2	2	2	2	3	-	-	2	2	2	2	2	2	2	2
9.a	MAC177	325	9	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3	3	3	-	-	3	3	3	3	3	3	3	3
9.a	MAC178	332	9	4	4	4	4	4	4	4	4	4	4	4	4	4	5	4	4	4	4	4	4	5	4	4	4	4	4	4	4	4	-	-	3	4	4	4	4	4	4	4
9.a	MAC179	336	9	1	2	3	2	1	2	2	1	2	3	2	2	3	2	1	2	1	1	2	3	2	2	2	3	-	1	2	-	2	-	-	2	1	1	2	1	1	2	2
9.a	MAC180	321	10	1	1	3	2	1	2	1	1	1	3	3	2	2	1	1	1	1	2	2	2	2	2	1	-	1	1	-	2	-	-	2	1	1	1	2	1	1	1	1
9.a	MAC181	332	10	2	2	3	2	2	3	2	2	2	2	3	3	2	2	2	2	2	2	2	2	3	2	3	2	2	2	2	2	2	-	-	2	2	2	2	2	2	2	2
9.a	MAC182	383	10	7	9	9	9	8	8	9	6	7	6	8	6	8	7	7	6	7	9	10	9	8	10	7	8	9	6	8	7	7	-	-	6	6	3	7	9	9	7	9
4.b	MAC183	277	9	2	1	1	1	1	1	3	1	1	1	2	1	1	2	1	1	1	1	1	2	1	2	1	1	1	1	1	1	2	-	-	1	1	1	1	1	1	1	1
4.b	MAC184	289	9	2	1	1	1	1	1	2	1	1	1	2	1	1	2	2	1	1	1	1	2	1	1	1	1	1	1	1	1	1	-	-	1	1	1	1	1	1	1	1
4.b	MAC185	295	9	2	1	1	1	1	1	2	1	1	1	2	1	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	3	-	-	1	1	1	1	1	1	1	1
4.b	MAC186	296	9	2	1	1	1	1	1	3	1	1	1	2	1	2	2	1	1	1	1	1	1	1	1	2	1	1	1	1	1	3	-	-	1	1	1	1	1	1	1	1
4.b	MAC187	302	9	2	1	1	1	1	1	3	1	1	1	2	2	2	2	1	1	1	1	1	2	1	1	1	1	1	1	1	1	-	-	-	1	1	1	1	1	1	1	1
4.b	MAC188	305	9	3	2	2	2	2	2	4	2	2	1	2	3	4	3	2	2	2	2	2	2	1	2	2	2	2	3	1	-	3	-	-	2	2	2	2	2	2	2	2
4.b	MAC189	303	9	3	3	3	3	2	3	3	2	2	2	3	3	3	3	2	2	3	3	3	2	3	3	3	2	3	3	2	3	3	-	-	2	2	2	3	3	2	3	3
4.b	MAC190	304	9	-	2	2	2	2	2	5	2	-	1	-	4	3	-	2	2	2	-	-	3	1	2	-	-	2	5	1	-	-	-	-	2	2	1	2	2	2	2	2
4.b	MAC191	310	9	2	2	2	2	2	2	3	2	2	1	3	3	2	3	2	2	2	2	2	2	1	2	2	2	2	3	1	-	4	-	-	2	2	1	2	2	2	2	2
4.b	MAC192	334	9	3	3	3	2	3	3	3	1	2	3	4	4	3	3	3	2	3	3	3	2	-	3	3	3	3	5	1	-	4	-	-	3	1	2	2	2	1	3	3
4.b	MAC193	336	9	4	4	4	3	4	4	4	4	3	3	5	4	4	4	4	3	3	5	4	4	3	4	3	4	4	3	2	3	3	-	-	3	3	3	4	4	3	4	4
4.b	MAC194	333	9	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3

Table 3.1. (cont.)

Area	Sample code	L (cm)	M	R1*	R2*	R3*	R4*	R5*	R6*	R7*	R8*	R9	R10*	R11*	R12*	R13*	R14*	R15*	R16*	R17*	R18*	R19*	R20*	R21*	R22*	R23	R24*	R25*	R26	R27	R28	R29	R30	R31	R32*	R33	R34	R35	R36	R37	MA all	MA ad
6	MAC211	294	7	-	10	11	8	9	-	7	4	-	8	10	-	8	5	8	-	10	10	10	4	1	-	2	11	10	-	-	-	3	-	6	6	4	3	10	8	8	10	10
6	MAC212	323	7	6	-	15	10	9	-	9	4	6	8	13	5	11	4	-	4	7	12	-	5	2	-	5	11	12	9	-	5	4	-	7	5	6	5	11	-	8	5	4
6	MAC213	327	7	-	-	14	10	10	-	-	3	-	-	-	10	13	4	-	-	-	12	-	5	1	-	3	10	14	-	-	-	3	-	-	3	3	3	10	-	11	3	10
6	MAC214	287	7	1	1	1	1	1	1	1	1	1	1	2	1	1	2	2	1	1	1	1	1	1	2	1	1	1	1	1	1	2	-	-	2	1	1	1	1	1	1	1
6	MAC215	370	7	-	6	8	5	6	-	6	4	4	5	6	7	8	4	-	4	7	7	6	5	4	5	5	4	6	5	3	-	4	-	-	3	3	2	5	6	4	4	6
6	MAC216	276	9	1	1	1	1	1	2	1	1	1	1	2	1	2	2	1	1	1	1	1	1	1	1	2	1	1	1	1	2	2	-	-	2	1	1	1	1	1	1	1
6	MAC217	274	9	1	1	1	1	1	2	1	1	1	1	2	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	-	-	1	1	1	1	1	1	1	1
5.b	MAC218	294	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	2	3	3	3	3	3	3	3	3	-	3	2	3	3	2	3	3	3	3
5.b	MAC219	382	1	-	9	8	7	7	7	9	7	6	5	9	8	8	6	6	6	9	9	9	7	7	9	8	9	7	6	7	6	5	-	5	4	6	4	7	9	9	9	9
5.b	MAC220	363	1	-	8	9	8	8	8	9	8	8	7	9	8	9	8	9	6	9	9	9	8	7	9	9	9	9	7	8	-	4	-	7	6	6	4	8	-	9	9	9
5.b	MAC221	337	1	5	5	5	5	5	5	5	5	4	5	5	5	5	5	5	3	5	5	5	5	2	5	6	5	5	4	4	4	3	-	4	3	4	3	5	5	5	5	5
5.b	MAC222	339	1	5	5	5	5	5	5	5	5	4	5	5	5	5	5	5	4	5	5	5	5	3	5	5	5	5	5	5	4	5	-	5	4	5	5	5	5	5	5	5
5.b	MAC223	354	1	5	6	6	6	7	6	6	6	6	6	7	7	7	6	7	4	7	7	7	7	5	6	7	7	7	5	6	6	5	-	6	4	6	4	6	7	7	6	7
5.b	MAC224	266	1	2	2	2	3	2	2	3	2	2	2	2	2	2	3	2	2	2	2	2	2	1	2	3	3	3	2	2	2	2	-	2	2	2	2	2	2	3	2	2
5.b	MAC225	398	7	-	12	12	10	9	-	10	7	8	9	13	11	11	7	11	6	9	12	13	9	9	12	8	12	12	8	-	-	7	-	8	6	7	3	10	12	12	12	12
5.b	MAC226	371	7	6	7	7	6	6	-	7	5	-	5	8	9	8	5	6	5	7	7	6	8	6	-	5	6	6	6	3	-	3	-	3	3	2	2	6	6	7	6	6
5.b	MAC227	366	7	4	5	5	5	6	5	5	5	5	5	7	5	6	5	6	5	6	5	5	5	6	6	5	5	6	5	5	5	4	-	5	4	5	4	5	5	5	5	5
5.b	MAC228	372	7	5	7	7	7	7	5	6	6	6	7	7	7	7	7	7	5	7	8	6	7	7	8	6	6	8	6	6	6	5	-	5	3	4	3	7	7	7	7	7
5.b	MAC229	379	7	7	9	9	8	8	8	8	6	8	7	8	8	9	7	9	6	9	8	8	8	8	9	7	8	9	7	7	8	3	-	8	5	8	4	8	10	8	8	8
5.b	MAC230	361	7	4	5	5	5	5	5	5	5	5	4	5	5	5	5	6	4	5	5	5	5	6	6	5	5	6	5	5	5	4	-	5	4	5	5	5	6	5	5	5
5.b	MAC231	382	12	-	8	8	6	6	6	8	6	6	8	8	6	8	8	6	6	7	8	8	6	8	8	10	9	8	8	-	-	5	-	3	6	6	2	7	7	7	8	8
5.b	MAC232	303	12	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	3	2	-	2	2	2	2	2	2	2	2	2
5.b	MAC233	318	12	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3	2	3	3	3	-	3	2	3	3	3	3	3	3	3
5.b	MAC234	367	12	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8	7	8	8	8	8	-	8	8	8	9	7	7	8	5	-	6	3	8	3	8	8	8	8	8
5.b	MAC235	365	12	8	8	9	8	8	8	8	8	8	8	9	8	8	8	8	7	8	8	8	9	8	8	8	8	9	8	8	8	4	-	7	4	8	3	8	8	8	8	8
5.b	MAC236	350	12	8	9	9	9	5	9	8	8	8	9	9	8	9	8	-	6	10	9	9	9	10	10	6	9	9	9	8	8	5	-	3	3	9	3	9	9	9	9	9
5.b	MAC237	371	12	-	-	9	9	10	-	10	-	-	-	10	8	9	7	-	6	-	9	-	9	-	-	6	10	-	8	7	-	4	-	3	4	5	3	7	-	8	9	9

3.1. ALL READERS' ANALYSIS.

The modal age range of all readers' analysis was 0-19 for the whole set of otoliths, with more than 10 otoliths of modal ages 0-10, 4 otoliths of modal age 11, 2 otoliths of modal age 12-14 and 1 otolith each of modal ages 16 and 19. The overall agreement was 64.7%. The best agreement was obtained for otoliths of modal age 0 (91.3%) and modal ages 1-3 (78.9, 77.5 and 79.1%, respectively). Otoliths with modal age >5 had less than 60% agreement. The least agreement was obtained for otoliths with modal age >10 (25.0-29.4% agreement) (Table 3.1.1). Overall CV was 34.3%. CV peaked at 36.6% for modal age 1. The lowest values were obtained for modal ages 3-7 (15.4-16.5%). The CV value of 318.3% for modal age 0 is probably obtained due to the difficulty of the Eltink-sheet application to calculate the CV for modal age 0 when one or more readers have a different estimation (Table 3.1.1). Overall bias was -0.28, being the bias values between 0.09 and -0.17 for younger ages (modal ages 0, 2-6) and values <-0.25 for older ages (Table 3.1.1).

The standard deviation showed an increasing of its values with the age for all readers combined, contrary to what happens with the percentage of agreement that showed a decreasing of its values with the age (Figure 3.1.1).

By component, the best agreement was obtained for the North Sea component set of otoliths (76.3%) while the lowest agreement was obtained for the Southern component (56.8%) and Northern distribution (59.6%). The lowest CV value was obtained for the Northern distribution (15.9%), being the highest value for the Western component (66.8%). Bias ranged from 0.02 (Western component) to -0.48 (Northern distribution) (Table 3.1.2).

A total of 83 otoliths from the 237 otoliths of the exchange had an agreement between all readers of more than 80%. From these, only 7 otoliths had 100% agreement (ages 0-3), 32 otoliths had 90-99% agreement (ages 0-5) and 45 otoliths had 80-89% agreement (ages 0-6) (Table 3.1.3). Also, a total of 23 otoliths had less than 30% agreement.

Table 3.1.1. Summary of the average percentage of agreement (PA), coefficient of variation (CV) and relative bias by age (Small scale otolith exchange NEA mackerel, all readers' analysis). (MA: modal age; N: number of otoliths).

MA	N	PA	CV	Bias
0	10	91.3	318.3	0.09
1	42	78.9	36.6	0.23
2	32	77.5	23.9	0.02
3	35	79.1	15.9	0.07
4	14	64.2	15.4	-0.07
5	16	61.6	16.0	0.07
6	23	55.3	15.9	-0.17
7	13	50.4	16.5	-0.25
8	15	48.5	18.0	-0.50
9	13	36.8	21.9	-0.90
10	12	36.6	18.4	-0.85
11	4	26.2	22.1	-1.38
12	2	28.4	-	-1.94
13	2	25.0	-	-1.94
14	2	25.4	20.1	-1.55
15	-	-	-	-
16	1	28.1	-	-11.64
17	-	-	-	-
18	-	-	-	-
19	1	29.4	-	-19.00
Total	**237**	**64.7**	**34.3**	**-0.28**

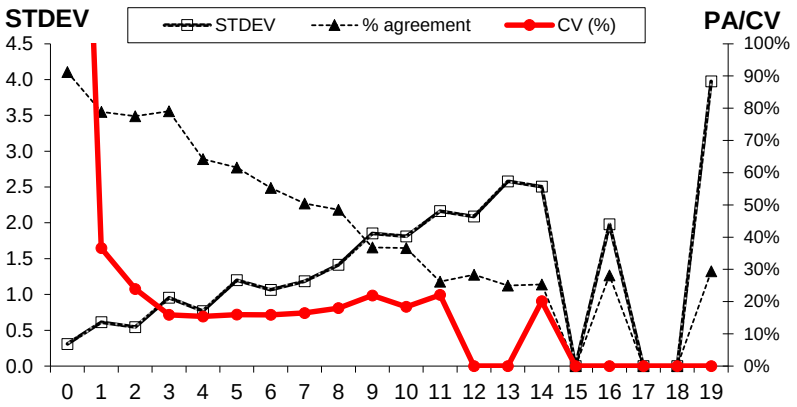


Figure 3.1.1. Coefficient of variation (CV%), percent of agreement and the standard deviation (STDEV) plotted against Modal Age (Small scale otolith exchange NEA mackerel, all readers' analysis).

Table 3.1.2. Summary of % agreement (PA), coefficient of variation (CV) and bias obtained by component (Small scale otolith exchange NEA mackerel, all readers' analysis).

Component	PA	CV	Bias
Southern component	56.8	27.0	-0.19
Western component	67.2	66.8	0.02
North Sea component	76.3	25.0	-0.04
Northern distribution	59.6	15.9	-0.48

Table 3.1.3. Otoliths with more than 80% agreement between all readers (Small scale otolith exchange NEA mackerel, all readers' analysis). (MA: modal age).

MA	100%	90-99%	80-89%
0	2	4	3
1	1	8	18
2	1	8	8
3	3	8	10
4	-	2	2
5	-	1	1
6	-	-	3
TOTAL	7	31	45

The results of the reader against modal age bias test are shown in Table 3.1.4. Readers R2, R4, R5, R6, R7, R12, R15, R20, R23, R35 and R37 showed no bias regarding the modal age, while readers R14, R17and R36 showed possibility of bias. Reader R30 also showed possibility of bias regarding the modal age, although this reader only participated partially in the exchange, making only 16 annotations (from the total of 237 otoliths).The rest of the readers showed certainty of bias regarding the modal age.

Table 3.1.4. Reader against modal age bias test (Small scale otolith exchange NEA mackerel, all readers' analysis). - = no sign of bias (p>0.05); * = possibility of bias (0.01<p<0.05); ** = certainty of bias (p<0.01). (MA: modal age).

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30	R31	R32	R33	R34	R35	R36	R37
MA	**	-	**	-	-	-	-	**	**	**	**	-	**	*	-	**	*	**	**	-	**	**	-	**	**	**	**	**	**	*	**	**	**	**	-	*	-

The inter-reader bias test showed four groups of affinity, with no bias or only possibility of bias between readers. One group was formed with readers R1, R8, R9, R10, R21, R26, R27, R28, R29 and R31. A second group was formed with readers R2, R4, R5, R6, R7, R12, R14, R15, R17, R19, R20, R23, R35, R36 and R37. A third group was formed with readers R3, R13, R18, R22, R24, R25, R33 and R34. And a fourth group was formed with readers R11, R16 and R32. Also, reader R13 showed no bias with reader R19, reader R25 showed no bias with readers R17, R19 and R36, and readers R16 and R32 showed no bias with readers R31 and R33 (Table 3.1.5). Reader R30 also showed no bias with most readers in the inter-reader bias test, although, as explained before, this reader only participated partially in the exchange, making only 16 annotations (from the total of 237 otoliths).

Table 3.1.5. Inter-reader bias test (Small scale otolith exchange NEA mackerel, all readers' analysis). - = no sign of bias (p>0.05); * = possibility of bias (0.01<p<0.05); ** = certainty of bias (p<0.01).

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30	R31	R32	R33	R34	R35	R36	R37
R1		**	**	**	**	**	**	-	-	*	**	**	**	**	**	**	**	**	**	**	-	**	**	**	**	*	-	-	-	*	-	**	**	**	**	**	**
R2	**		**	*	*	*	-	**	**	**	**	-	**	**	*	**	-	**	-	-	**	**	-	**	**	**	**	**	**	*	**	**	**	**	-	-	-
R3	**	**		**	**	**	**	**	**	**	**	**	-	**	**	**	**	-	**	**	**	-	**	-	-	**	**	**	**	*	**	**	**	**	**	**	**
R4	**	*	**		-	-	*	**	**	**	**	-	**	*	-	**	*	**	**	-	**	**	-	**	**	**	**	**	**	*	**	**	**	**	-	*	-
R5	**	*	**	-		-	*	**	**	**	**	-	**	-	-	**	**	**	**	-	**	**	-	**	**	**	**	**	**	*	**	**	**	**	-	**	-
R6	**	*	**	-	-		*	**	**	**	**	-	**	-	-	**	*	**	**	*	**	**	-	**	**	**	**	**	**	*	**	**	**	**	-	**	-
R7	**	-	**	*	*	*		**	**	**	**	-	*	**	-	**	-	**	-	-	**	**	*	**	**	**	**	**	**	**	**	**	**	**	-	-	-
R8	-	**	**	**	**	**	**		**	**	**	**	**	**	**	**	**	**	**	**	-	**	**	**	**	-	-	-	-	-	**	**	**	**	**	**	**
R9	-	**	**	**	**	**	**	**		-	**	**	**	**	**	**	**	**	**	**	-	**	**	**	**	**	-	-	*	-	**	**	**	**	**	**	**
R10	*	**	**	**	**	**	**	**	-		**	**	**	*	**	**	**	**	**	**	-	**	**	**	**	**	*	-	*	-	**	**	**	**	**	**	**
R11	**	**	**	**	**	**	**	**	**	**		**	**	**	**	*	**	**	**	**	**	**	**	**	**	**	**	**	**	-	**	**	*	*	**	**	**
R12	**	-	**	-	-	-	-	**	**	**	**		**	*	-	**	-	**	*	-	**	**	-	**	**	**	**	**	**	-	**	**	**	**	-	-	-
R13	**	**	-	**	**	**	*	**	**	**	**	**		**	**	**	*	-	-	**	**	-	**	-	-	**	**	**	**	-	**	**	*	*	**	*	**
R14	**	**	**	*	-	-	**	**	**	*	**	*	**		-	**	**	**	**	**	**	**	-	**	**	**	**	**	**	-	**	**	**	**	*	**	*
R15	**	*	**	-	-	-	-	**	**	**	**	-	**	-		**	*	**	**	-	**	**	-	**	**	**	**	**	**	-	**	**	**	**	-	**	-
R16	**	**	**	**	**	**	**	**	**	**	*	**	**	**	**		**	**	**	**	**	**	**	**	**	**	**	**	**	-	-	-	-	**	**	**	**
R17	**	-	**	*	**	*	-	**	**	**	**	-	*	**	*	**		**	-	-	**	*	-	**	-	**	**	**	**	-	**	**	**	**	-	-	-
R18	**	**	-	**	**	**	**	**	**	**	**	**	-	**	**	**	**		**	**	**	-	**	-	-	**	**	**	**	-	**	**	*	**	**	**	**
R19	**	-	**	**	**	**	-	**	**	**	**	*	-	**	**	**	-	**		-	**	*	**	**	-	**	**	**	**	-	**	**	**	**	*	-	-
R20	**	-	**	-	-	*	-	**	**	**	**	-	**	**	-	**	-	**	-		**	**	-	**	**	**	**	**	**	-	**	**	**	**	-	-	-
R21	-	**	**	**	**	**	**	-	-	-	**	**	**	**	**	**	**	**	**	**		**	**	**	**	*	-	-	-	-	-	**	**	**	**	**	**
R22	**	**	-	**	**	**	**	**	**	**	**	**	-	**	**	**	*	-	*	**	**		**	-	-	**	**	**	**	-	**	**	**	**	**	*	**
R23	**	-	**	-	-	-	*	**	**	**	**	-	**	-	-	**	-	**	**	-	**	**		**	**	**	**	**	**	-	**	**	**	**	-	-	-
R24	**	**	-	**	**	**	**	**	**	**	**	**	-	**	**	**	**	-	**	**	**	-	**		-	**	**	**	**	-	**	**	*	*	**	*	**
R25	**	**	-	**	**	**	**	**	**	**	**	**	-	**	**	**	-	-	-	**	**	-	**	-		**	**	**	**	-	**	**	*	**	**	-	**
R26	*	**	**	**	**	**	**	-	**	**	**	**	**	**	**	**	**	**	**	**	*	**	**	**	**		**	*	-	-	-	**	**	**	**	**	**
R27	-	**	**	**	**	**	**	-	-	*	**	**	**	**	**	**	**	**	**	**	-	**	**	**	**	**		-	-	-	**	**	**	**	**	**	**
R28	-	**	**	**	**	**	**	-	-	-	**	**	**	**	**	**	**	**	**	**	-	**	**	**	**	*	-		-	-	-	*	**	**	**	**	**
R29	-	**	**	**	**	**	**	-	*	*	**	**	**	**	**	**	**	**	**	**	-	**	**	**	**	-	-	-		**	-	**	**	**	**	**	**
R30	*	*	*	*	*	*	**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**		-	-	-	-	-	-	-
R31	-	**	**	**	**	**	**	**	**	**	**	**	**	**	**	-	**	**	**	**	-	**	**	**	**	-	**	-	-	-		-	**	**	**	**	**
R32	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	-	**	**	**	**	**	**	**	**	**	**	**	*	**	-	-		-	**	**	**	**
R33	**	**	**	**	**	**	**	**	**	**	*	**	*	**	**	-	**	*	**	**	**	**	**	*	*	**	**	**	**	-	**	-		**	**	**	**
R34	**	**	**	**	**	**	**	**	**	**	*	**	*	**	**	**	**	**	**	**	**	**	**	*	**	**	**	**	**	-	**	**	**		**	**	**
R35	**	-	**	-	-	-	-	**	**	**	**	-	**	*	-	**	-	**	*	-	**	**	-	**	**	**	**	**	**	-	**	**	**	**		*	-
R36	**	-	**	*	**	**	-	**	**	**	**	-	*	**	**	**	-	**	-	-	**	*	-	*	-	**	**	**	**	-	**	**	**	**	*		-
R37	**	-	**	-	-	-	-	**	**	**	**	-	**	*	-	**	-	**	-	-	**	**	-	**	**	**	**	**	**	-	**	**	**	**	-	-	

Figure 3.1.2 shows age bias plots with the mean age recorded and the standard deviation of each age reader and all readers combined plotted against the modal age. Readers R2, R4, R5, R6, R7, R10, R12, R13, R14, R15, R17, R19, R20, R23, R35, R36 and R37 showed better estimation regarding the modal age at least until age 7, most of them showing underestimation regarding the modal age in older ages. Readers R1, R8, R9, R21, R26, R27 and R28 showed underestimation in most ages regarding the modal age. This underestimation was more pronounced in readers R16, R31, R32, R33 and R34. On the other hand, readers R3, R11, R18, R22, R24 and R25 showed mostly a light overestimation of most ages regarding the modal age. Finally, reader R29 showed overestimation in ages 0-2 and underestimation in all other ages with regards to the modal age. As commented before, reader R30 made only 16 annotations (ages 0-3). In the case of all readers combined plotted against the modal age, there was a good estimation until age 7, with an underestimation of older ages.

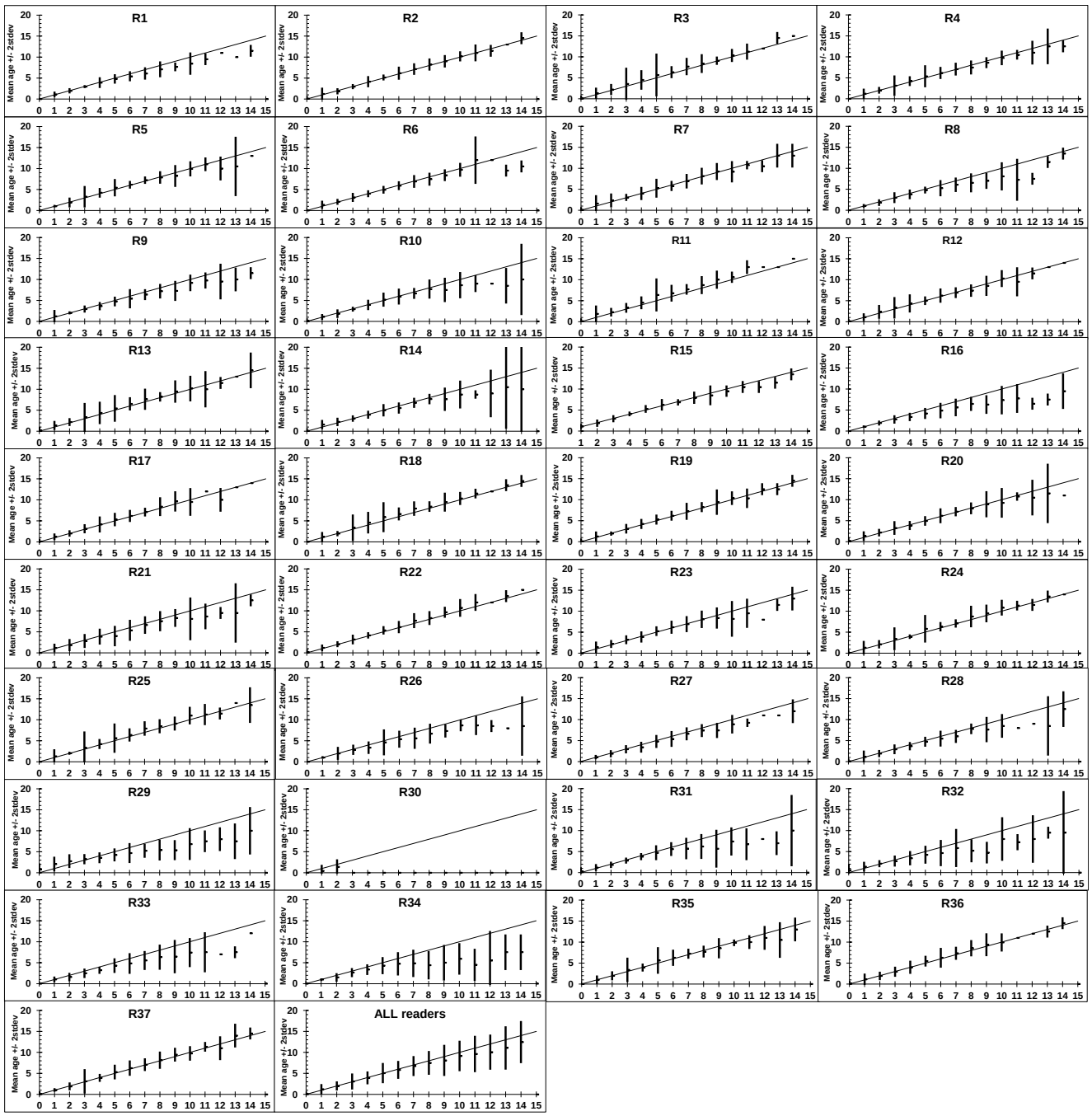


Figure 3.1.2. Age bias plot with the mean age recorded +/- 2stdev of each reader and all readers combined and plotted against the Modal Age (Small scale otolith exchange NEA mackerel, all readers' analysis).

Most readers showed similar mean length-at-age for ages <9, but showed higher values for older ages regarding the mean values of all readers together. Also, for some readers these differences were more pronounced: reader R11 showed lower mean length-at-age of most ages; readers R29 and R31 showed lower mean length-at-age <3, but higher values for the other ages; reader R32 showed higher values for ages >4; and reader R34 showed higher values for all ages (Table 3.1.5; Figure 3.1.3).The 16 annotations of reader R30 showed also lower mean length-at age-for ages 0-3, compared with the values of all readers.

Table 3.1.5. Mean length-at-age (mm) of each reader (Small scale otolith exchange NEA mackerel, all readers' analysis).

Age	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19
0	206	199	199	201	201	201	201	201	201	199	194	198	198	199	201	201	199	201	199
1	257	261	250	256	263	247	250	268	256	265	225	259	242	224	260	256	254	258	250
2	292	294	284	293	289	288	287	286	297	288	284	284	290	287	296	300	286	291	294
3	314	308	309	312	311	311	308	316	313	314	311	311	312	313	313	325	312	309	312
4	342	335	330	328	333	335	324	344	344	342	317	332	329	337	330	350	341	325	326
5	356	346	347	349	349	356	351	355	356	356	339	351	343	350	351	366	343	345	345
6	361	363	360	363	360	361	362	372	363	367	355	365	361	369	364	373	361	363	362
7	375	369	367	368	369	370	367	380	373	372	359	371	374	376	366	381	366	363	367
8	373	370	372	367	375	377	375	381	379	368	376	370	370	374	368	391	372	367	374
9	403	375	377	381	372	381	376	391	382	380	368	387	374	387	379	395	387	377	380
10	410	379	389	383	395	404	394		407	408	379	383	383	408	403	412	371	383	382
11	413	406	394	402	395	417	397	400	411	392	395	393	386	420	385	415	401	402	387
12	415	394	396	418	390	420	395	420	405	415	382	428	400		420	415	380	381	412
13	415	397		405	413	410	415	405		405	389	397	385		405		396	372	381
14		405	351	418	413	403	413	415			410	410		413	415		410	413	415
15		415	391	410				410			410							415	410
16									415				415	413	415		415		
17		415	415							410	415							413	
18							410								410				
19		410	410								410		410				410		
Age	**R20**	**R21**	**R22**	**R23**	**R24**	**R25**	**R26**	**R27**	**R28**	**R29**	**R30**	**R31**	**R32**	**R33**	**R34**	**R35**	**R36**	**R37**	**All**
0	198	202	198	201	199	199	201	201	198	166	189	188	184	200	198	200	203	199	199
1	244	267	249	252	257	251	266	265	256	208	239	232	249	272	274	267	262	264	257
2	290	299	289	284	289	294	293	292	283	271	239	285	292	299	309	291	292	290	290
3	312	314	312	309	306	308	318	317	314	314	240	323	326	334	340	313	312	312	315
4	329	339	332	328	331	325	349	338	344	339		357	358	348	361	325	335	339	338
5	351	353	344	353	342	340	355	359	352	366		362	362	363	365	349	341	348	353
6	363	369	358	359	361	364	369	364	367	369		360	371	373	370	360	364	363	364
7	368	374	363	371	362	361	379	369	376	385		378	375	382	367	371	363	368	370
8	371	382	375	379	376	376	387	380	371	395		387	396	380	391	369	368	366	375
9	382	391	379	390	378	373	374	393	398	419		390	390	390	405	385	386	374	382
10	400	397	382	392	382	375	393	410	415			413	410	395		381	385	395	390
11	397	435	396	420	373	398	413	414	418			415	435	390	413	357	398	372	396
12	400	418	402	390	393	393				415			385	412		418	413	394	399
13		405	393		420	409		415				415	422				372	374	397
14	420	415	420	415	398	374			405							405	415	415	406
15			410			415											405	413	407
16					415	415											415	415	415
17			415													415			414
18	413																410		411
19			410		410	410										410		410	410

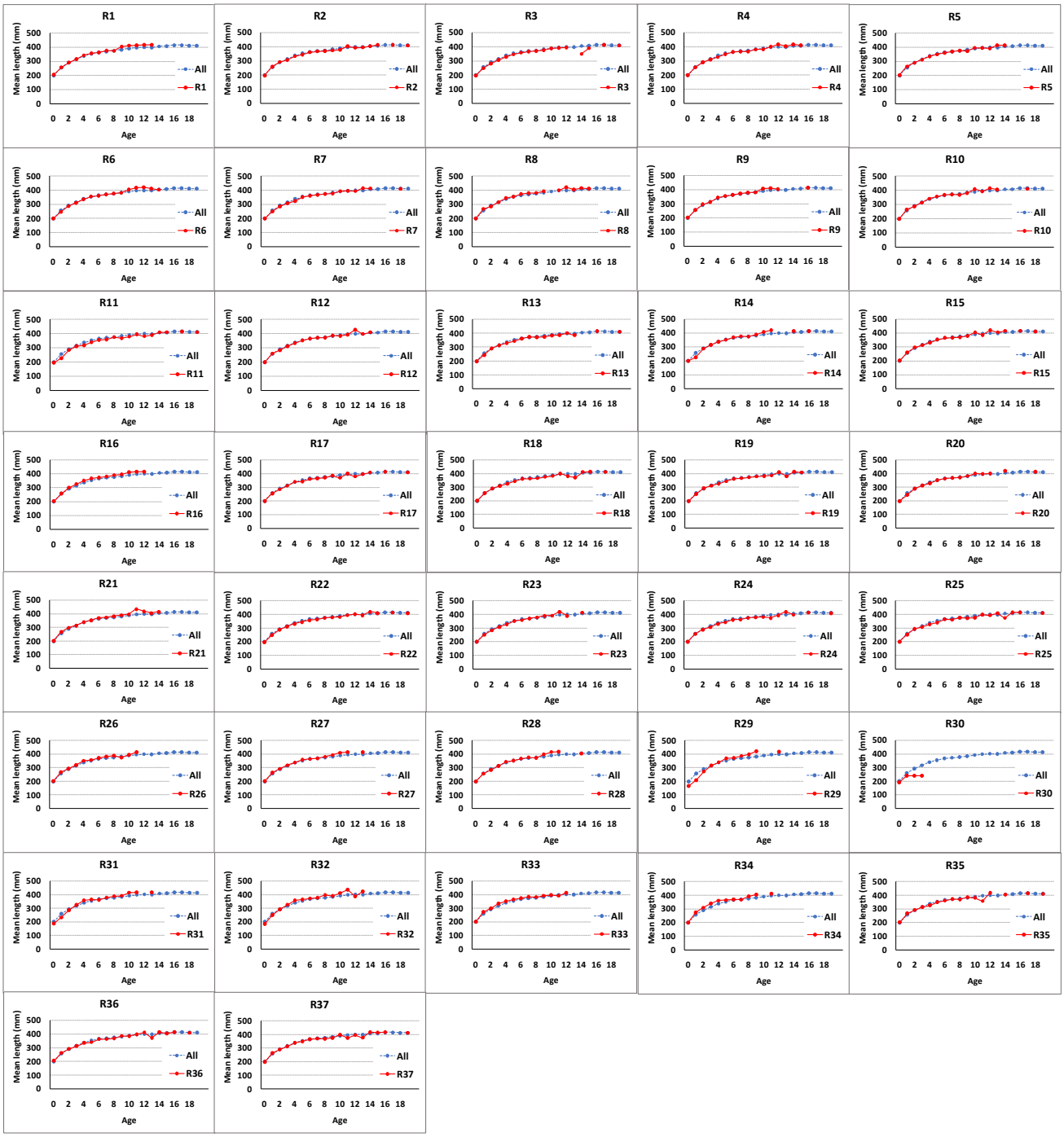


Figure 3.1.3. Mean length at age of each reader compared with the mean values of all readers together (Small scale otolith exchange NEA mackerel, all readers' analysis).

The error matrix of all readers regarding the modal age showed the best values (≥0.65) for ages 0-3 (respectively, 0.88, 0.75, 0.73 and 0.75). These values decrease with older ages, being the values of less than 0.50 for age ≥7 (Table 3.1.6).

Table 3.1.6. Error matrix of all readers regarding the modal age (Small scale otolith exchange NEA mackerel, all readers' analysis). (A: age; MA: modal age; black: rate of age estimates coincident with MA; red: rate of age estimates no coincident with MA; white: rate of rejected otoliths by modal age).

All A\MA	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
0	0.88	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0.08	0.75	0.11	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0.01	0.14	0.73	0.10	0.01	0.01	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0.03	0.09	0.75	0.21	0.04	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0	0	0	0	0	0	0
4	0	0.01	0.01	0.06	0.62	0.15	0.05	0.02	0.02	0.04	0.01	0.01	0	0	0	0	0	0	0	0
5	0	0	0	0.02	0.09	0.59	0.17	0.07	0.03	0.04	0.02	0.01	0	0	0	0	0	0	0	0
6	0	0	0	0	0.02	0.13	0.52	0.20	0.10	0.07	0.04	0.05	0.03	0.05	0.05	0	0	0	0	0
7	0	0	0	0	0.01	0.02	0.13	0.48	0.17	0.10	0.05	0.06	0.08	0.07	0.03	0	0	0	0	0.03
8	0	0	0	0	0	0.01	0.02	0.11	0.45	0.16	0.11	0.08	0.09	0.07	0.03	0	0	0	0	0.03
9	0	0	0	0	0	0.01	0.01	0.05	0.09	0.33	0.18	0.11	0.12	0.09	0.01	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0.03	0.10	0.34	0.15	0.09	0.05	0.01	0	0	0	0	0.16
11	0	0	0	0	0	0.01	0	0	0.01	0.02	0.11	0.22	0.18	0.09	0.11	0	0.05	0	0	0.08
12	0	0	0	0	0	0	0	0	0	0.01	0.03	0.09	0.26	0.11	0.15	0	0.08	0	0	0
13	0	0	0	0	0	0	0	0	0	0.01	0.01	0.03	0.04	0.23	0.15	0	0.11	0	0	0.03
14	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0.12	0.24	0	0.16	0	0	0.05
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0.16	0	0.03	0	0	0.08
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0.24	0	0	0.03
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.16	0	0	0.05
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0	0	0.11
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.27
-	0.04	0.05	0.06	0.05	0.04	0.05	0.05	0.06	0.08	0.11	0.08	0.18	0.09	0.08	0.04	0	0.14	0	0	0.08
N	10	42	32	35	14	16	23	13	15	13	12	4	2	2	2	-	1	-	-	1

3.2. ADVANCED READERS' ANALYSIS.

The modal age range of the advance readers' analysis (readers whose age estimations are used in NEA mackerel assessment) was 0-19 for the whole set of otoliths, with more than 10 otoliths of modal ages 0-10, 3 otoliths of modal age 12, 2 otoliths of modal ages 11 and 13 and 1 otolith each of the modal ages 14-16 and 19. The overall agreement for the readers involved in assessment was 67.8%. The best agreement was obtained for otoliths of modal age 0 (91.1%) and modal ages 1-3 (79.1-82.1%). Otoliths with modal age >6 had less than 60% agreement. The lowest agreement was obtained for otoliths with modal ages 15 and 16 (25.0 and 26.1% agreement, respectively) (Table 3.2.1). Overall CV was 24.1%. Highest values of CV were for modal ages 1 and 2 (30.5 and 20.6%, respectively). For the rest of modal ages the CV was <20% (Table 3.2.1). Overall bias was -0.21, being the bias values between 0.25 and -0.11 for younger modal ages (0-8) and values <-0.29 for older ages (Table 3.2.1).

The standard deviation showed a increasing of its values with the age for all readers combined, contrary to what happens with the percentage of agreement that showed a decreasing of its values with the age (Figure 3.2.1).

By component, the best agreement between the advanced readers was obtained for the North Sea component set of otoliths (78.1%) while the lowest agreement was obtained for the Southern component (60.5%). The lowest CV value was obtained for the Northern distribution (12.8%), being the highest value for the Western component (37.9%). Bias ranged from 0.02 (North Sea components) to -0.29 (Northern distribution) (Table 3.2.2).

Table 3.2.1. Summary of the average percentage of agreement (PA), coefficient of variation (CV) and relative bias by age (Small scale otolith exchange NEA mackerel, advanced readers). (MA: modal age).

MA	N	PA	CV	Bias
0	10	91.1	149.3	0.09
1	40	80.6	30.5	0.25
2	34	79.1	20.6	0.02
3	34	82.1	12.8	0.04
4	13	70.1	16.3	0.18
5	16	65.7	13.1	0.00
6	22	60.4	14.1	-0.11
7	14	55.5	14.3	-0.11
8	15	55.6	14.3	-0.30
9	13	43.3	17.3	-0.60
10	15	38.0	19.1	-0.43
11	2	32.5	-	-1.13
12	3	32.9	15.9	-1.29
13	2	32.6	-	-1.26
14	1	30.4	-	-1.13
15	1	25.0	-	-2.08
16	1	26.1	-	-11.49
17	-	-	-	-
18	-	-	-	-
19	1	33.3	-	-19.00
Total	**237**	**67.8**	**24.1**	**-0.21**

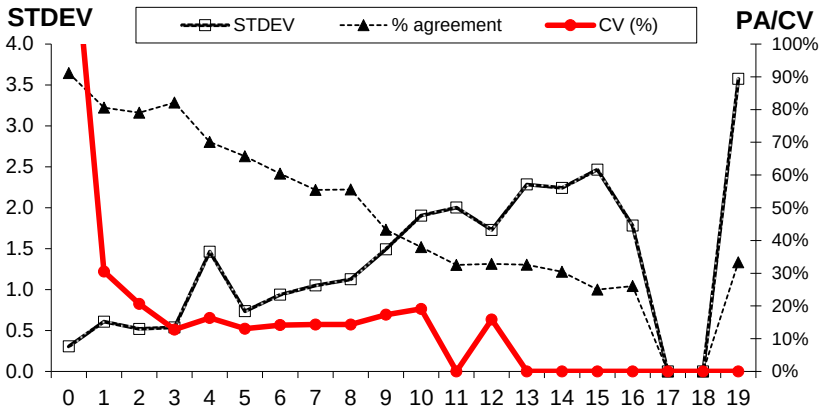


Figure 3.2.1. Coefficient of variation (CV%), percent of agreement and the standard deviation (STDEV) plotted against Modal Age (Small scale otolith exchange NEA mackerel, advanced readers' analysis).

Table 3.2.2. Summary of % agreement (PA), coefficient of variation (CV) and bias obtained by component (Small scale otolith exchange NEA mackerel, advanced readers' analysis).

Component	PA	CV	Bias
Southern component	60.5	25.7	-0.07
Western component	69.3	37.9	-0.01
North Sea component	78.1	19.6	0.02
Northern distribution	64.3	12.8	-0.29

A total of 80 otoliths from the 237 otoliths of the exchange had an agreement between the advanced readers of more than 80%. From these, 22 otoliths had 100% agreement (ages 0-3), 35 otoliths had 90-99% agreement (ages 0-5) and 23 otoliths had 80-89% agreement (ages 0-6, 8) (Table 3.2.3). A total of 15 otoliths had less than 30% agreement.

Table 3.2.3. Otoliths with more than 80% agreement between all readers involved in assessment (Small scale otolith exchange NEA mackerel, advanced readers' analysis). (MA: modal age).

MA	100%	90-99%	80-89%
0	5	3	1
1	7	12	2
2	4	9	4
3	6	9	5
4	-	1	3
5	-	1	2
6	-	-	4
7	-	-	-
8	-	-	2
TOTAL	22	35	23

The results of the reader against modal age bias test for the advanced readers are shown in Table 3.2.4. Readers R2, R4, R5, R6, R7, R12, R17 and R20 showed no bias regarding the modal age, while readers R15 and R19 showed possibility of bias. The rest of the readers showed certainty of bias regarding the modal age.

Table 3.2.4. Reader against modal age bias test (Small scale otolith exchange NEA mackerel, advanced readers' analysis). - = no sign of bias (p>0.05); * = possibility of bias (0.01<p<0.05); ** = certainty of bias (p<0.01). (MA: modal age).

	R1	R2	R3	R4	R5	R6	R7	R8	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R24	R25	R32
MA	**	-	**	-	-	-	-	**	**	**	-	**	**	*	**	-	**	*	-	**	**	**	**	**

Figure 3.2.2 shows age bias plots with the mean age recorded and the standard deviation of each advanced reader and all these readers combined plotted against the model age. Readers R2, R3, R4, R5, R6, R7,R10, R12,R15, R17, R19,R20, R22 and R24 showed better estimation regarding the modal age at least until age 7, most of them showing underestimation regarding the modal age in older ages. Readers R1, R8, R14, R16, R21 and R32 showed underestimation in most ages with regards to the modal age and readers R11, R13, R18 and R25 showed mostly a light overestimation of most ages regarding the modal age. In the case of all advanced readers combined plotted against the modal age, there was a good agreement until age 8, with underestimation of older ages.

Most readers showed similar mean length-at-age, at least until age 8, with regards to the mean values of all advanced readers together. However, differences occurred for some readers: reader R11 showed lower mean length-at-age of most ages; readers R16 and R25 showed slightly higher values for ages ≥4 and reader R32 showed lower values for ages 0 and 1 but higher values for ages ≥3. Also,

reader R14 showed lower mean length-at-age 1, while reader R21 showed a higher value for this age (Table 3.2.5; Figure 3.2.3).

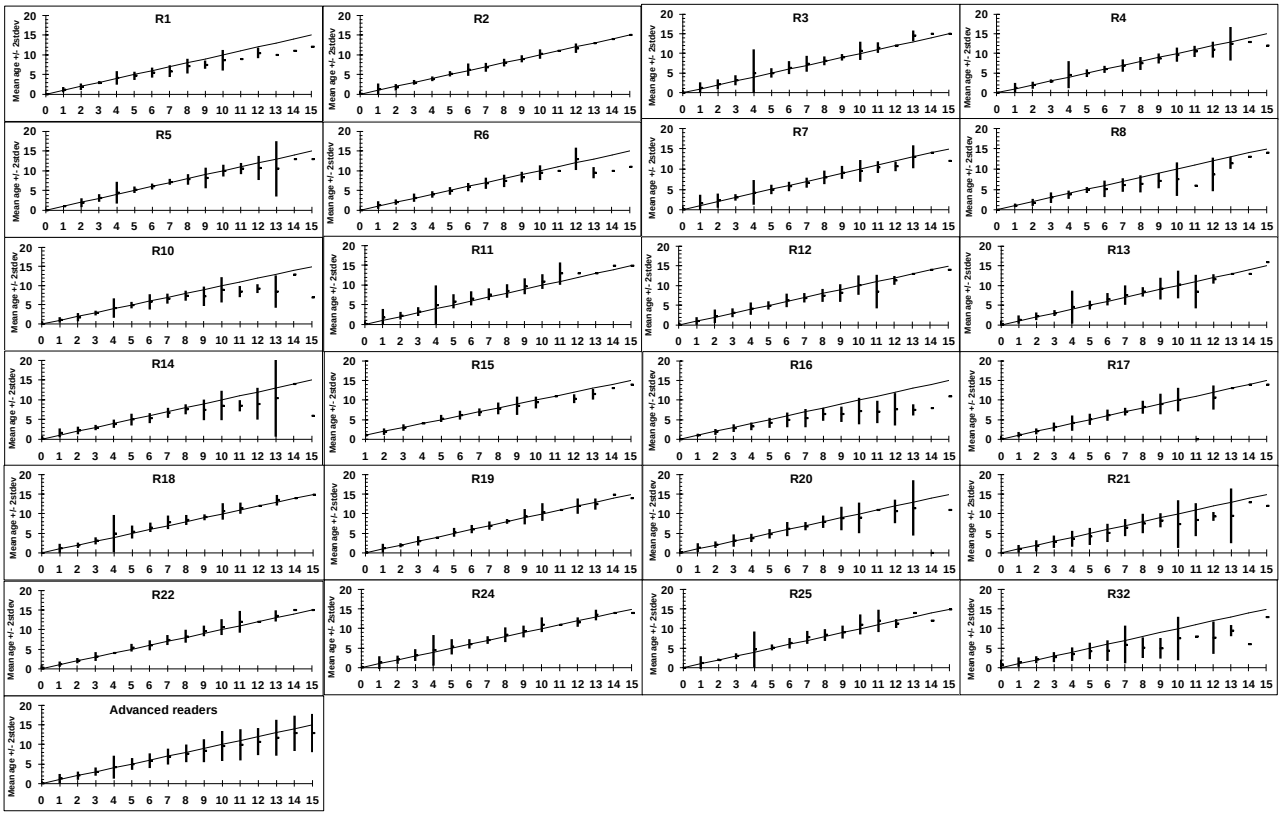


Figure 3.2.2. Age bias plot with the mean age recorded +/- 2stdev of each reader and all readers combined and plotted against the modal age (Small scale otolith exchange NEA mackerel, advanced readers' analysis).

Table 3.2.5. Mean length-at-age (mm) of each advanced reader (Small scale otolith exchange NEA mackerel, advanced readers' analysis).

Age	R1	R2	R3	R4	R5	R6	R7	R8	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R24	R25	R32	All ad
0	206	199	199	201	201	201	201	201	199	194	198	198	199	201	201	199	201	199	198	202	198	199	199	184	199
1	257	261	250	256	263	247	250	268	265	225	259	242	224	260	256	254	258	250	244	267	249	257	251	249	255
2	292	294	284	293	289	288	287	286	288	284	284	290	287	296	300	286	291	294	290	299	289	289	294	292	290
3	314	308	309	312	311	311	308	316	314	311	311	312	313	313	325	312	309	312	312	314	312	306	308	326	313
4	342	335	330	328	333	335	324	344	342	317	332	329	337	330	350	341	325	326	329	339	332	331	325	358	335
5	356	346	347	349	349	356	351	355	356	339	351	343	350	351	366	343	345	345	351	353	344	342	340	362	351
6	361	363	360	363	360	361	362	372	367	355	365	361	369	364	373	361	363	362	363	369	358	361	364	371	364
7	375	369	367	368	369	370	367	380	372	359	371	374	376	366	381	366	363	367	368	374	363	362	361	375	369
8	373	370	372	367	375	377	375	381	368	376	370	370	374	368	391	372	367	374	371	382	375	376	376	396	374
9	403	375	377	381	372	381	376	391	380	368	387	374	387	379	395	387	377	380	382	391	379	378	373	390	380
10	410	379	389	383	395	404	394		408	379	383	383	408	403	412	371	383	382	400	397	382	382	375	410	389
11	413	406	394	402	395	417	397	400	392	395	393	386	420	385	415	401	402	387	397	435	396	373	398	435	396
12	415	394	396	418	390	420	395	420	415	382	428	400		420	415	380	381	412	400	418	402	393	393	385	397
13	415	397		405	413	410	415	405	405	389	397	385		405		396	372	381		405	393	420	409	422	398
14		405	351	418	413	403	413	415		410	410		413	415		410	413	415	420	415	420	398	374		405
15		415	391	410				410		410							415	410			410		415		406
16												415	413	415		415						415	415		414
17		415	415						410	415							413				415				414
18							410							410					413						411
19		410	410							410		410				410					410	410	410		410

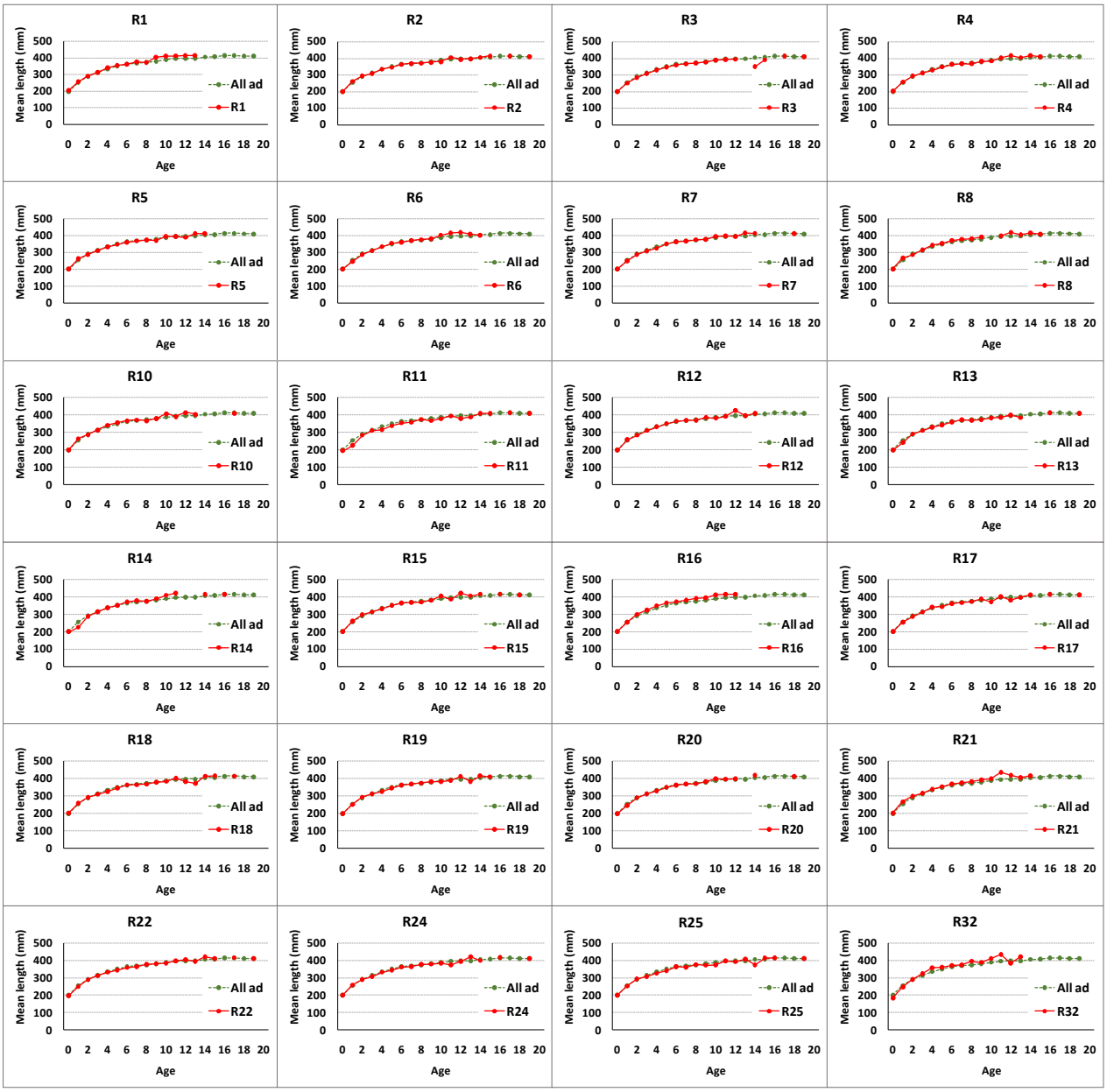


Figure 3.2.3. Mean length-at-age of each advanced reader compared with the mean values of all advanced readers together (Small scale otolith exchange NEA mackerel, advanced readers' analysis).

The error matrix of the advanced readers regarding the modal age showed the best values (≥0.65) for ages 0-5 (respectively, 0.90, 0.80, 0.78, 0.82, 0.68 and 0.65). These values decrease with older ages, being the values of less than 0.50 for ages ≥9 (Table 3.2.6).

The analysis of the error matrix of each advanced reader regarding the modal age (MA; for MA with 10 or more otoliths, ages 0-10) showed that all advanced readers presented values ≥0.80 of coincidence with MA 0, with the exception of reader R32 (0.50). Most readers showed values ≥0.75 of coincidence with MA 1, while readers R11 and R14 showed the lowest values (0.45). Most readers showed values ≥0.70 of coincidence with MA 2 and 3, while R21 showed the lowest values (0.50 and 0.47, respectively) (Table 3.2.7).

This analysis also showed that readers R2, R3, R4, 45, R6, R13, R15, R18, R19, R20, R22, R24 and R25 presented values of ≥0.65 of coincidence with most of the MA (in 7 or more ages), while readers R16, R21 and R32 presented values <0.50 of coincidence in most ages.

Table 3.2.6. Error matrix of all advanced readers regarding the modal age (Small scale otolith exchange NEA mackerel, advanced readers' analysis). (A: age; MA: modal age; black: rate of age estimates coincident with MA; red: rate of age estimates no coincident with MA; white: rate of rejected otoliths by modal age).

All A\MA	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
0	0.90	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0.08	0.80	0.10	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0	0	0	0
2	0	0.14	0.78	0.08	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0.03	0.09	0.82	0.16	0.02	0.02	0.01	0.01	0	0.01	0	0	0	0	0	0	0	0	0
4	0	0.01	0.01	0.07	0.68	0.15	0.05	0.01	0.01	0.02	0.01	0	0	0	0	0	0	0	0	0
5	0	0	0	0.02	0.07	0.65	0.16	0.05	0.03	0.03	0.01	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0.02	0.14	0.59	0.18	0.08	0.07	0.03	0.06	0.03	0	0.04	0	0	0	0	0
7	0	0	0	0	0	0.02	0.13	0.54	0.15	0.09	0.04	0.06	0.06	0.08	0	0	0	0	0	0.04
8	0	0	0	0	0.01	0.01	0.02	0.13	0.53	0.16	0.08	0.10	0.01	0.04	0.04	0	0	0	0	0
9	0	0	0	0	0.01	0	0.01	0.04	0.12	0.40	0.14	0.06	0.11	0.06	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0.02	0.12	0.34	0.15	0.13	0.08	0.04	0	0	0	0	0.13
11	0	0	0	0	0.01	0	0	0	0.01	0.03	0.15	0.27	0.25	0.06	0.04	0	0	0	0	0
12	0	0	0	0	0.01	0	0	0	0	0.01	0.06	0.06	0.32	0.10	0.04	0.50	0.08	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0.03	0.04	0.06	0.31	0.29	0	0.13	0	0	0.04
14	0	0	0	0	0	0	0	0	0	0	0	0.02	0.01	0.19	0.29	0	0.21	0	0	0.08
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02	0.17	0.50	0.04	0	0	0.13
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.25	0	0	0.04
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.21	0	0	0.08
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.04	0	0	0.13
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.33
-	0.01	0.01	0.02	0	0.03	0.01	0.02	0.02	0.06	0.07	0.10	0.17	0.03	0.04	0.04	0	0.04	0	0	0
N	10	40	34	34	13	16	22	14	15	13	15	2	3	2	1	1	1	-	-	1

Table 3.2.7. Error matrix of each advanced reader regarding the modal age (for ages with more than 10 otoliths, ages 0-10) (Small scale otolith exchange NEA mackerel, advanced readers' analysis). (A: age; MA: modal age; black: rate of age estimates coincident with MA; red: rate of age estimates no coincident with MA; white: rate of rejected otoliths by modal age).

R1 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	0.90	0	0	0	0	0	0	0	0	0	0
1	0	0.88	0.12	0	0	0	0	0	0	0	0
2	0	0.13	0.82	0.03	0	0	0	0	0	0	0
3	0	0	0.03	0.97	0.23	0	0	0	0	0	0
4	0	0	0	0	0.54	0.31	0.05	0	0	0	0
5	0	0	0	0	0.15	0.63	0.36	0.29	0.07	0	0
6	0	0	0	0	0.08	0	0.45	0.36	0.07	0	0.07
7	0	0	0	0	0	0	0	0.14	0.33	0.31	0
8	0	0	0	0	0	0	0	0	0.27	0.31	0.13
9	0	0	0	0	0	0	0	0	0	0.00	0.20
10	0	0	0	0	0	0	0	0	0	0	0.13
11	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
-	0.10	0	0.03	0	0	0.06	0.14	0.21	0.27	0.38	0.47
N	10	40	34	34	13	16	22	14	15	13	15

R2 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	0.90	0	0	0	0	0	0	0	0	0	0
1	0.10	0.90	0.21	0	0	0	0	0	0	0	0
2	0	0.03	0.79	0.06	0	0	0	0	0	0	0
3	0	0.05	0	0.91	0.08	0	0	0	0	0	0
4	0	0	0	0.03	0.85	0	0	0	0	0	0
5	0	0.03	0	0	0	0.88	0.09	0	0	0	0
6	0	0	0	0	0	0.13	0.73	0.21	0	0	0
7	0	0	0	0	0	0	0.14	0.71	0.07	0	0
8	0	0	0	0	0	0	0	0.07	0.67	0.08	0
9	0	0	0	0	0	0	0.05	0	0.13	0.77	0.07
10	0	0	0	0	0	0	0	0	0	0.08	0.53
11	0	0	0	0	0	0	0	0	0	0	0.27
12	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
-	0	0	0	0	0.08	0	0	0	0.13	0.08	0.13
N	10	40	34	34	13	16	22	14	15	13	15

Table 3.2.7. (cont.).

R3 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	0.90	0	0	0	0	0	0	0	0	0	0
1	0.10	0.75	0.03	0	0	0	0	0	0	0	0
2	0	0.08	0.79	0.03	0	0	0	0	0	0	0
3	0	0.10	0.15	0.79	0	0	0	0	0	0	0
4	0	0	0	0.09	0.85	0.13	0	0	0	0	0
5	0	0	0.03	0.09	0	0.69	0	0	0	0	0
6	0	0	0	0	0.08	0.19	0.73	0.14	0	0	0
7	0	0	0	0	0	0	0.18	0.50	0.07	0	0
8	0	0	0	0	0	0	0.05	0.14	0.67	0.08	0
9	0	0	0	0	0	0	0.05	0.21	0.27	0.85	0
10	0	0	0	0	0	0	0	0	0	0.08	0.60
11	0	0	0	0	0	0	0	0	0	0	0.20
12	0	0	0	0	0	0	0	0	0	0	0.13
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0.07
15	0	0	0	0	0.08	0	0	0	0	0	0
-	0	0.08	0	0	0	0	0	0	0	0	0
N	10	40	34	34	13	16	22	14	15	13	15

R4 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	1.00	0	0	0	0	0	0	0	0	0	0
1	0	0.85	0.12	0	0	0	0	0	0	0	0
2	0	0.10	0.79	0.06	0	0	0	0	0	0	0
3	0	0.03	0.09	0.94	0.08	0	0	0	0	0	0
4	0	0.03	0	0	0.62	0.13	0	0	0	0	0
5	0	0	0	0	0.23	0.75	0.09	0	0	0	0
6	0	0	0	0	0	0.13	0.82	0.21	0.13	0	0
7	0	0	0	0	0	0	0.09	0.64	0.33	0.08	0
8	0	0	0	0	0	0	0	0.07	0.47	0.15	0.13
9	0	0	0	0	0	0	0	0.07	0.07	0.77	0.20
10	0	0	0	0	0.08	0	0	0	0	0	0.53
11	0	0	0	0	0	0	0	0	0	0	0.13
12	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
-	0	0	0	0	0	0	0	0	0	0	0
N	10	40	34	34	13	16	22	14	15	13	15

R5 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	1.00	0	0	0	0	0	0	0	0	0	0
1	0	1.00	0.21	0	0	0	0	0	0	0	0
2	0	0	0.74	0.06	0	0	0	0	0	0	0
3	0	0	0.03	0.82	0	0	0	0	0	0	0
4	0	0	0.03	0.09	0.92	0	0	0	0	0	0
5	0	0	0	0.03	0	0.81	0.05	0	0	0.08	0
6	0	0	0	0	0	0.19	0.86	0	0.07	0	0
7	0	0	0	0	0	0	0.09	0.86	0.13	0.15	0
8	0	0	0	0	0	0	0	0.14	0.73	0.31	0
9	0	0	0	0	0.08	0	0	0	0.07	0.38	0.27
10	0	0	0	0	0	0	0	0	0	0.08	0.47
11	0	0	0	0	0	0	0	0	0	0	0.27
12	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
-	0	0	0	0	0	0	0	0	0	0	0
N	10	40	34	34	13	16	22	14	15	13	15

R6 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	1.00	0	0	0	0	0	0	0	0	0	0
1	0	0.68	0.03	0	0	0	0	0	0	0	0
2	0	0.33	0.88	0.06	0	0	0	0	0	0	0
3	0	0	0.09	0.79	0.08	0	0	0	0	0	0
4	0	0	0	0.12	0.77	0.19	0	0	0	0	0
5	0	0	0	0.03	0.08	0.75	0.18	0.07	0	0	0
6	0	0	0	0	0	0.06	0.68	0.14	0.13	0	0
7	0	0	0	0	0	0	0.05	0.71	0.20	0.08	0
8	0	0	0	0	0	0	0	0.07	0.47	0.38	0.07
9	0	0	0	0	0	0	0	0	0	0.38	0.33
10	0	0	0	0	0	0	0	0	0	0	0.20
11	0	0	0	0	0	0	0	0	0	0	0.13
12	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
-	0	0	0	0	0.08	0	0.09	0	0.20	0.15	0.27
N	10	40	34	34	13	16	22	14	15	13	15

R7 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	0.90	0	0	0	0	0	0	0	0	0	0
1	0.10	0.68	0.12	0	0	0	0	0	0	0	0
2	0	0.08	0.62	0.06	0	0	0	0	0	0	0
3	0	0.15	0.18	0.82	0.23	0	0	0	0	0	0
4	0	0.08	0.06	0.12	0.62	0.19	0	0	0	0	0
5	0	0	0.03	0	0.08	0.69	0.32	0	0	0	0
6	0	0	0	0	0	0.13	0.64	0.36	0.07	0	0
7	0	0	0	0	0	0	0.05	0.57	0.07	0	0.13
8	0	0	0	0	0	0	0	0.07	0.73	0.15	0.07
9	0	0	0	0	0.08	0	0	0	0.07	0.62	0.13
10	0	0	0	0	0	0	0	0	0.07	0.15	0.40
11	0	0	0	0	0	0	0	0	0	0.08	0.20
12	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
-	0	0.03	0	0	0	0	0	0	0	0	0.07
N	10	40	34	34	13	16	22	14	15	13	15

R8 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	1.00	0	0	0	0	0	0	0	0	0	0
1	0	0.95	0.24	0.03	0	0	0	0	0	0	0
2	0	0.05	0.76	0.06	0	0	0	0	0	0	0
3	0	0	0	0.85	0.31	0	0.09	0	0	0	0.07
4	0	0	0	0	0.69	0.13	0.14	0.07	0	0	0.07
5	0	0	0	0.06	0	0.88	0.32	0.07	0.20	0	0
6	0	0	0	0	0	0	0.45	0.57	0.40	0.31	0.13
7	0	0	0	0	0	0	0	0.29	0.20	0.15	0.13
8	0	0	0	0	0	0	0	0	0.20	0.46	0.27
9	0	0	0	0	0	0	0	0	0	0.00	0.27
10	0	0	0	0	0	0	0	0	0	0	0.00
11	0	0	0	0	0	0	0	0	0	0	0.07
12	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
-	0	0	0	0	0	0	0	0	0	0.08	0
N	10	40	34	34	13	16	22	14	15	13	15

R10 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	0.90	0	0	0	0	0	0	0	0	0	0
1	0.10	0.95	0.26	0	0	0	0	0	0	0	0
2	0	0.03	0.68	0.09	0	0	0	0	0	0	0
3	0	0.03	0.06	0.91	0.23	0	0	0	0	0	0
4	0	0	0	0	0.62	0.13	0.05	0	0	0	0
5	0	0	0	0	0.08	0.81	0.27	0.07	0	0.08	0
6	0	0	0	0	0	0.06	0.55	0.21	0.07	0.23	0.07
7	0	0	0	0	0	0	0.09	0.64	0.40	0.15	0.13
8	0	0	0	0	0.08	0	0	0	0.47	0.31	0.07
9	0	0	0	0	0	0	0.05	0	0	0.15	0.13
10	0	0	0	0	0	0	0	0	0	0	0.27
11	0	0	0	0	0	0	0	0	0	0	0.13
12	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
-	0	0	0	0	0	0	0	0.07	0.07	0.08	0.20
N	10	40	34	34	13	16	22	14	15	13	15

R11 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	0.80	0	0	0	0	0	0	0	0	0	0
1	0.10	0.45	0	0	0	0	0	0	0	0	0
2	0	0.38	0.76	0	0	0	0	0	0	0	0
3	0	0.08	0.18	0.76	0	0	0	0	0	0	0
4	0	0.08	0.03	0.18	0.69	0	0	0	0	0	0
5	0	0.03	0	0.06	0.15	0.38	0.05	0	0	0	0
6	0	0	0	0	0.08	0.44	0.45	0	0	0	0
7	0	0	0	0	0	0.13	0.36	0.43	0	0	0
8	0	0	0	0	0	0.06	0.09	0.43	0.53	0.08	0
9	0	0	0	0	0	0	0.05	0.14	0.33	0.31	0
10	0	0	0	0	0	0	0	0	0	0.46	0.33
11	0	0	0	0	0	0	0	0	0.07	0.08	0.40
12	0	0	0	0	0	0	0	0	0	0.08	0.13
13	0	0	0	0	0.08	0	0	0	0	0	0.07
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
-	0.10	0	0.03	0	0	0	0	0	0.07	0	0.07
N	10	40	34	34	13	16	22	14	15	13	15

Table 3.2.7. (cont.).

R12 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	0.90	0.05	0	0	0	0	0	0	0	0	0
1	0.10	0.85	0.12	0	0	0	0	0	0	0	0
2	0	0.08	0.62	0.06	0	0	0	0	0	0	0
3	0	0.03	0.18	0.79	0.15	0	0	0	0	0	0
4	0	0	0.06	0.12	0.62	0.13	0	0	0	0	0
5	0	0	0.03	0.03	0.15	0.75	0.14	0	0	0	0
6	0	0	0	0	0.08	0.13	0.59	0.21	0.13	0.08	0
7	0	0	0	0	0	0	0.23	0.64	0.27	0.15	0.07
8	0	0	0	0	0	0	0	0.14	0.53	0.46	0
9	0	0	0	0	0	0	0.05	0	0.07	0.15	0.13
10	0	0	0	0	0	0	0	0	0	0.15	0.33
11	0	0	0	0	0	0	0	0	0	0	0.33
12	0	0	0	0	0	0	0	0	0	0	0.07
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
-	0	0	0	0	0	0	0	0	0	0	0.07
N	10	40	34	34	13	16	22	14	15	13	15

R13 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	0.80	0	0	0	0	0	0	0	0	0	0
1	0.20	0.68	0	0	0	0	0	0	0	0	0
2	0	0.30	0.85	0.06	0	0	0	0	0	0	0
3	0	0.03	0.12	0.88	0.23	0	0	0	0	0	0
4	0	0	0.03	0.06	0.54	0.13	0	0	0	0	0
5	0	0	0	0	0.08	0.69	0	0	0	0	0
6	0	0	0	0	0.08	0.19	0.68	0.07	0	0.08	0
7	0	0	0	0	0	0	0.14	0.57	0	0	0.07
8	0	0	0	0	0	0	0.18	0.21	0.67	0.15	0.13
9	0	0	0	0	0	0	0	0.07	0.27	0.31	0.07
10	0	0	0	0	0	0	0	0	0.07	0.31	0.27
11	0	0	0	0	0.08	0	0	0.07	0	0.15	0.27
12	0	0	0	0	0	0	0	0	0	0	0.07
13	0	0	0	0	0	0	0	0	0	0	0.13
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
-	0	0	0	0	0	0	0	0	0	0	0
N	10	40	34	34	13	16	22	14	15	13	15

R14 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	0.90	0	0	0	0	0	0	0	0	0	0
1	0.10	0.45	0.03	0	0	0	0	0	0	0	0
2	0	0.53	0.71	0.06	0	0	0	0	0	0	0
3	0	0.03	0.24	0.88	0.15	0	0	0	0	0	0
4	0	0	0	0.06	0.77	0.19	0.09	0	0	0	0.07
5	0	0	0	0	0.08	0.69	0.45	0	0	0.08	0.07
6	0	0	0	0	0	0.06	0.45	0.36	0.07	0.15	0
7	0	0	0	0	0	0.06	0	0.57	0.27	0.31	0.07
8	0	0	0	0	0	0	0	0.07	0.67	0.15	0.13
9	0	0	0	0	0	0	0	0	0	0.31	0.27
10	0	0	0	0	0	0	0	0	0	0	0.40
11	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
-	0	0	0.03	0	0	0	0	0	0	0	0
N	10	40	34	34	13	16	22	14	15	13	15

R15 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	1.00	0	0	0	0	0	0	0	0	0	0
1	0	0.93	0.15	0	0	0	0	0	0	0	0
2	0	0.08	0.74	0.12	0	0	0	0	0	0	0
3	0	0	0.03	0.82	0	0	0	0	0	0	0
4	0	0	0	0.06	0.92	0	0	0	0	0	0
5	0	0	0	0	0	0.75	0.09	0	0	0	0
6	0	0	0	0	0	0.25	0.64	0.14	0.07	0.08	0
7	0	0	0	0	0	0	0.23	0.79	0.13	0.08	0
8	0	0	0	0	0	0	0	0.07	0.60	0.08	0.13
9	0	0	0	0	0	0	0	0	0.13	0.46	0.27
10	0	0	0	0	0	0	0	0	0	0.08	0.47
11	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
-	0	0	0.09	0	0.08	0	0.05	0	0.07	0.23	0.13
N	10	40	34	34	13	16	22	14	15	13	15

R16 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	1.00	0	0	0	0	0	0	0	0	0	0
1	0	0.98	0.15	0	0	0	0	0	0	0	0
2	0	0.03	0.85	0.26	0	0	0	0	0	0	0
3	0	0	0	0.71	0.69	0.13	0.09	0.07	0	0	0
4	0	0	0	0.03	0.31	0.56	0.18	0.14	0	0	0.07
5	0	0	0	0	0	0.31	0.45	0.29	0.13	0.15	0.07
6	0	0	0	0	0	0	0.27	0.36	0.40	0.46	0.13
7	0	0	0	0	0	0	0	0.14	0.40	0.23	0.20
8	0	0	0	0	0	0	0	0	0.07	0.15	0.20
9	0	0	0	0	0	0	0	0	0	0.00	0.13
10	0	0	0	0	0	0	0	0	0	0	0.07
11	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
-	0	0	0	0	0	0	0	0	0	0	0.13
N	10	40	34	34	13	16	22	14	15	13	15

R17 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	0.90	0	0	0	0	0	0	0	0	0	0
1	0.10	0.83	0.06	0	0	0	0	0	0	0	0
2	0	0.15	0.79	0	0	0	0	0	0	0	0
3	0	0	0.06	0.91	0.15	0	0	0	0	0	0
4	0	0	0	0.03	0.69	0.19	0.05	0	0	0	0
5	0	0	0	0	0.08	0.50	0.05	0	0	0	0
6	0	0	0	0.03	0	0.31	0.64	0.07	0	0	0
7	0	0	0	0	0.08	0	0.27	0.71	0.13	0.15	0
8	0	0	0	0	0	0	0	0.14	0.47	0	0.13
9	0	0	0	0	0	0	0	0	0.20	0.54	0.07
10	0	0	0	0	0	0	0	0	0.07	0.08	0.33
11	0	0	0	0	0	0	0	0	0	0	0.07
12	0	0	0	0	0	0	0	0	0	0.08	0.07
13	0	0	0	0	0	0	0	0	0	0	0.07
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
-	0	0.03	0.09	0.03	0	0	0	0.07	0.13	0.15	0.27
N	10	40	34	34	13	16	22	14	15	13	15

R18 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	1.00	0	0	0	0	0	0	0	0	0	0
1	0	0.90	0.09	0	0	0	0	0	0	0	0
2	0	0.03	0.85	0.03	0	0	0	0	0	0	0
3	0	0.03	0.03	0.85	0	0	0	0	0	0	0
4	0	0.03	0	0.09	0.77	0.06	0	0	0	0	0
5	0	0	0	0.03	0.08	0.63	0	0	0	0	0
6	0	0	0	0	0	0.19	0.50	0	0	0	0
7	0	0	0	0	0	0.13	0.45	0.43	0	0	0
8	0	0	0	0	0.08	0	0.05	0.29	0.67	0	0
9	0	0	0	0	0	0	0	0.29	0.27	0.85	0.07
10	0	0	0	0	0	0	0	0	0.07	0.15	0.47
11	0	0	0	0	0	0	0	0	0	0	0.27
12	0	0	0	0	0.08	0	0	0	0	0	0.13
13	0	0	0	0	0	0	0	0	0	0	0.07
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
-	0	0.03	0.03	0	0	0	0	0	0	0	0
N	10	40	34	34	13	16	22	14	15	13	15

R19 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	0.90	0	0	0	0	0	0	0	0	0	0
1	0.10	0.80	0.06	0	0	0	0	0	0	0	0
2	0	0.13	0.91	0.03	0	0	0	0	0	0	0
3	0	0	0	0.91	0	0	0	0	0	0	0
4	0	0.03	0	0.03	0.85	0	0	0	0	0	0
5	0	0	0	0	0	0.81	0.09	0	0	0	0
6	0	0	0	0.03	0	0.13	0.68	0.14	0	0	0
7	0	0	0	0	0	0.06	0.18	0.71	0	0.08	0
8	0	0	0	0	0	0	0	0.14	0.80	0	0
9	0	0	0	0	0	0	0	0	0.07	0.46	0.13
10	0	0	0	0	0	0	0	0	0	0.31	0.40
11	0	0	0	0	0	0	0	0	0	0.08	0.20
12	0	0	0	0	0	0	0	0	0	0	0.07
13	0	0	0	0	0	0	0	0	0	0	0.07
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
-	0	0.05	0.03	0	0.15	0	0.05	0	0.13	0.08	0.13
N	10	40	34	34	13	16	22	14	15	13	15

Table 3.2.7. (cont.).

R20 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	0.80	0	0	0	0	0	0	0	0	0	0
1	0.20	0.75	0.03	0	0	0	0	0	0	0	0
2	0	0.20	0.79	0.06	0	0	0	0	0	0	0
3	0	0.05	0.18	0.79	0.23	0.06	0	0	0	0	0
4	0	0	0	0.06	0.69	0.06	0	0	0	0	0.07
5	0	0	0	0.06	0.08	0.81	0.18	0.07	0	0	0.07
6	0	0	0	0.03	0	0.06	0.64	0.00	0.07	0.08	0
7	0	0	0	0	0	0	0.05	0.93	0.07	0.08	0
8	0	0	0	0	0	0	0.14	0	0.67	0.15	0.07
9	0	0	0	0	0	0	0	0	0.20	0.54	0.20
10	0	0	0	0	0	0	0	0	0	0	0.53
11	0	0	0	0	0	0	0	0	0	0.08	0.07
12	0	0	0	0	0	0	0	0	0	0.08	0
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
-	0	0	0	0	0	0	0	0	0	0	0
N	10	40	34	34	13	16	22	14	15	13	15

R21 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	1.00	0.08	0	0	0	0	0	0	0	0	0
1	0	0.75	0.32	0	0	0	0	0	0	0	0.13
2	0	0.18	0.50	0.32	0.15	0.06	0.05	0	0	0	0
3	0	0	0.18	0.47	0.31	0.19	0	0	0	0	0
4	0	0	0	0.15	0.31	0.38	0.18	0	0.07	0	0
5	0	0	0	0.03	0.23	0.25	0.32	0.21	0	0	0
6	0	0	0	0	0	0.13	0.32	0.29	0	0	0
7	0	0	0	0	0	0	0.09	0.29	0.13	0.15	0.13
8	0	0	0	0	0	0	0	0.21	0.53	0.31	0.27
9	0	0	0	0	0	0	0	0	0.07	0.31	0.20
10	0	0	0	0	0	0	0	0	0	0.08	0.07
11	0	0	0	0	0	0	0	0	0	0	0.07
12	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
-	0	0	0	0.03	0	0	0.05	0	0.20	0.15	0.13
N	10	40	34	34	13	16	22	14	15	13	15

R22 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	0.80	0	0	0	0	0	0	0	0	0	0
1	0.20	0.85	0.03	0	0	0	0	0	0	0	0
2	0	0.15	0.88	0	0	0	0	0	0	0	0
3	0	0	0.09	0.88	0	0	0	0	0	0	0
4	0	0	0	0.09	0.85	0	0.05	0	0	0	0
5	0	0	0	0	0	0.63	0.05	0	0	0	0
6	0	0	0	0.03	0	0.31	0.68	0.07	0	0	0
7	0	0	0	0	0	0	0.14	0.43	0.07	0	0
8	0	0	0	0	0	0	0	0.43	0.67	0	0
9	0	0	0	0	0	0	0	0	0.07	0.38	0
10	0	0	0	0	0	0	0	0	0.13	0.46	0.47
11	0	0	0	0	0	0	0	0	0	0.08	0.13
12	0	0	0	0	0	0	0	0	0	0	0.07
13	0	0	0	0	0	0	0	0	0	0	0.07
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
-	0	0	0	0	0.15	0.06	0.09	0.07	0.07	0.08	0.27
N	10	40	34	34	13	16	22	14	15	13	15

R24 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	0.90	0	0	0	0	0	0	0	0	0	0
1	0.10	0.85	0.06	0	0	0	0	0	0	0	0
2	0	0.05	0.79	0.06	0	0	0	0	0	0	0
3	0	0.08	0.09	0.74	0.08	0	0	0	0	0	0
4	0	0	0.03	0.15	0.85	0.06	0.05	0	0	0	0
5	0	0.03	0	0.03	0	0.69	0.00	0	0	0	0
6	0	0	0	0.03	0	0.13	0.77	0.07	0	0	0
7	0	0	0	0	0	0.06	0.18	0.79	0.07	0	0
8	0	0	0	0	0	0.06	0	0.14	0.53	0.08	0
9	0	0	0	0	0	0	0	0	0.33	0.62	0
10	0	0	0	0	0	0	0	0	0	0.23	0.40
11	0	0	0	0	0.08	0	0	0	0.07	0.08	0.20
12	0	0	0	0	0	0	0	0	0	0	0.40
13	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
-	0	0	0.03	0	0	0	0	0	0	0	0
N	10	40	34	34	13	16	22	14	15	13	15

R25 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	0.90	0	0	0	0	0	0	0	0	0	0
1	0	0.80	0	0	0	0	0	0	0	0	0
2	0	0.08	0.91	0.09	0	0	0	0	0	0	0
3	0	0	0.03	0.79	0	0	0	0	0	0	0
4	0	0.03	0	0.06	0.85	0	0	0	0	0	0
5	0	0.03	0	0	0	0.81	0	0	0	0	0
6	0	0	0	0	0	0.19	0.82	0	0	0	0
7	0	0	0	0	0	0	0.14	0.43	0.07	0.08	0
8	0	0	0	0	0	0	0	0.36	0.53	0	0
9	0	0	0	0	0	0	0.05	0.21	0.33	0.54	0
10	0	0	0	0	0	0	0	0	0.07	0.23	0.47
11	0	0	0	0	0	0	0	0	0	0	0.20
12	0	0	0	0	0.08	0	0	0	0	0	0.20
13	0	0	0	0	0	0	0	0	0	0	0.07
14	0	0	0	0	0	0	0	0	0	0	0.07
15	0	0	0	0	0	0	0	0	0	0	0
-	0.10	0.08	0.06	0.06	0.08	0	0	0	0	0.15	0
N	10	40	34	34	13	16	22	14	15	13	15

R32 A\MA	0	1	2	3	4	5	6	7	8	9	10
0	0.50	0	0	0	0	0	0	0	0	0	0
1	0.40	0.65	0.06	0.03	0	0	0	0	0	0	0
2	0.10	0.30	0.79	0.29	0.08	0	0.05	0	0	0	0
3	0	0.05	0.15	0.59	0.54	0.19	0.23	0.14	0.13	0.08	0.07
4	0	0	0	0.09	0.23	0.56	0.27	0.14	0.20	0.38	0.07
5	0	0	0	0	0.15	0.13	0.23	0.14	0.27	0.23	0
6	0	0	0	0	0	0.06	0.18	0.29	0.20	0.23	0.33
7	0	0	0	0	0	0.06	0.05	0.14	0.20	0	0.07
8	0	0	0	0	0	0	0	0	0.00	0.08	0
9	0	0	0	0	0	0	0	0.07	0	0.00	0.20
10	0	0	0	0	0	0	0	0	0	0	0.07
11	0	0	0	0	0	0	0	0	0	0	0.07
12	0	0	0	0	0	0	0	0.07	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0.07
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
-	0	0	0	0	0	0	0	0	0	0	0.07
N	10	40	34	34	13	16	22	14	15	13	15

4. DISCUSSION AND CONCLUSIONS.

This exchange was carried out using the SmartDots application, which most participants had already used before and they were familiar with it. However, some problems occurred during the exercise, mainly related to the position of the reading line and the quality of some images. Due to the complaints of some participants about the position of the reading line, it was decided to eliminate it so that each reader could make their annotations where they could best observe the annuli in the otoliths. The problem of the quality of the images was more difficult to solve as they were provided

by different laboratories, each one with different equipment that produced images of different quality. However, the readers were encouraged to add their comments in the SmartDots application when they found an image of bad quality and make use of the "3 point grading system" (AQ1, AQ2, AQ3) recommended by WKNARC (ICES, 2011), assigning AQ2 or AQ3, respectively, for difficult and/or impossible age estimation of these otoliths.

The average values of the percentage of agreement (64.7%) and CV (34.3%) for all readers were slightly worse than last workshop exercise in 2018 (WK-EX 2018) (66.8% and 31.4%, respectively). These values are better for the advanced readers' analysis (67.8% of agreement and 24.1% of CV), although these are also slightly worse than the expert readers analysis of WK-EX 2018 (73.2% and 16.4%, respectively). These results may have been influenced by the larger number of participants in the present exchange (a total of 37 readers, 24 of them advance readers) in comparison with WK-EX 2018 (a total of 23 readers, 15 of them expert readers).

A good agreement (≥60%) was obtained for modal ages 0-5 for all readers and 0-6 for advanced readers. The best agreement (≥70%) remain similar to WK-EX 2018, ages 0-3 for all readers and 0-4 for advanced readers (although in the case of expert readers of WK-EX 2018, modal age 7 also had >70% agreement).

The error matrix showed good values (≥0.60 of coincidence with the modal age) for ages 0-4 for all readers, and for ages 0-5 for advanced readers, being the best values (≥0.75) for ages 0-3 (for both, all and advanced readers).

For all readers, a total of 83 otoliths had ≥80% agreement (modal ages 0-6), 7 of these otoliths having 100% agreement (modal ages 0-3). In the case of advanced readers, a total of 80 otoliths had ≥80% (modal ages 0-8), 22 of these otoliths with 100% agreement (modal ages 0-3). These otoliths will be included as otoliths of reference in the Age Reader Forum site. A selection of these otoliths is included in annex A.1. A selection of otoliths with low agreement is also shown in annex A.2.

To sum up, there has been a slight decrease in the overall agreement, both for all and advanced readers since last workshop in 2018, but maintaining a good agreement until age 5/6, with the best values for ages 0-3. Agreement for otoliths with modal age 5 and older remains quite low. As pointed out during last workshop in 2018 (ICES 2019), this situation seems to have a difficult solution as the age estimation in these older otoliths is quite subjective and each reader seems to have a different interpretation of the growth pattern in these older otoliths.

In light of these results the continuation of exchange and workshops for NEA mackerel is recommended. A next workshop could be scheduled for 2023.

REFERENCES

Eltink, A.T.G.W. 2000. Age Reading Comparisons (MS Excel Workbook version 1.0 October 2000). http://www.efan.no.

ICES, 2011. Report of the Workshop of National Age Readings Coordinators (WKNARC). 5-9 September 2011, Boulogne-sur-Mer (France). ICES CM 2011/ACOM:45.

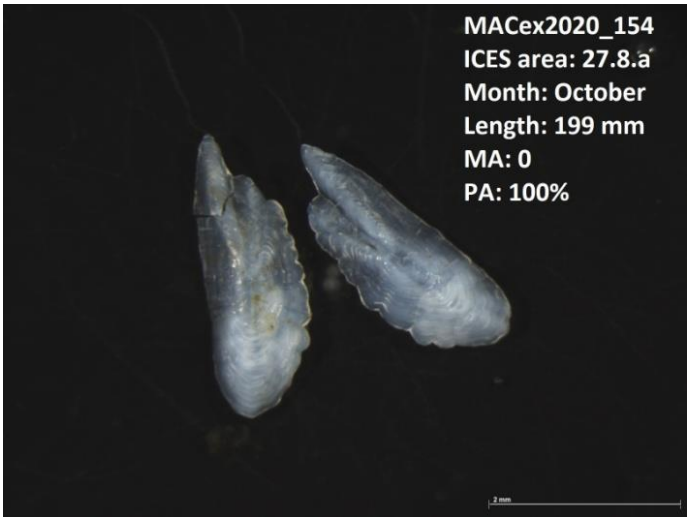
ICES, 2018. Report of the Workshop on Mackerel biological parameter Quality Indicators (WKMACQI). ICES CM 2018/EOSG:34.

ICES, 2019. Report of the Workshop on Age Estimation of Atlantic Mackerel (*Scomber scombrus*) (WKARMAC2). 22-26 October 2018, San Sebastian, Spain. ICES CM 2019/EOSG:32.

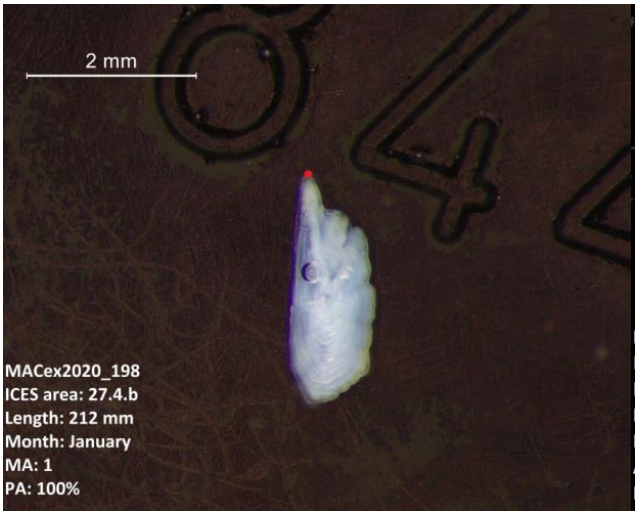
ANNEX

A.1. Selection of otoliths with more than 80% agreement between advance readers.

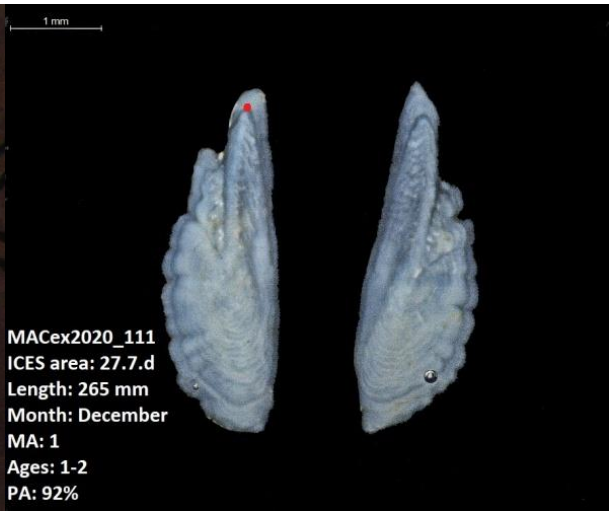
Age 0 – Semester 2



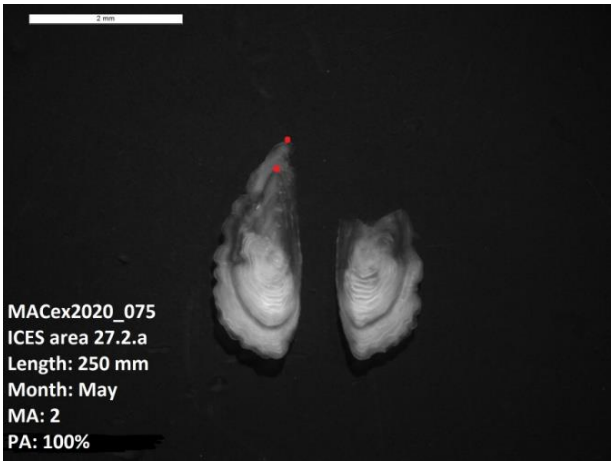
Age 1 – Semester 1



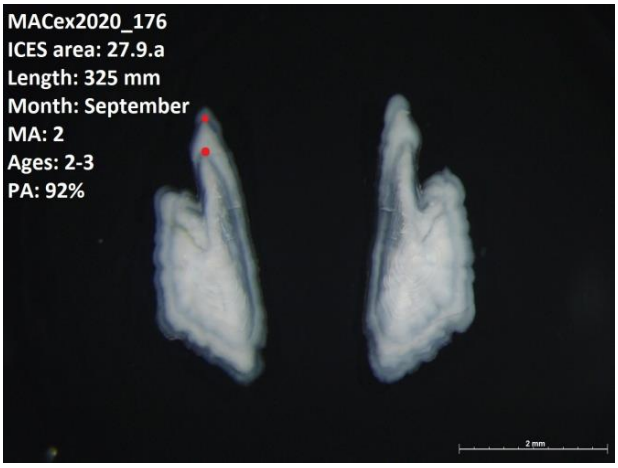
Age 1 – Semester 2



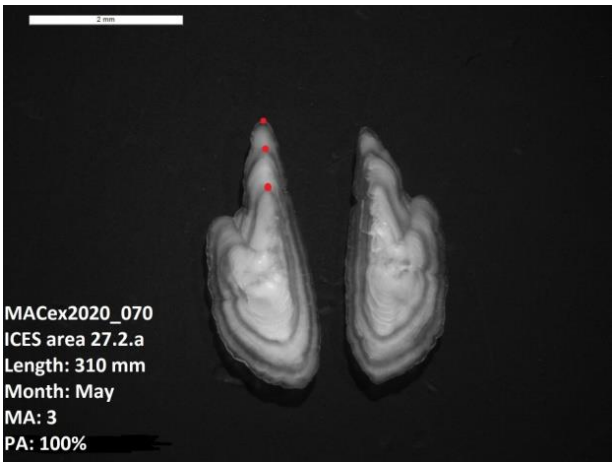
Age 2 – Semester 1



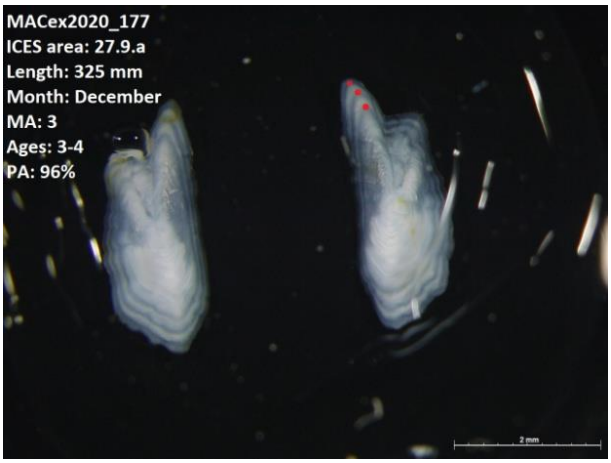
Age 2 – Semester 2



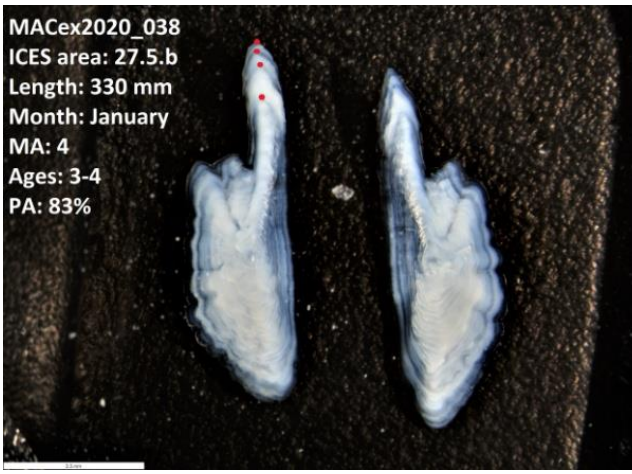
Age 3 – Semester 1



Age 3 – Semester 2

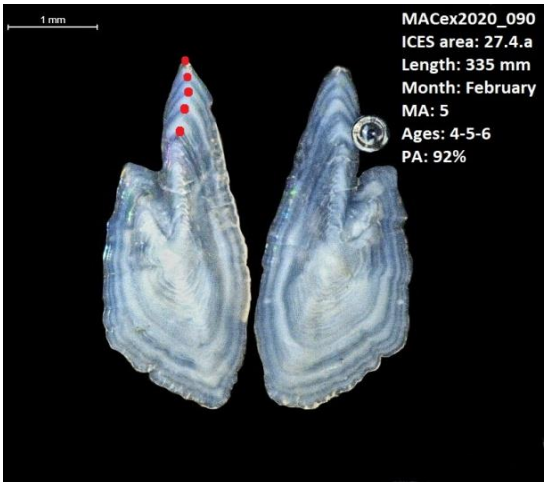


Age 4 – Semester 1



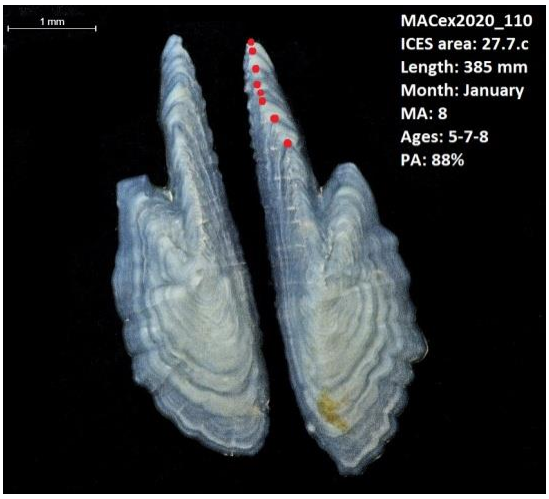
Age 4 – Semester 2

Age 5 – Semester 1

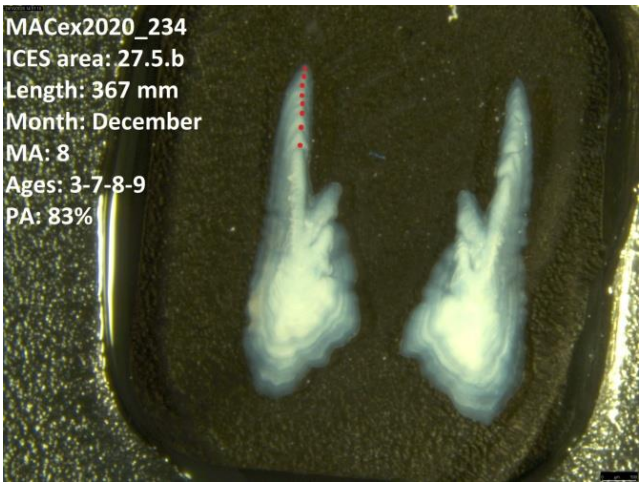


Age 6 – Semester 1

Age 8 – Semester 1

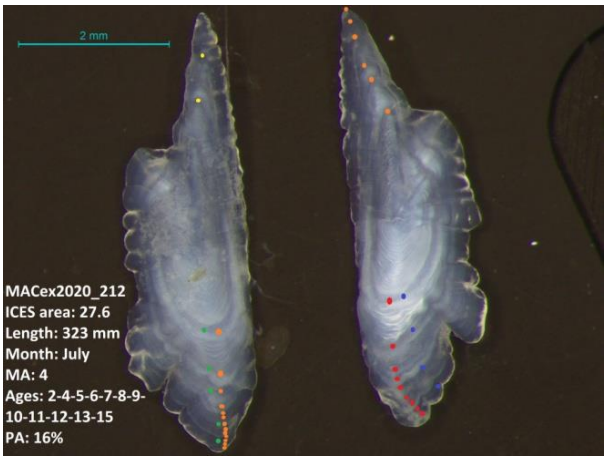


Age 8 – Semester 2

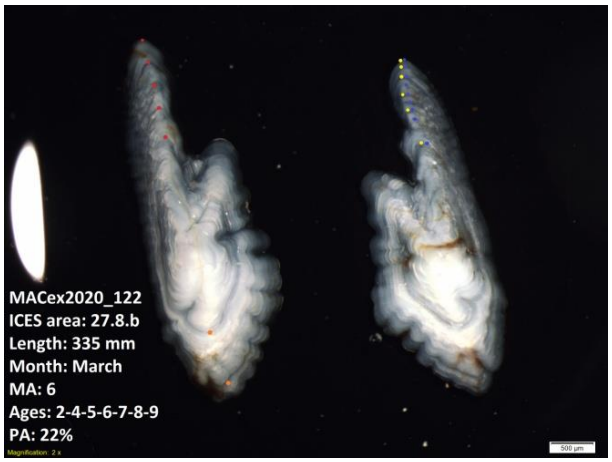


A.2.Relevant otoliths with low agreement.

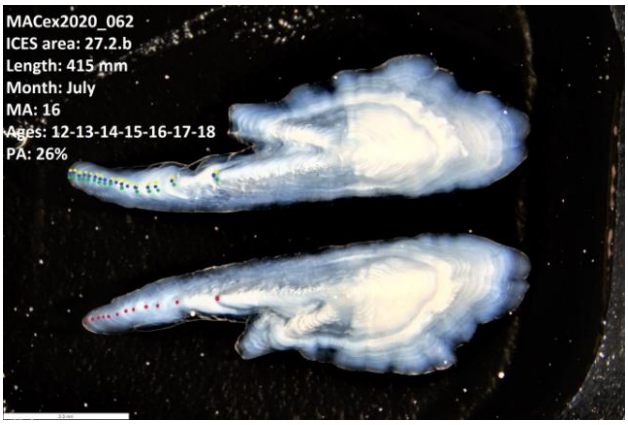
PA: 16%



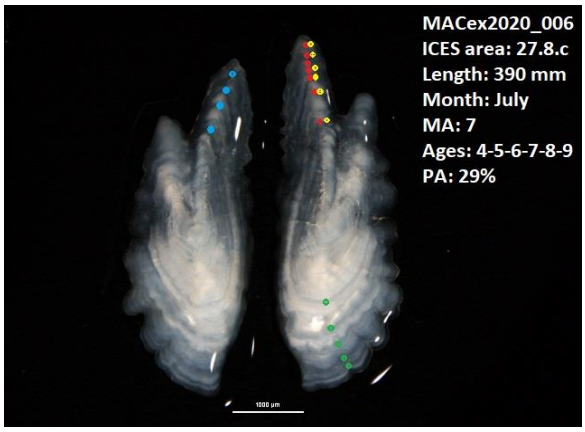
PA: 22%



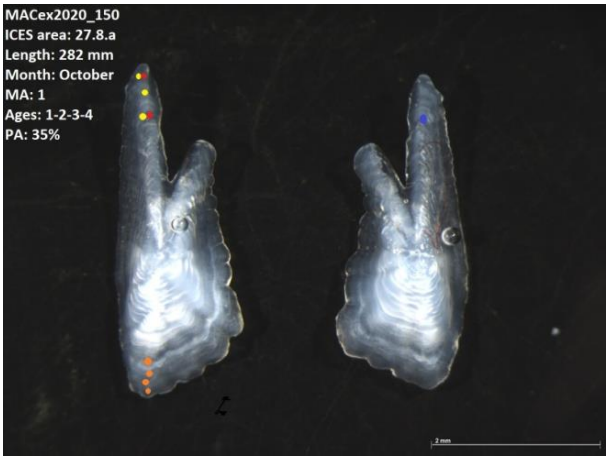
PA: 26%



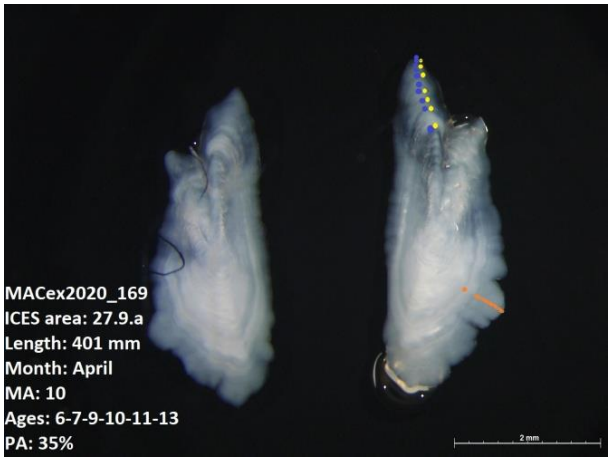
PA: 29%



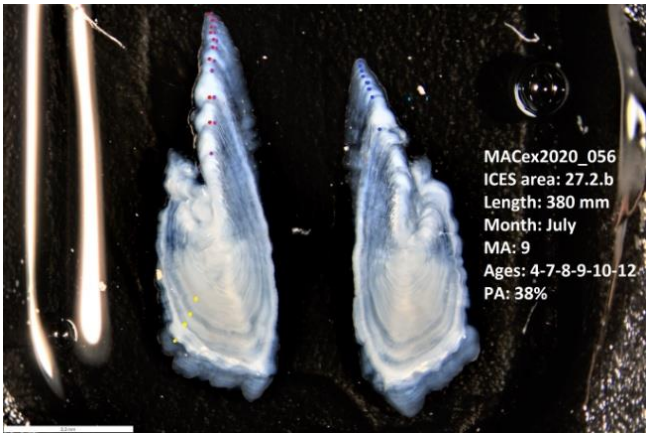
PA: 35%



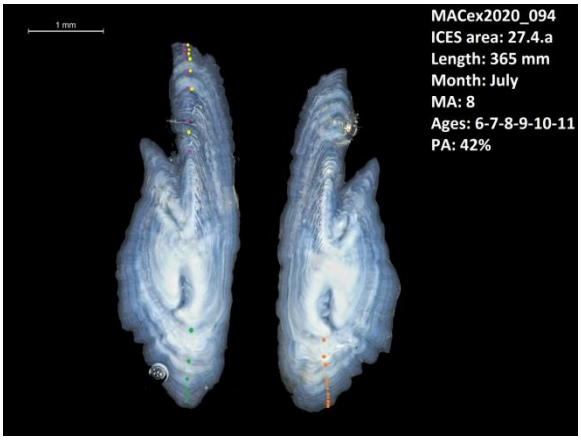
PA: 35%



PA: 38%


MACex2020_056
ICES area: 27.2.b
Length: 380 mm
Month: July
MA: 9
Ages: 4-7-8-9-10-12
PA: 38%

PA: 42%


1 mm
MACex2020_094
ICES area: 27.4.a
Length: 365 mm
Month: July
MA: 8
Ages: 6-7-8-9-10-11
PA: 42%