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Report of the Age Calibration Exercise Analysis for Anchovy in Division 9a (IBERAS survey 2018) - IEO-IPMA Readers

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1. Introduction

In November 2018, a new acoustic survey (IBERAS) coordinated by IEO and IPMA was carried out in order to estimate the strength of sardine and anchovy recruitment in the Atlantic waters of the Iberian Peninsula (ICES Division 9a) and to map its distribution area. As well as determine the main biological characteristics of these species in the area.

In January-February 2019, an otolith reading exercise was carried out on the anchovy from the survey to determine its age, with the objective of calibrating the age readings among the anchovy readers of the IEO and the IPMA, and estimating the accuracy and discrepancies in the determination of anchovy age among these readers. As well as, to obtain the age length keys of the survey.

2. Participants

A total of 3 readers were involved in the present Calibration, two of them from IEO (Spain) and the third from IPMA (IPMA).

The two readers of the IEO are experts in determining the age of the anchovy, but only one of them is an advanced reader (Advanced being those who provide age data for assessment purposes). The IPMA reader's experience in determining the age of the anchovy is intermediate, and he is also an advanced reader. In IPMA there are two new anchovy readers who have not participated in this calibration, since they still need a period of training, and for this a workshop will be included in May 2019 in the CO of Santander. The three readers participated in the last International Exchange of 2018, but nevertheless the reader of the IPMA did not participate in the last workshop of 2016 (ICES WKARA2), where the current criteria for determining the age of the anchovy were standardized and implemented. A list of the participants with a summary about their experience in age estimation of anchovy and the area where they are readers is shown in the **Table 2.1**.

3. Material and Methods

A set the 334 otoliths of anchovy distributed in Atlantic waters of Iberian Peninsula (ICES Division 9a) from the IBERAS 2018 survey were reading and analyzed (**Tabla 3.1**)

Tabla 3.1. Overview of samples used of Anchovy calibration

Division 9a	Number of Otoliths	Size range	Month
Central-South (9a-CS)	30	100-162 mm	November
Central North (9a-CN)	304	107-183 mm	November
Whole area	334	100-183 mm	November

For the analysis of the results, AGE COMPARISON excel workbook (Eltink, 2000) has been used and the analysis has been made for the whole area, since the number of otoliths in the Subdivision 9a CS was very small.

Table 2.1. Participants and qualification of readers.

**Advanced being those who provide age data for assessment purposes and basic if they do not*

Country	Participants in this calibration 2019 (preliminary list, contact person in bold)	Email	Age reading expertise: Trainee / Intermediate / Expert	Reads for assessment (Yes/No)	Level of expertise in Smartdots (Advanced/ Basic)*	Anchovy Stock/Area of Expertise	Participation in Workshop 2016 (Yes/No)	Participation in Exchange 2018 (Yes/No)	Final Paticipation in this Calibration and reader code
Spain-IEO	**Begoña Villamor**	begona.villamor@ieo.es	Coordinator	Yes	Advanced	Bay of Biscay (Subarea 8) and Sub-Division 9a North	Yes (Co-chair)	Yes (coordinator)	Yes (coordinator)
	Clara Dueñas	clara.duenas@ieo.es	Expert	Yes	Advanced		Yes	Yes	Yes- R01 (CD)
	Ana Antolinez	ana.antolinez@ieo.es	Expert	No	Basic		Yes	Yes	Yes- R03 (AA)
Portugal - IPMA	**Eduardo Soares**	esoares@ipma.pt	Intermediate	yes	Advanced	Portuguese Coast (Sub-Divs. IXa CN, CS and S)	No	Yes	Yes- R02 (ES)
	Raquel Milhazes	rmilhazes@ipma.pt	Trainee	No	Basic		No	Yes	No
	Diana Feijó	dfeijo@ipma.pt	Trainee	No	Basic		No	Yes	No

4. Results

Analyses were performed for the total area. Overall age reading results for each otolith and reader are shown in **Annex 1**. From the total of 334 otoliths of anchovy two readers analyzed 332 otoliths and one reader analyzed 318.

The weighted average percentage agreement (PA) based on modal ages for all readers and samples are 93.4 %, with the weighted average CV of 8.4 % (**Table 4.1**). Most of the anchovy otoliths were well classified by the readers during the 2019 calibration, with a good agreement and precision. 267 out of the 334 otoliths reached 100% of agreement

Table 4.1 shows the PA, CV and Bias by age. The best agreements are reached for age 0 (91%) and age 1 (95.8%), and the lowest agreement for age 2 (75%). No individuals over 2 years of age were assigned in the sample.

The analysis including all age readers revealed a low coefficient of variation (CV) of 8.4% (**Table 4.1**). Lowest CVs were revealed for modal age group 1 (5.9%). CV peaked at 25.8% for modal age 2 (the CV was not calculated at age 0) and it shows a negative bias in age 2, which means that some readers assign younger ages.

Table 4.1. Summary of the average percentage of agreement (PA), Coefficient of variation (CV) and relative bias by age.

Modal Age	Otolith N	CV	% Agreement	Bias
0	70		91.9%	0.08
1	236	5.9%	95.8%	0.03
2	26	25.8%	75.0%	-0.25
3		-	-	-
4		-	-	-
5		-	-	-
Total	**332**	**8.4%**	**93.4%**	**0.02**

Figure 4.1 shows age bias plots for each reader. Some deviations from the modal age (solid line) can be seen in the Reader 2 for the age 2.

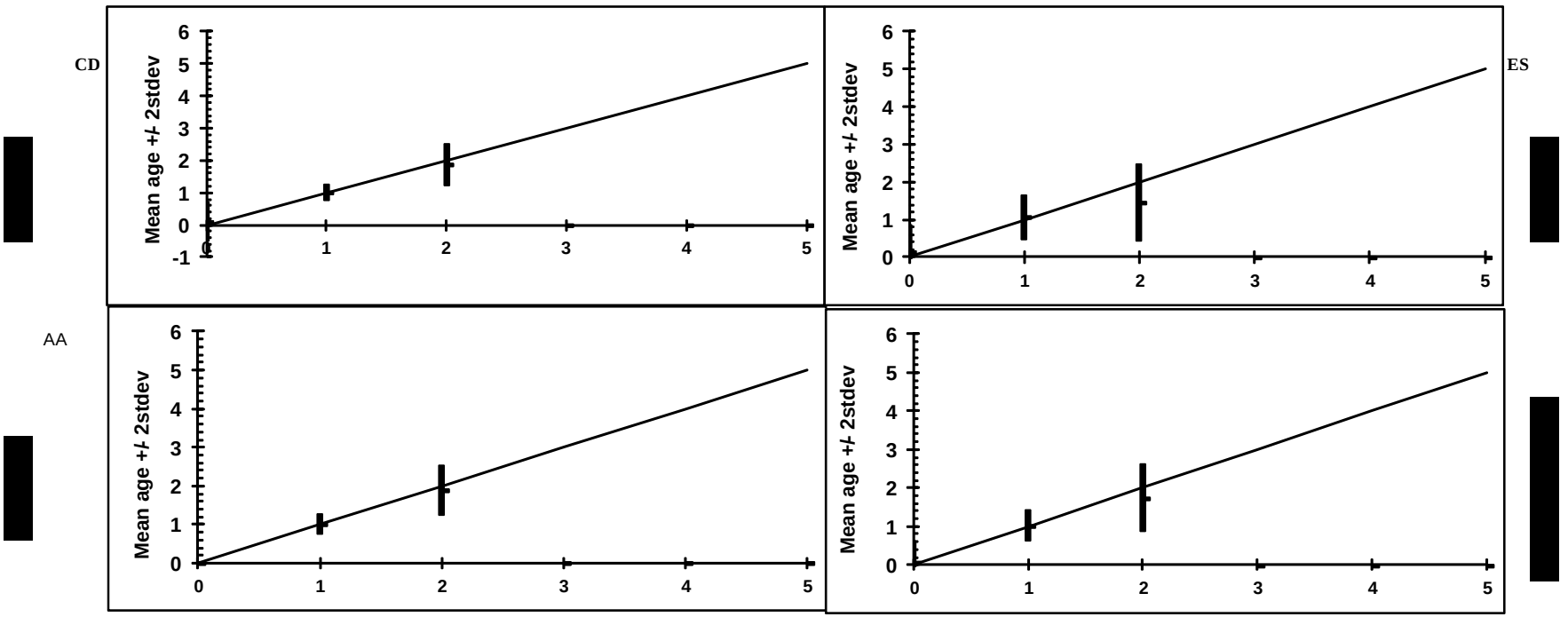

Figure 4.1. Age bias plot for each reader and all readers. Mean age recorded +/- 2 stdev of each reader and all readers combined are plotted against modal age by group. The estimated mean age corresponds to modal age when the estimated mean age is on the 1:1 equilibrium line (solid line). Relative bias is the age difference between estimated mean age and modal age.

The agreement of each reader with the modal age is higher than 86%, reaching the reader 3 (AA) to the highest agreement with the modal age (97.6%). Among readers, the advanced readers (CD and ES) have an agreement between them of 81%, and the reader 3 (AA) has an agreement of 94% with the reader of the same laboratory (CD) and drops to 84% with the Advanced reader of Portugal (ES). Another fact is that there are no signal biases of each reader with the modal age and neither between them, which means that they have a good precision in the determination of the age of the anchovy in the studied area (**Table 4.2**).

Table 4.2. Inter-reader bias test and reader against modal age bias test. Advanced readers in red color: Advanced being those who provide age data for assessment purposes.

	CD	ES	AA
	Reader 1	**Reader 2**	**Reader 3**
Reader 1	**95.8**	-	-
Reader 2	**81.8**	**86.2**	-
Reader 3	**94.0**	**84.3**	**97.9**
MODAL age	-	-	-

-	**= no sign of bias (p>0.05)**
*	**= possibility of bias (0.01<p<0.05)**
* *	**= certainty of bias (p<0.01)**
	= percentage of reading agreement between each reader and the MODAL age

Individual otolith cases of disagreement and their examination is shown in **Annex 2**. This Annex show images of otoliths resulting in divergent annotations/interpretations. In **Annex 3** of this report the synoptic table from WKARA2 has been added to facilitate the understanding of the anchovy growth pattern.

5. Conclusions

- In general, it can be said that in view of the results (high agreements, low CV and without biases) of this Calibration the three readers apply well the current age determination criteria updated in the last workshop of the anchovy age (ICES WKARA2, 2016).

- Taking as reference the Bay of Biscay anchovy where several workshops and exchanges have regularly taken place (since 1989) (and age validations are achieved), WKARA2 suggested threshold values of agreements around 80% and of CVs around 20% in the training process as a minimum for age readers to be operative to deliver inputs for assessment. And targets should be for agreements above 90% and CV of 10% or less. The results of this Calibration among of these readers are in the levels of the objectives of agreement and CV suggested by WKARA2.
- The three readers have achieved higher agreements and lower CVs in this Calibration than in the last International Exchange of anchovy in the Bay of Biscay in 2018 (Villamor et al., 2019), especially noted the improvement of the IPMA reader. In 2018 Exchange, the two readers of the IEO had a PA above 90% (91 and 92% respectively with the modal age) and a CV of 15% and the IPMA reader had a PA of 76% and CV 21%.
- If we compare this Calibration with the results of the 2014 international exchange of the anchovy from the same area (Division 9a), we see that the improvement is great for the three readers (in 2014, PA between 45 and 71% and CV between 34 and 37% with respect to modal age) (Villamor et al., 2015).
- The biggest discrepancies found in this Calibration were in age 2. This is mainly due to the fact that in some cases the false spawn ring that deposits the anchovy in summer is confused with the annual winter ring (See **Annex 2**).
- The greatest agreements in this Calibration were found between the IEO readers (CD and AA), and this is logical since they are from the same laboratory, and therefore they present a good consistency in their readings.
- It is recommended to continue and follow the protocols and criteria for the interpretation of anchovy age in all areas proposed in WKARA-2.
- We recommend the readers to review and read the WKARA2 report (where there are many examples) and to review the collection of otoliths of reference which is in the Age Readerôs Forum website (https://community.ices.dk/ExternalSites/arf/default.aspx) in the folder called ôEngraulis encrasicolus Otolith Reference Collectionô.

- In WKARA2 after discussing and recognizing the reasons for the discrepancies, the following conclusions were reached for the interpretation of an otolith of anchovy:

- Try not to look at the size of the fish: see the structure of the otolith and growth pattern;

- Next try to interpret the otolith: What winter hyaline rings can be recognized resulting in a coherent growth pattern? How much has the edge grown throughout the year until its capture? Do the resulting annual growth pattern and edge formation match with known pattern of otolith growth and seasonality of edge formation by ages respectively?

- If a coherent interpretation is achieved then apply the age allocation rule corresponding to the adopted birthdates for the population (in our case first of January), if not try another interpretation or discard the otolith.

- For the application of the ageing rules, it is compulsory to use the number of winter translucent rings recognized (after interpretation), rather than the total number of hyaline marks seen (which may include some checks).

6. References

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7. Annex 1. Additional results

Table 1 Anchovy Otolith 9a (Campaña IBERAS 2018

Stratum	Sample year	Sample no	h SmartD no	Fish length	Sex	Landing month	CD Reader 1	ES Reader 2	AA Reader 3	RANGE r. 1-5 MODAL age	Percent agreement	Precision CV
ocs	06/11/2018	AP.10	1	10.0		11	0	0	0	0	100%	
ocs	06/11/2018	AP.10	2	10.1		11	0	0	0	0	100%	
ocs	06/11/2018	AP.10	3	10.1		11	0	0	0	0	100%	
ocs	06/11/2018	AP.10	4	10.1		11	0	0	0	0	100%	
ocs	06/11/2018	AP.10	5	10.6		11	0	0	0	0	100%	
ocs	06/11/2018	AP.10	6	10.5		11	0	0	0	0	100%	
ocs	06/11/2018	AP.10	7	10.6		11	0	0	0	0	100%	
ocs	06/11/2018	AP.10	8	11.3		11	1	0	1	1	67%	87%
ocs	06/11/2018	AP.10	9	11.4		11	0	1	0	0	67%	
ocs	06/11/2018	AP.10	10	11.3		11	0	1	0	0	67%	
ocs	06/11/2018	AP.10	11	11.8		11	1	1	1	1	100%	0%
ocs	06/11/2018	AP.10	12	11.9		11	0	0	0	0	100%	
ocs	06/11/2018	AP.10	13	11.9		11	0	1	0	0	67%	
ocs	06/11/2018	AP.10	14	11.5		11	1	1	1	1	100%	0%
ocs	06/11/2018	AP.10	15	11.5		11	0	1	0	0	67%	
ocs	06/11/2018	AP.10	16	11.7		11	0	1	0	0	67%	
ocs	06/11/2018	AP.10	17	11.7		11	0	1	0	0	67%	
ocs	06/11/2018	AP.10	18	11.8		11	0	1	0	0	67%	
ocs	06/11/2018	AP.10	19	12.2		11	1	1	1	1	100%	0%
ocs	06/11/2018	AP.10	20	12.1		11	0	1	0	0	67%	
ocs	06/11/2018	AP.10	21	12.2		11	0	1	0	0	67%	
ocs	06/11/2018	AP.10	22	12.3		11	0	0	0	0	100%	0%
ocs	06/11/2018	AP.10	23	12.4		11	1	1	1	1	100%	0%
ocs	06/11/2018	AP.10	24	12.2		11	1	1	1	1	100%	0%
ocs	06/11/2018	AP.10	25	12.6		11	1	0	1	1	67%	87%
ocs	06/11/2018	AP.10	26	12.8		11	1	1	1	1	100%	0%
ocs	06/11/2018	AP.10	27	13.0		11	1	1	1	1	100%	0%
ocs	06/11/2018	AP.10	28	15.2		11	1	2	1	1	67%	43%
ocs	06/11/2018	AP.10	29	16.2		11	1	1	1	1	100%	0%
ocs	06/11/2018	AP.10	30	16.2		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	1	12.4		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	2	11.9		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	3	12.6		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	4	12.9		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	5	13.9		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	6	13.9		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	7	13.8		11	1	2	1	1	67%	43%
ocn	14/11/2018	AP.14	8	13.3		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	9	14.1		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	10	14.4		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	11	14.2		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	12	14.3		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	13	14.2		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	14	14.3		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	15	13.4		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	16	13.5		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	17	13.8		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	18	14.0		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	19	14.8		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	20	14.6		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	21	14.9		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	22	14.9		11	1	1	1	1	100%	0%
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ocn	14/11/2018	AP.14	25	14.5		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	26	14.6		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	27	14.7		11	1	1	2	1	67%	43%
ocn	14/11/2018	AP.14	28	14.9		11	2	1	2	2	67%	35%
ocn	14/11/2018	AP.14	29	15.7		11	2	1	2	2	67%	35%
ocn	14/11/2018	AP.14	30	15.6		11	2	1	1	1	67%	43%
ocn	14/11/2018	AP.14	31	15.9		11	2	1	2	2	67%	35%
ocn	14/11/2018	AP.14	32	15.0		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	33	15.2		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	34	15.3		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	35	15.4		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	36	14.4		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	37	15.9		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	38	15.7		11	2	1	2	2	67%	35%
ocn	14/11/2018	AP.14	39	15.8		11	2	1	2	2	67%	35%
ocn	14/11/2018	AP.14	40	15.9		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	41	15.3		11	2	1	1	1	67%	43%
ocn	14/11/2018	AP.14	42	15.4		11	2	1	2	2	67%	35%

ocn	14/11/2018	AP.14	43	15.1		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	44	15.5		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	45	15.3		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	46	16.0		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	47	16.0		11	1	1	2	1	67%	43%
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ocn	14/11/2018	AP.14	50	16.6		11	1	1	2	1	67%	43%
ocn	14/11/2018	AP.14	51	16.8		11	2	1	2	2	67%	35%
ocn	14/11/2018	AP.14	52	17.0		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.14	53	17.6		11	2	1	2	2	67%	35%
ocn	14/11/2018	AP.14	54	18.2		11	1	1	1	1	100%	0%
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ocn	14/11/2018	AP.15	3	11.3		11	1	1	1	1	100%	0%
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ocn	14/11/2018	AP.15	31	13.7		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.15	32	13.8		11	1	-	1	1	100%	0%
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ocn	14/11/2018	AP.15	34	14.1		11	1	-	1	1	100%	0%
ocn	14/11/2018	AP.15	35	14.2		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.15	36	14.0		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.15	37	14.2		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.15	38	14.1		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.15	39	14.9		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.15	40	14.8		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.15	41	14.7		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.15	42	14.8		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.15	43	14.7		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.15	44	15.0		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.15	45	15.2		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.15	46	15.5		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.15	47	15.6		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.15	48	15.5		11	2	1	2	2	67%	35%
ocn	14/11/2018	AP.15	49	16.8		11	2	-	1	2	50%	47%
ocn	14/11/2018	AP.15	50	17.6		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	1	14.3		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	2	14.4		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	3	14.9		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	4	14.8		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	5	14.5		11	2	2	1	2	67%	35%
ocn	14/11/2018	AP.16	6	14.9		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	7	14.8		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	8	14.8		11	2	1	2	2	67%	35%
ocn	14/11/2018	AP.16	9	14.9		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	10	14.9		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	11	14.9		11	2	1	2	2	67%	35%
ocn	14/11/2018	AP.16	12	14.8		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	13	14.9		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	14	14.9		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	15	15.3		11	2	2	2	2	100%	0%
ocn	14/11/2018	AP.16	16	15.3		11	1	2	1	1	67%	43%
ocn	14/11/2018	AP.16	17	15.4		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	18	15.4		11	1	2	1	1	67%	43%
ocn	14/11/2018	AP.16	19	15.3		11	1	2	1	1	67%	43%
ocn	14/11/2018	AP.16	20	15.2		11	1	2	1	1	67%	43%
ocn	14/11/2018	AP.16	21	15.3		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	22	15.3		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	23	15.8		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	24	15.9		11	2	2	2	2	100%	0%
ocn	14/11/2018	AP.16	25	15.6		11	1	2	2	2	67%	35%
ocn	14/11/2018	AP.16	26	15.6		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	27	16.1		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	28	16.3		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	29	16.2		11	1	2	1	1	67%	43%
ocn	14/11/2018	AP.16	30	16.2		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	31	16.3		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	32	16.3		11	2	2	2	2	100%	0%
ocn	14/11/2018	AP.16	33	16.1		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	34	16.5		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	35	16.9		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	36	16.5		11	1	1	1	1	100%	0%

ocn	14/11/2018	AP.16	37	16.6		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	38	16.6		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	39	16.7		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	40	16.5		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	41	16.6		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	42	16.5		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	43	17.1		11	1	2	1	1	67%	43%
ocn	14/11/2018	AP.16	44	17.0		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	45	17.1		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	46	17.5		11	2	2	1	2	67%	35%
ocn	14/11/2018	AP.16	47	17.8		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	48	17.6		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	49	17.7		11	1	1	1	1	100%	0%
ocn	14/11/2018	AP.16	50	18.1		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	1	12.3		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	2	12.3		11	1	-	1	1	100%	0%
ocn	15/11/2018	AP.17	3	12.6		11	1	2	1	1	67%	43%
ocn	15/11/2018	AP.17	4	12.9		11	1	2	1	1	67%	43%
ocn	15/11/2018	AP.17	5	13.3		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	6	13.2		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	7	13.4		11	1	2	2	2	67%	35%
ocn	15/11/2018	AP.17	8	13.0		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	9	13.0		11	1	-	1	1	100%	0%
ocn	15/11/2018	AP.17	10	13.8		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	11	13.6		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	12	13.9		11	1	-	1	1	100%	0%
ocn	15/11/2018	AP.17	13	13.6		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	14	14.0		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	15	14.0		11	1	2	1	1	67%	43%
ocn	15/11/2018	AP.17	16	14.1		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	17	14.3		11	1	-	1	1	100%	0%
ocn	15/11/2018	AP.17	18	14.1		11	1	2	1	1	67%	43%
ocn	15/11/2018	AP.17	19	14.3		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	20	14.1		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	21	14.0		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	22	14.1		11	1	2	1	1	67%	43%
ocn	15/11/2018	AP.17	23	14.9		11	1	2	1	1	67%	43%
ocn	15/11/2018	AP.17	24	14.6		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	25	14.9		11	1	-	1	1	100%	0%
ocn	15/11/2018	AP.17	26	14.7		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	27	14.8		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	28	14.6		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	29	14.7		11	2	2	2	2	100%	0%
ocn	15/11/2018	AP.17	30	14.9		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	31	14.6		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	32	14.6		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	33	14.7		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	34	15.0		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	35	15.2		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	36	15.2		11	1	2	1	1	67%	43%
ocn	15/11/2018	AP.17	37	15.5		11	1	2	1	1	67%	43%
ocn	15/11/2018	AP.17	38	15.2		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	39	15.1		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	40	15.6		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	41	15.5		11	2	2	2	2	100%	0%
ocn	15/11/2018	AP.17	42	15.6		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	43	15.7		11	1	2	1	1	67%	43%
ocn	15/11/2018	AP.17	44	16.2		11	1	-	1	1	100%	0%
ocn	15/11/2018	AP.17	45	16.2		11	1	-	1	1	100%	0%
ocn	15/11/2018	AP.17	46	16.3		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	47	16.7		11	1	2	1	1	67%	43%
ocn	15/11/2018	AP.17	48	16.7		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	49	16.7		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.17	50	16.8		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	1	12.7		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	2	12.6		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	3	13.1		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	4	13.2		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	5	13.3		11	0	0	0	0	100%	
ocn	15/11/2018	AP.18	6	13.2		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	7	13.9		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	8	13.8		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	9	13.8		11	0	0	0	0	100%	
ocn	15/11/2018	AP.18	10	13.7		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	11	13.6		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	12	14.2		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	13	14.4		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	14	14.3		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	15	14.1		11	1	-	1	1	100%	0%
ocn	15/11/2018	AP.18	16	14.2		11	1	1	1	1	100%	0%

ocn	15/11/2018	AP.18	17	14.3		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	18	14.3		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	19	14.3		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	20	14.8		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	21	14.6		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	22	14.8		11	1	2	1	1	67%	43%
ocn	15/11/2018	AP.18	23	14.5		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	24	14.7		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	25	14.7		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	26	14.6		11	1	-	1	1	100%	0%
ocn	15/11/2018	AP.18	27	14.5		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	28	14.6		11	2	-	2	2	100%	0%
ocn	15/11/2018	AP.18	29	14.5		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	30	15.0		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	31	15.1		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	32	15.3		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	33	15.2		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	34	15.3		11	2	2	2	2	100%	0%
ocn	15/11/2018	AP.18	35	15.7		11	2	1	2	2	67%	35%
ocn	15/11/2018	AP.18	36	15.6		11	1	2	2	2	67%	35%
ocn	15/11/2018	AP.18	37	15.7		11	1	-	1	1	100%	0%
ocn	15/11/2018	AP.18	38	15.9		11	-	-	-			
ocn	15/11/2018	AP.18	39	15.7		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	40	15.7		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	41	16.2		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	42	16.3		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	43	16.4		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	44	16.1		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	45	16.8		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	46	16.9		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	47	16.7		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	48	17.4		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	49	17.9		11	1	1	1	1	100%	0%
ocn	15/11/2018	AP.18	50	18.3		11	2	1	1	1	67%	43%
ocn	16/11/2018	AP.20	1	10.8		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	2	10.7		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	3	10.9		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	4	10.8		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	5	10.9		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	6	10.8		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	7	11.2		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	8	11.4		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	9	11.1		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	10	11.0		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	11	11.4		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	12	11.3		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	13	11.2		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	14	11.3		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	15	11.3		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	16	11.2		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	17	11.4		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	18	11.4		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	19	11.2		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	20	11.3		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	21	11.4		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	22	11.2		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	23	11.7		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	24	11.8		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	25	11.9		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	26	11.7		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	27	11.7		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	28	11.9		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	29	11.6		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	30	11.7		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	31	11.6		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	32	11.9		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	33	11.6		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	34	11.7		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	35	12.3		11	1	0	0	0	67%	
ocn	16/11/2018	AP.20	36	12.4		11	1	0	0	0	67%	
ocn	16/11/2018	AP.20	37	12.2		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	38	12.4		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	39	12.2		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	40	12.3		11	1	0	0	0	67%	
ocn	16/11/2018	AP.20	41	12.2		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	42	12.4		11	1	0	0	0	67%	
ocn	16/11/2018	AP.20	43	12.3		11	1	0	0	0	67%	
ocn	16/11/2018	AP.20	44	12.4		11	1	0	0	0	67%	
ocn	16/11/2018	AP.20	45	12.3		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	46	12.3		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	47	12.1		11	0	0	0	0	100%	
ocn	16/11/2018	AP.20	48	12.7		11	1	0	0	0	67%	
ocn	16/11/2018	AP.20	49	12.8		11	1	1	0	1	67%	87%
ocn	16/11/2018	AP.20	50	13.8		11	0	0	0	0	100%	
					Total read		332	318	332		**93.4%**	**8.4%**
					Total NOT read		0	14	0			

Table 7.2 Number of age readings table gives an overview of number of readings per reader and modal age. The total numbers of readings per reader and per modal age are summarized at the end of the table.

	MODAL	CD	ES	AA	
	age	Reader 1	Reader 2	Reader 3	TOTAL
	0	70	70	70	**210**
	1	236	224	236	**696**
	2	26	24	26	**76**
	3	-	-	-	**-**
	4	-	-	-	**-**
	5	-	-	-	**-**
Total	**0-15**	**332**	**318**	**332**	**982**

Table 7.3. Age composition by reader gives a summary of number of readings per reader

		CD	ES	AA	
	Age	Reader 1	Reader 2	Reader 3	TOTAL
	0	63	62	71	**196**
	1	242	226	235	**703**
	2	27	30	26	**83**
	3	-	-	-	**-**
	4	-	-	-	**-**
	5	-	-	-	**-**
Total	**0-15**	**332**	**318**	**332**	**982**

Table 7.4. Mean length at age per reader is calculated per reader and age (not modal age) and for all readers combined per age. A weighted mean is also given.

		CD	ES	AA	
	Age	Reader 1	Reader 2	Reader 3	ALL
	0	11.5	11.6	11.6	**11.6**
	1	14.5	14.6	14.6	**14.6**
	2	15.8	15.1	15.6	**15.5**
	3	-	-	-	**-**
	4	-	-	-	**-**
	5	-	-	-	**-**
Weighted mean	**0-15**	**14.1**	**14.0**	**14.1**	**14.1**

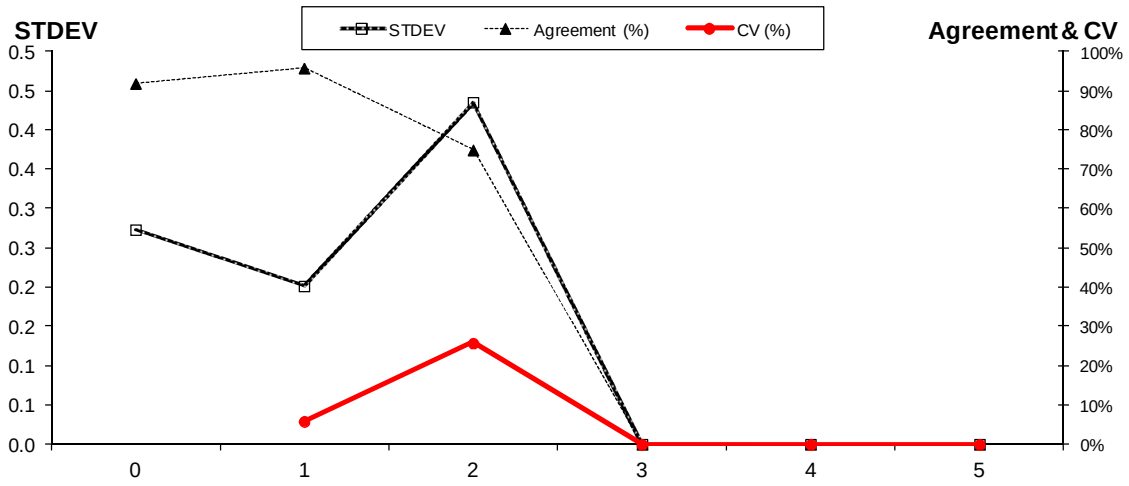


Figure 7.1. CV, PA and (STDEV (standard deviation) are plotted against modal age

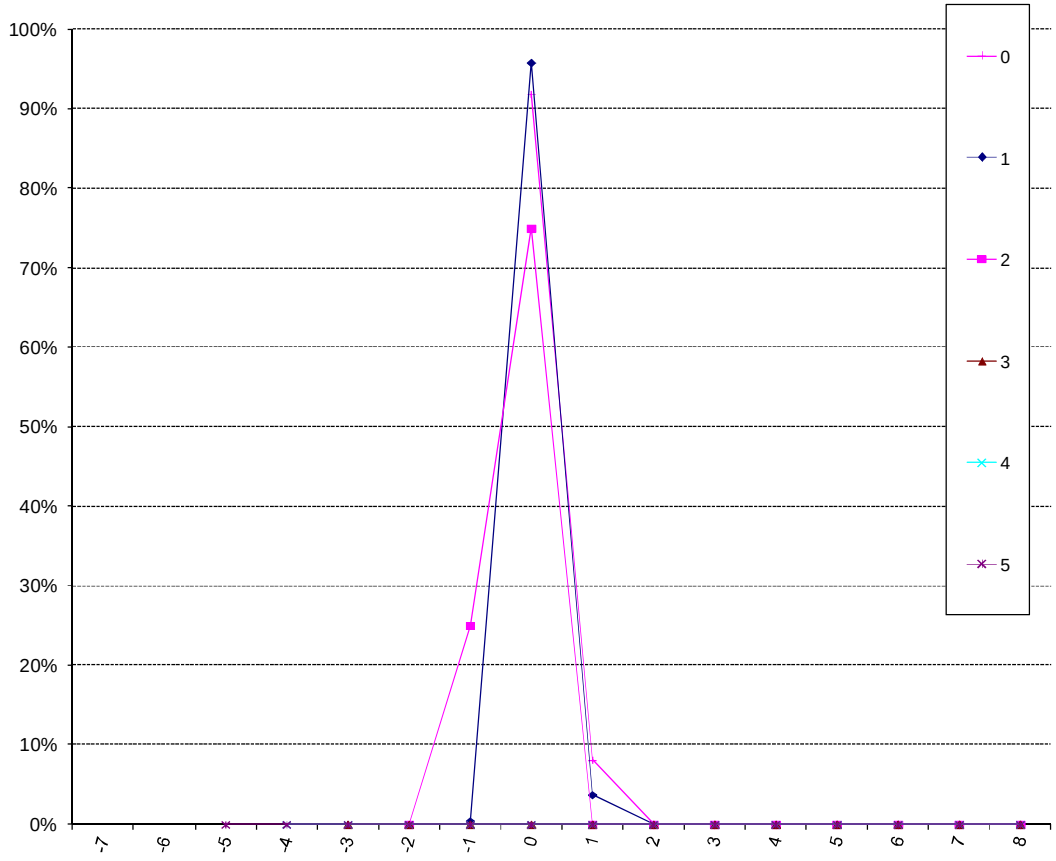


Figure 7.2. The distribution of the age reading errors in percentage by modal age as observed from the whole group of age readers in an age reading comparison to modal age. The achieved precision in age reading by MODAL age group is shown by the spread of the age readings errors. There appears to be no relative bias, if the age reading errors are normally distributed. The distributions are skewed, if relative bias occurs.

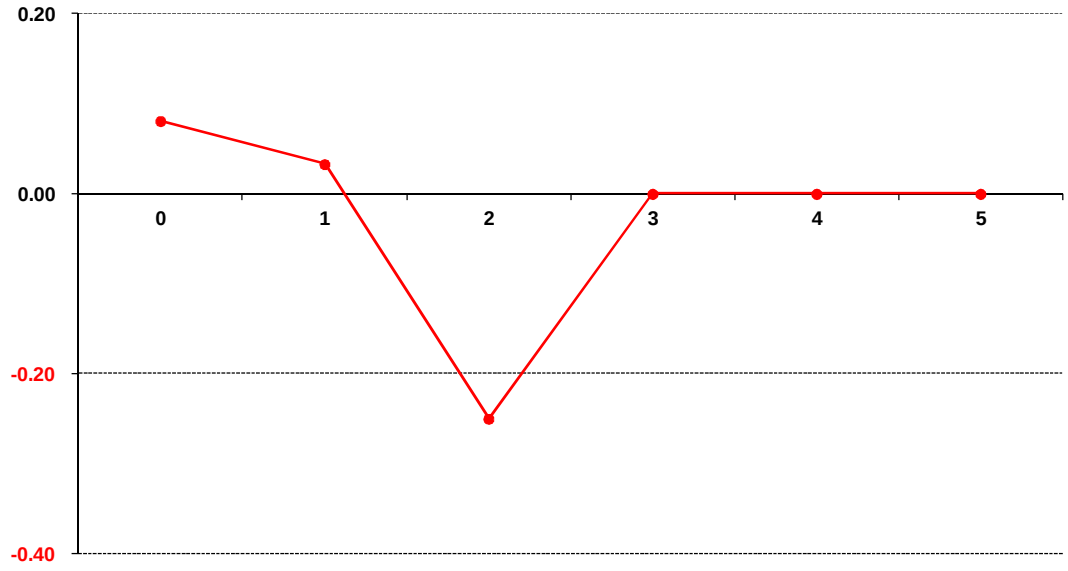


Figure 6.3. The relative bias by modal age as estimated by all age readers combined.

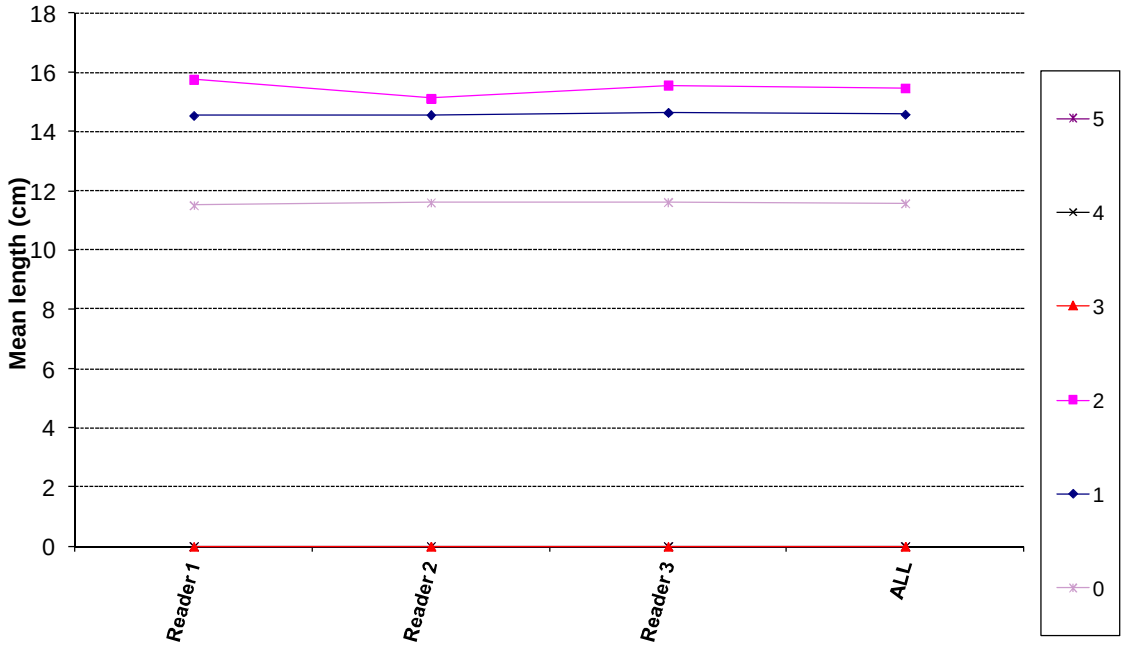


Figure 7.4: The mean length at age as estimated by each age reader.

8. Annex 2. Images of Anchovy (Division 9a-IBERAS survey))

Figure 8.1. Age Reading for anchovy AP.20 nº11, 11.4 cm; caught in November 2018. **100% agreement Age 0**. Conventional birthdates: 1st January. The marked ring is very close to the nucleus of the otolith, it cannot be considered a winter ring because it does not meet the expected rapid growth of the growth pattern in the first months of life. For what is considered a check (green circle) C05 since from the center to the ring there is a 50% of the growth that must be expected until forming its first winter ring.

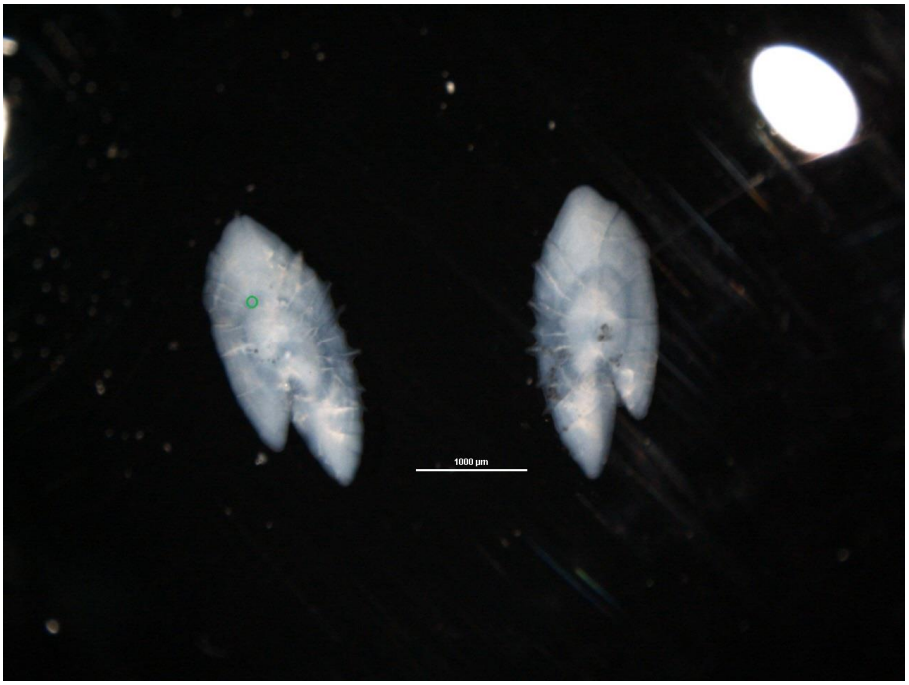


Figure 8.2. Age Reading for anchovy AP.20.nº 17, 11.4 cm; caught in November 2018. **100% agreement Age 0**. Conventional birthdates: 1st January. The ring marked is understood by all readers as a central check C08, that it is a false ring (green circle) deposited to 80% of the estimate from the center of the otolith until reaching its final estimated growth, where it would form the real winter ring (so age 0). There is no winter mark (all is growth during its first months of life).

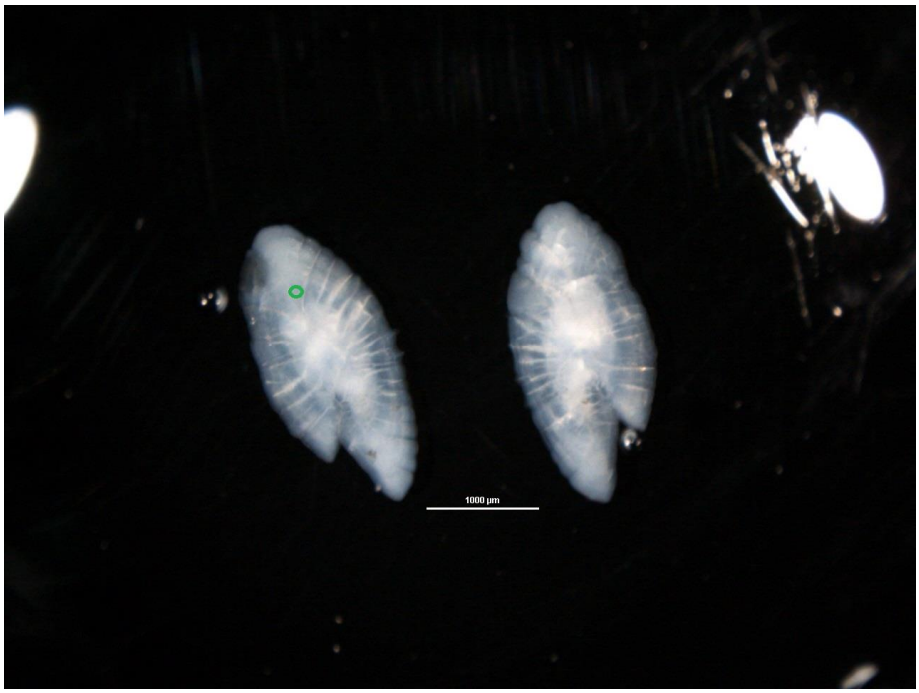


Figure 8.3. Age Reading for anchovy AP.10.nº18; 11.8 cm; caught in November 2018. **67% of agreement: Age 0 (IEO readers age 0; IPMA reader age 1)**. Conventional birthdates: 1st January. A fish that we estimate was born in the second quarter and that has been captured in the fourth and last quarter of that same year, we hope it has a final edge hyaline. The winter ring must be marked in a clear and continuous way around the nucleus of the otolith. The check marked as first winter mark is understood as a check (green circle) (C08) by most of the readers (so age 0).This otolith illustrates that a bad recognition of the typical growth pattern and of checks leads to over estimation of the actual age. There is no winter mark (all is growth during its first months of life)

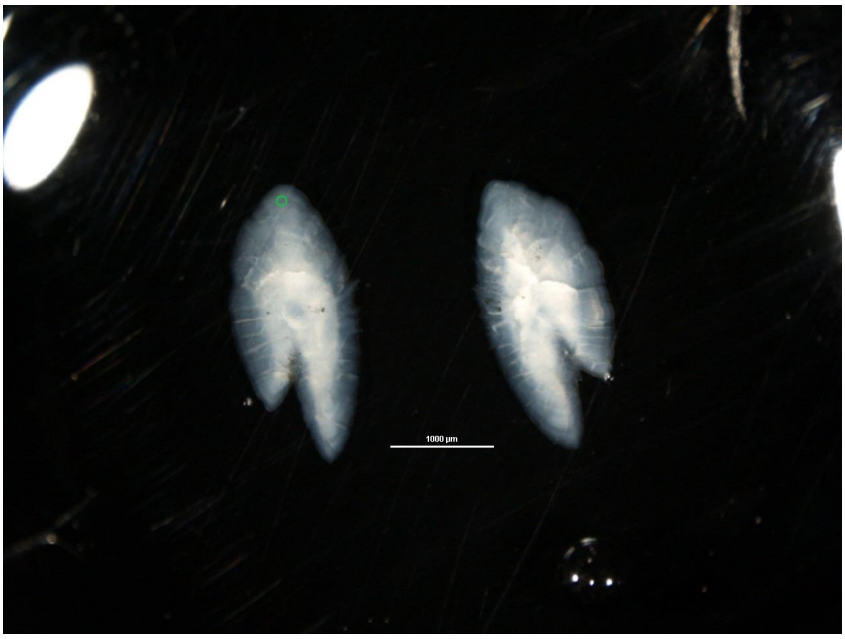


Figure 8.4. Age Reading for anchovy AP.10.nº 20; 12.1 cm; caught in November 2018. **67% agreement: Age 0 (IEO readers ages 0; IPMA reader age 1)**. Conventional birthdates: 1st January. In the rostrum of the otolith several faint rings are observed and one of them can see their outline from the nucleus, but it is not well marked nor does it have the great estimated growth that characterizes the first months of life, reason why it is considered a false central rings (green circles) by most of the readers (so age 0).This otolith illustrates that a bad recognition of the typical growth pattern and of

checks leads to over estimation of the actual age. There is no winter mark (all is growth during its first months of life)

Figure 8.5. Age Reading for anchovy AP20.nº 50; 13.8cm; caught in November 2018. **100% agreement: Age 0**. Conventional birthdates: 1st January A weak ring is intuited around the nucleus of the otolith that is little marked and presents small growth. It is considered a false central ring C08 by all readers (so age 0). There is no winter mark (all is growth during its first months of life).

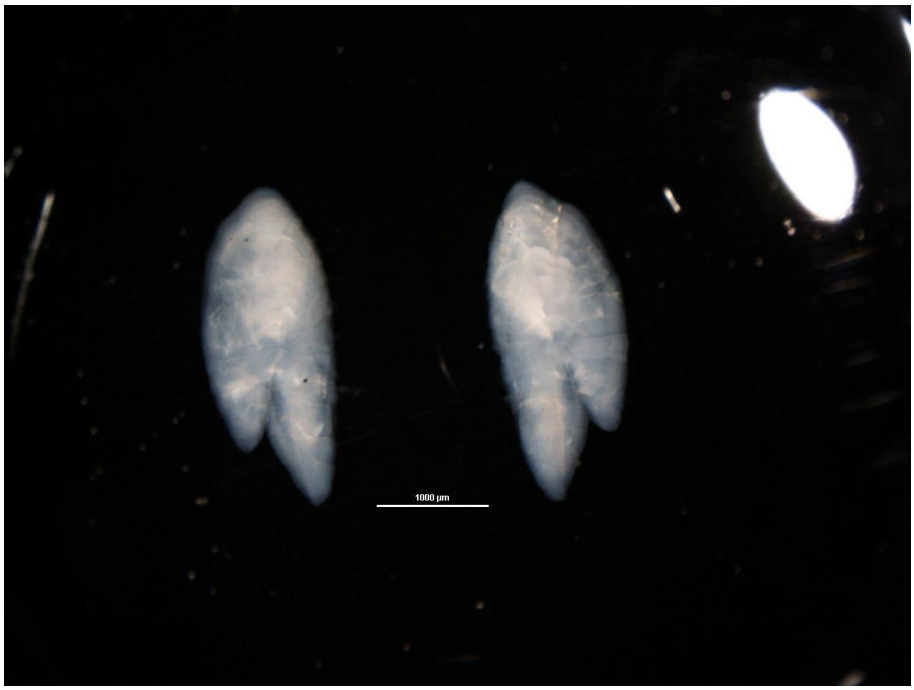


Figure 8. 6. Age reading for anchovy AP10. nº30; 16.2cm; caught in November 2018. **100% agreement: Age 1**. Conventional brithdates: 1st Junuary. The otolith shows the typical pattern for such age/season, with a strong marked first winter hyaline ring followed by an opaque band corresponding to the season's growth. Central ring mark can be identified as annual (winter) ring. A wide opaque band correspond the intense growth pattern expected during the second year of life ï as age 1. At the edge some hyaline edge formation seems to be occurring. In this case, no checks appear in the otolith; despite some spawning/summer checks could occur.

Figure 8.7. Age Reading for anchovy AP.15.nº 46; 15.5 cm; caught in November 2018. **100% agreement Age 1**. Conventional birthdates: 1st January. This otolith is very similar previous example. The otolith shows the typical pattern for such age/season, with a strong marked first winter hyaline ring followed by an opaque band corresponding to the season's growth. Central ring mark can be identified as annual (winter) ring. A wide opaque band correspond the intense growth pattern expected during the second year of life ï as age 1. At the edge some hyaline edge formation seems to be occurring. In this case, no checks appear in the otolith; despite some spawning/summer checks could occur.

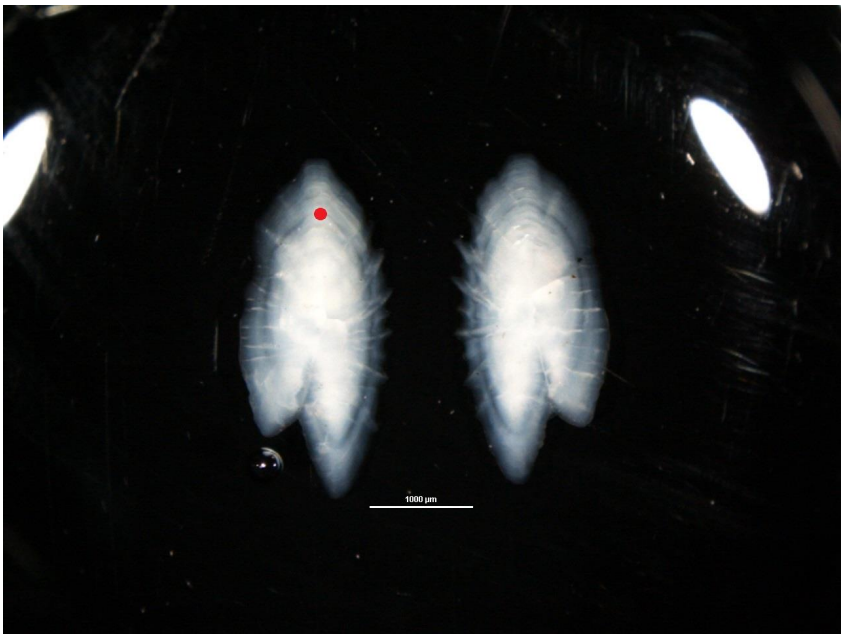


Figure 8.8. Age Reading for anchovy APE.15.no 27; 13.9 cm; caught in November 2018. **100% agreement Age 1**. Conventional birthdates: 1st January. Very similar to the previous example, the intense central ring mark can be identified as annual (winter) ring. A wide opaque band correspond the

intense growth pattern expected during the second year of life ï as age 1. Around the nucleus weak concentric rings are intuited that would be central checks. At the edge some hyaline edge formation seems to be occurring.

Figure 8.9. Age Reading for anchovy AP.17.nº 36; 15.2 cm; caught in November 2018. **67% agreement Age 1. (IEO readers ages 1; IPMA reader age 2)**. Conventional birthdates: 1st January. Rings marked on the rostrum and anti-rostrum. Of the 1st winter annual ring (red point) to the edge, there is one almost equidistant strong hyaline ring (green circle) which might be a spawning check (C18) or a true winter ring (then it would show an atypical growth pattern). Difficulties in distinguishing between C18 or second winter ring because of the strong hyaline mark.

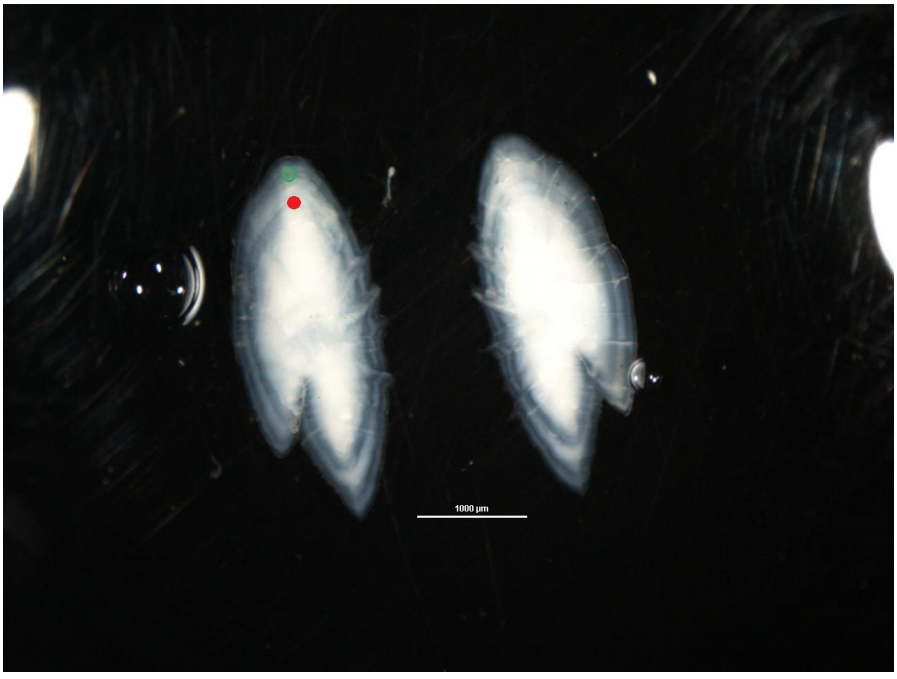


Figure 8.10. Age Reading for anchovy AP.17.nº 22, 14.1 cm, caught November 2018. **67% agreement: Age 1 (IEO readers ages 1; IPMA reader age 2)**. Conventional birthdates: 1st January. This otolith is a similar to the previous example and in addition with a weak central mark taken as check C08. This otolith illustrates that a bad recognition of the typical growth pattern and of checks leads to over estimation of the actual age (resulting in that case in a less intense growth pattern than expected in particular during the second year of life ï as age 1)

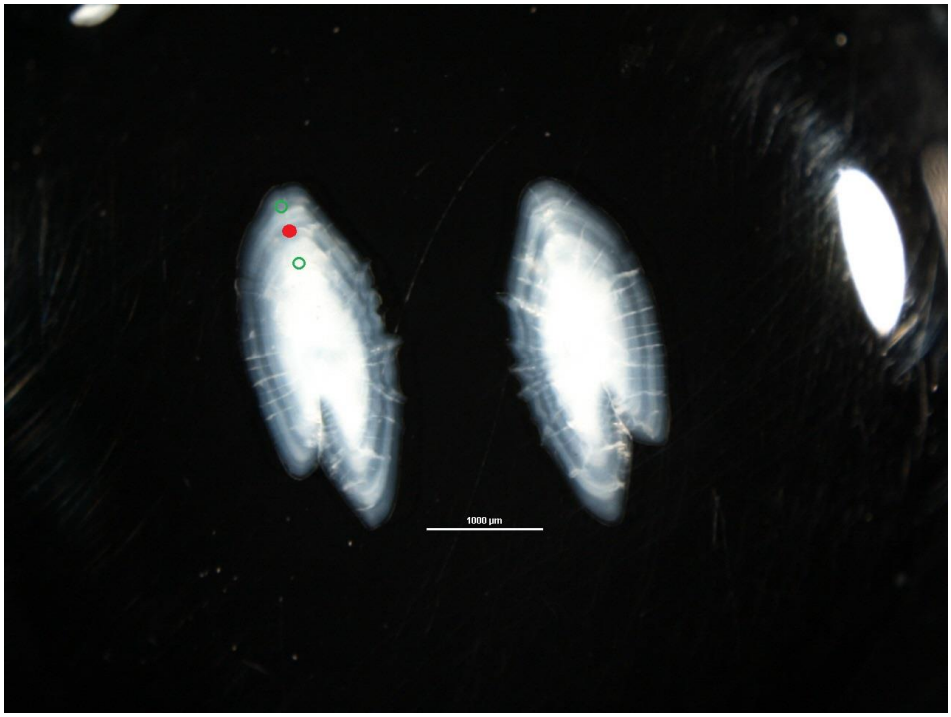


Figure 8. 11. Age Reading for anchovy AP16. Nº24; 15.9cm; caught November 2018. **100% agreement Age 2**.Conventional birthdates: 1st January. The otolith shows the first winter ring, in this case, very narrow but strongly marked all around the otolith; A wide opaque band correspond the intense growth pattern expected during the second year of life; the second winter hyaline ring follows and finally an narrow opaque band corresponding to the most recent season growth.

Figure 8.12. Age Reading for anchovy AP16. Nº32; 16.3cm; caught November 2018. **100% agreement Age 2**. Conventional birthdates: 1st January. The otolith shows the first winter ring, in this case, very narrow but strongly marked all around the otolith; A wide opaque band correspond the intense growth pattern expected during the second year of life; the second winter hyaline ring follows and finally an narrow opaque band corresponding to the most recent season growth.

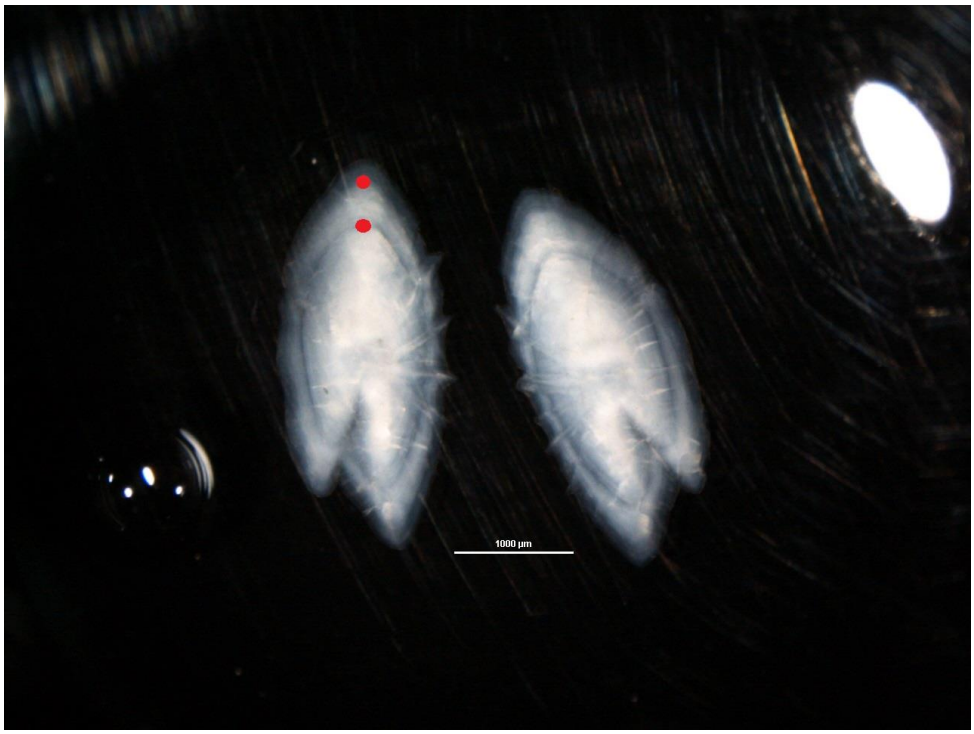


Figure 8.13. Age Reading for anchovy AP.14.nº53; 17.6 cm; caught November 2018. **67% agreement: Age 2 (IEO readers ages 2; IPMA reader age 1)**. Conventional birthdates: 1st January. The otolith shows the first winter ring, in this case, very narrow but strongly marked all around the otolith; A wide opaque band correspond the intense growth pattern expected during the second year of life; the second winter hyaline ring follows and finally an narrow opaque band corresponding to the most recent season growth.

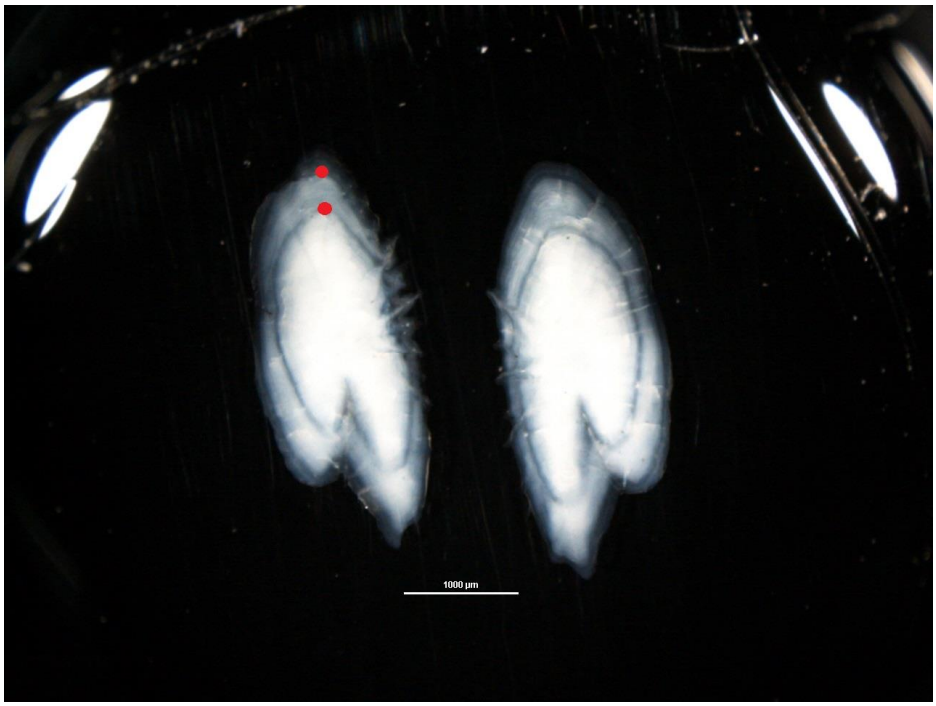
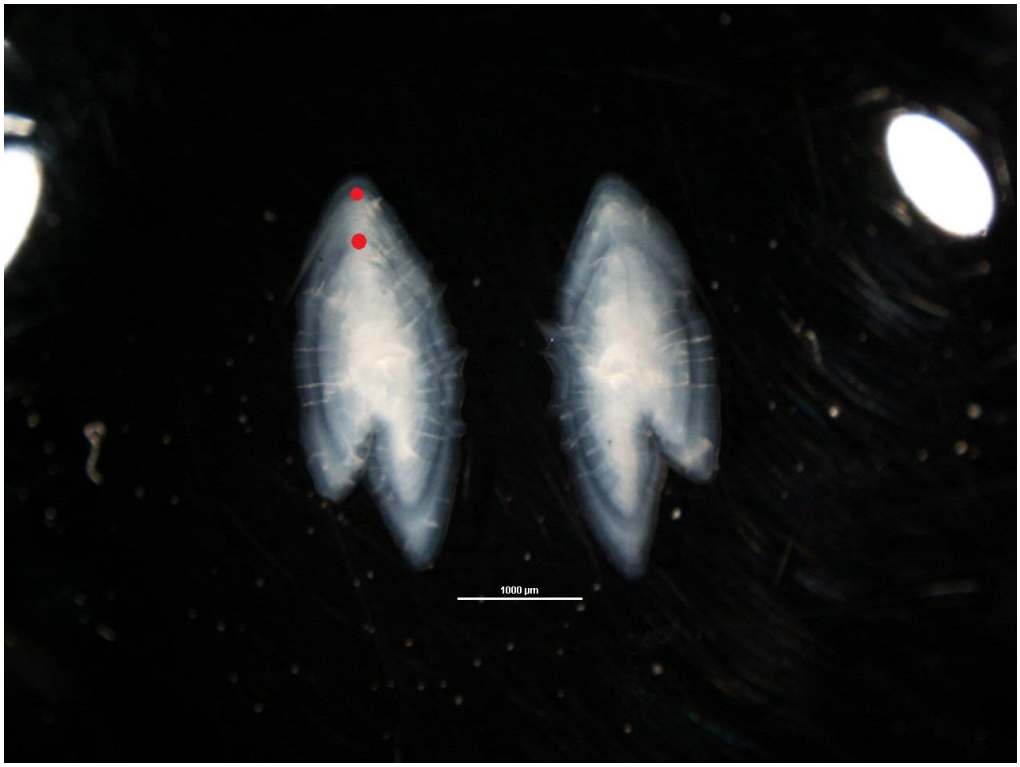


Figure 8.14. Age Reading for anchovy AP.17.nº 7; 13.4cm; caught November 2018. **67% agreement Age 2 (IEO and IPMA readers ages 2; IEO reader age 1)**. Conventional birthdates: 1st January. This otolith is Very similar to the previous example. The growth pattern shows a progressive decreasing of growth bands between subsequent age classes. Around to the center of the otolith there is a weak mark that would be a false central ring. This individual is a good example that its small length should not condition the estimate of age.



9. Annex 3. Recommended reading Axis and Synoptic representation of the anchovy otolith development in time.

Reading axis: The translucent rings (hyaline) are counted preferably in the anterior (rostrum) and posterior (post-rostrum) of the otolith (Figure 9.1).

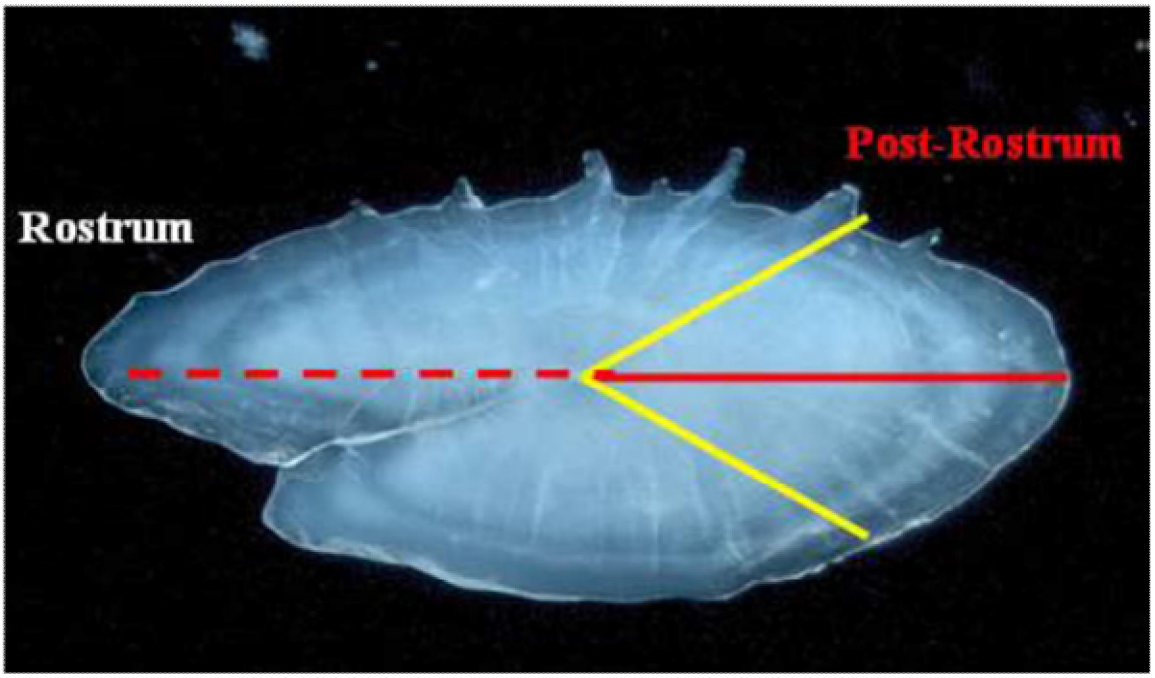


Figura 9.1. Recommended reading axis by WKARA1 and WKARA2 (ICES 2009 and 2016). Photo taken from the report of the Anchovy Otoliths Workshop WKARA2009 (ICES, 2009)

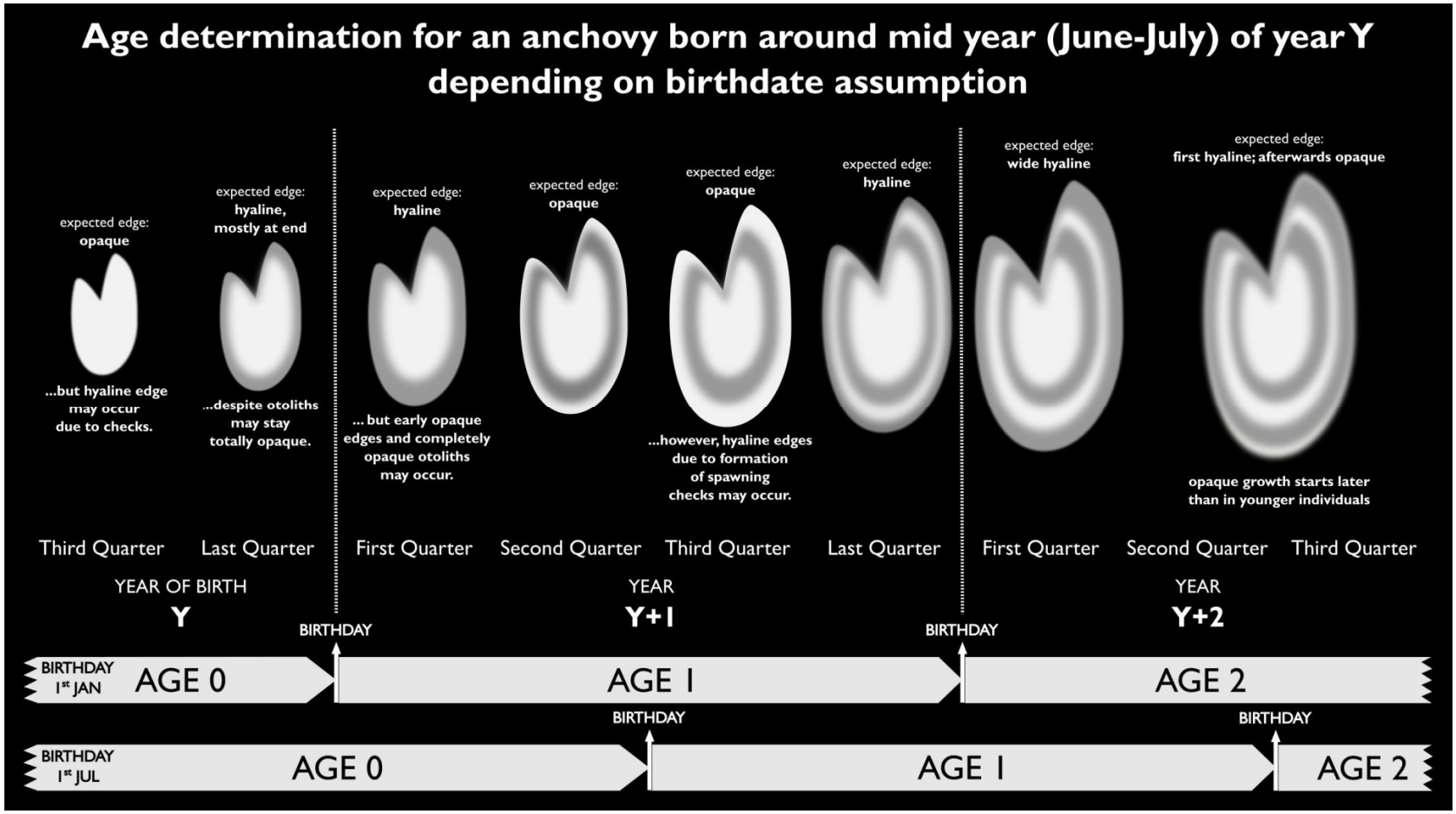


Figure 9.2. Synoptic representation of the anchovy otolith development in time and the different age allocation according to the two conventional birth dates at 1st January and at 1st July. Outline taken from the workshop report of anchovy otoliths WKARA2 2016 (ICES, 2016)