Report of the Small Exchange of *Scomber colias* Otoliths from Atlantic and Mediterranean Areas

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CONTENTS

1. INTRODUCTION.

Following a recommendation of the Planning Group on Commercial Catches, Discards and Biological Sampling (PGCCDBS) in 2011, an exchange of chub mackerel otoliths was carried out in 2012-2013 to assess difficulties in age reading, provide a first evaluation of the agreement, precision and accuracy of age determination. Five age readers from Portugal and Spain participated in the exchange. A total of 244 otoliths were examined, collected in 2011 off the ICES areas VIIIc, IXa and in Western Mediterranean (Martins *et al*., 2014).

The Planning Group on Commercial Catch, Discards and Biological Sampling (PGCCDBS) meeting in February 2014, recommended a Workshop to discuss the results of this exchange and the development of validation studies in this species. This Workshop on Age Reading of Chub Mackerel (*Scomber colias*) [WKARCM], chaired by Andreia Silva (Portugal) and María Rosario Navarro (Spain), will be held in Lisbon, Portugal, the 2-6 of November, 2015.

However, due to the time passed since the exchange took place and a renovation of the readers of this species (retirements and new incorporations), it was thought necessary to carry out a new otolith exchange before the start of the Workshop. As the time available to carry out the new exchange was so short, it was decided to use a selection of 125 otolith images from the previous exchange. This Small Exchange of *Scomber colias* otolith images was hold via WebGR between March and June 2015, and organized by IEO-Santander (Spain) and IPMA (Portugal). This report presents the results of this exchange, summarizing the readings of 14 readers from six laboratories in three European countries (Portugal, Spain and Italy).

This exchange has followed the following objectives:

1- Evaluate the current precision in otolith age reading of chub mackerel among readers of fishery and surveys samples throughout the year.
2- Identify major difficulties in chub mackerel otolith interpretation for age determinations concerning observed disagreements (e.g. identification of true rings or checks).
3- Report results to the Workshop on Age Reading of Chub Mackerel (*Scomber colias*) [WKARCM] that will take place in November 2015.

2. MATERIAL AND METHODS.

2.1. PARTICIPANTS AND QUALIFICATION OF READERS.

A total of 14 readers from six laboratories of three European countries (Portugal, Spain and Italy) participated in the Small Exchange of *Scomber colias* Otoliths. A summary of their experience in the age determination of *Scomber colias*, as well as other species, and information about their area of expertise is shown in Table 1.1 (Annex I).

Readers were ranked as Expert, Intermediate and Trainee level considering the number of otoliths (first) and the number of years of experience (second) with this species. It was considered that the expert readers should be those with an experience ageing at least 10000

otoliths, readers with an Intermediate level should be those with an experience ageing between 2000-10000 otoliths, being readers with a Trainee level those with an experience ageing less than 2000 otoliths. As no reader had an experience ageing 10000 or more otoliths, it was considered the participants to be ranked with Intermediate and Trainee levels. A summary with the readers experience scale is shown in Table 1.2 (Annex I).

2.2. SET OF OTOLITHS.

A total of 125 otolith images were selected from the three sets of otoliths of the previous exchange carried out in 2012-2013 (Annex I, Table 1.3). Originally, a total of 150 otolith images were selected (50 images from each set). However, due to some problems when inserting the last set of images in WebGR, the last 25 images were not able to be used in the exchange.

2.3. AGE DETERMINATION PROCEDURES.

The 125 images of chub mackerel otoliths were uploaded for analyzing using the WebGR application (Web services for support of Growth and Reproduction Studies http://webgr.azti.es). Readers had to indicate the annual age determination and position of the winter rings supporting their interpretation of the age. Checks or false rings were not marked, thought their presence could be mentioned in the remark field of the reading.

Readings were made preferably without consulting the length of the fish, based on the otolith examination according to the date of capture and general knowledge of the seasonal otolith growth pattern during the year and being aware of the conventional birth date:

- For the three sets of otoliths of this exchange the conventional birth date is the 1st January.
- The spawning period of this species occurs in spring, between March and June in Iberian waters (Martins, 1996; Navarro *et al*., 2014).
- True annual rings will be those formed in winter each year. Checks or false rings may be present throughout the year causing problems in the age determination.

2.4. DATA ANALYSIS.

Age readings results were analyzed using the GussEltink spreadsheet (Eltink, 2000) following the guidelines of the Planning Group for Commercial Catches, Discards and Biological Sampling for otolith exchanges (ICES, 2014a). Precision were estimated by the coefficient of variation (CV) of annuli counting between different readers. Relative bias and percentage of agreement between readers and modal age, as well as an overall estimate for percentage agreement were performed. The analysis was performed for the total of areas and for all readers; and also considering only the intermediate readers, and with only the trainee readers. Additional analyses were performed by set of otoliths: Bay of Biscay set, Portugal set and Mediterranean

set. It was also analyzed the chub mackerel growth pattern using the length at age per area and reader using R software 2.15.0 (R Development Core Team 2008).

3. RESULTS.

3.1. ANALYSIS BY GROUP OF READERS.

3.1.1. All readers.

Overall age reading results of all readers are shown in Annex 2. From the total of 125 images of chub mackerel otoliths 6 readers estimated the age of all images; 4 readers estimated the age of 124 images; 1 reader estimated the age of 122 images; 1 reader estimated the age of 121 images; 1 reader estimated the age of 119 images and 1 reader estimated the age of 100 images. The results of all readers showed modal ages from 0 to 6.

The overall agreement for all readers was 57.3% (Annex 3, Table 3.1). The best agreements were reached for age 1 (74%), for ages 2 and 3 agreements were 59% each, for age 0 agreement was 57%, for ages 5 and 6 agreements were only 50%, being the lowest agreement for age 4 (49%).

The analysis including all readers revealed a coefficient of variation (CV) of 29.6% (Annex 3, Table 3.1). CV peaked at 119.8% for modal age 0, which was due mostly to the difficulty that the formula shows when analyzing different values for modal age 0 (age 0 of some readers opposite to age 1 of the other readers). Lowest CV was revealed for modal age 6 (15.3%). The overall relative bias was low (0.18) (Annex 3, Table 3.1).

Table 3.2 (Annex 3) shows the mean length at age of all readers.

Table 3.3 (Annex 3) shows the results of the inter-reader bias test and the reader against Modal age bias test. The results of the inter-reader bias test show a group of readers with no bias between their readings clearly defined: a group with readers 1, 6, 13 and 14; a second group with readers 2, 5, 7 and 9; another group with readers 3 and 4; and a last group with readers 8, 10, 11 and 12. Only readers 8, 11 and 12 do not show bias between their readings and the Modal age.

Figure 3.1 (Annex 3) 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. Deviations from the modal age (solid line) can be seen for most readers. Readers 1, 13 and 14 showed an underestimation in older ages regarding the modal age. Reader 6 showed also a lighter underestimation in older ages. Readers 3 and 4 showed an overestimation in most ages regarding the modal age. Readers 2 and 5 showed also a lighter overestimation in some ages. Reader 9 showed an overestimation in younger ages and an underestimation in older ages regarding the modal age. As the overall agreement between readers is lower with older ages, the standard deviations are also mostly higher for the older ages for all readers combined (Annex 3, Figure 3.2). Nevertheless, bias seems to be a matter of concern for all age readers. Levels of precision by age of each reader are different to the average values for the combined readers. The higher values of ages/readers should be closer examined.

3.1.2. Intermediate readers.

Overall age reading results are shown in Annex 2. From the total of 125 images of chub mackerel otoliths, 2 readers estimated the age of all images; 1 reader estimated the age of 121 images and 1 reader estimated the age of 100 images. The results of intermediate readers showed modal ages from 0 to 8.

The overall agreement for intermediate readers was 53.3% (Annex 4, Table 4.1). The best agreements were reached for age 7 (75%) and age 1 (74%). The lowest agreement was reached for age 5 (50%).

The analysis including Intermediate readers revealed a coefficient of variation (CV) of 31.0% (Annex 4, Table 4.1). CV peaked at 157.7% for modal age 0, which was due mostly to the difficulty that the formula shows when analyzing different values for modal age 0 (two readers who interpreted some otoliths as age 1 in opposite to the other two readers). Lowest CV was revealed for modal age 7 (11.4%). The overall relative bias for Intermediate readers was really low -0.02 (Annex 4, Table 4.1).

Table 4.2 (Annex 4) shows the results of the intermediate readers against Modal age bias test. All intermediate readers show certainty of bias between their readings and the Modal age.

Figure 4.1 (Annex 4) shows age bias plots with the mean age recorded and the standard deviation of each Intermediate reader and all Intermediate readers combined plotted against the modal age. Reader 1 showed an underestimation in older ages regarding the modal age. Reader 2 showed also a light underestimation in older ages, whereas Readers 3 and 4 showed a light overestimation in some ages regarding the modal age. The standard deviation showed an increment of its values with the age (except for age 7) for all Intermediate readers combined (Annex 4, Figure 4.2).

3.1.3. Trainee readers.

Overall age reading results are shown in Annex 2. From the total of 125 images of chub mackerel otoliths, 4 readers estimated the age of all images; 4 readers estimated the age o 124 images; 1 reader estimated the age of 122 images and 1 reader estimate the age of 119 images. The results of trainee readers showed modal ages from 0 to 6.

The overall agreement for trainee readers was 63.7% (Annex 53, Table 5.1). The best agreement was reached for age 1 (74%), followed by age 3 (66%) and 2 (65%). The lowest agreement was reached for age 0 (50%).

The analysis including trainee readers revealed a coefficient of variation (CV) of 25.4% (Annex 5, Table 5.1). CV peaked at 59.1% for modal age 1. Lowest CV was revealed for modal age 6 (15.4%). (Annex 5, Table 5.1). The overall relative bias for trainee readers was low, 0.03.

Table 5.2 (Annex 5) shows the results of the trainee readers against Modal age bias test. Only readers 8, 11 and 12 showed no bias between their readings and the Modal age.

Figure 5.1 (Annex 5) shows age bias plots with the mean age recorded and the standard deviation of each trainee reader and all trainee readers combined plotted against the modal age. Readers 5 and 7 showed a light overestimation in most ages regarding the modal age. Readers 6, 8, 11, 12, 13 and 14 showed a light underestimation in older ages, whereas reader 9 showed a light underestimation in younger ages but a light overestimation in older ages regarding the modal age. Reader 10 showed a good estimation regarding the modal age. The standard deviation showed an increment of its values with the age for all trainee readers combined (Annex 5, Figure 5.2).

3.2. ANALYSIS BY SET OF OTOLITHS.

3.2.1. Bay of Biscay set.

Overall age reading results are shown in Annex 2. From the total of 50 images of chub mackerel otoliths of the Bay of Biscay set, 6 readers estimated the age of all images; 4 readers estimated the age of 49 images; 1 reader estimated the age of 48 images; 2 readers estimated the age of 47 images and 1 reader estimated the age of 40 images. The results showed modal ages from 2 to 6 for the Bay of Biscay set.

The overall agreement for the Bay of Biscay set was 53.5% (Annex 6, Table 6.1). The best agreement were reached for age 2 (67%) and the lowest agreement was reached for age 6 (37%).

The analysis of the Bay of Biscay set including all readers revealed a coefficient of variation (CV) of 27.4% (Annex 6, Table 6.1). CV peaked at 35.3% for modal age 2. Lowest CV was revealed for modal age 6 (18.8%) and 5 (18.1%). The overall relative bias was 0.25. (Annex 6, Table 6.1).

Table 6.2 (Annex 6) shows the mean length at age of all readers of the Bay of Biscay set of otoliths.

Table 6.3 (Annex 6) shows the results of the inter-reader bias test and reader against Modal age bias test for the Bay of Biscay set of otoliths. Only readers 8, 9, 10, 11 and 12 showed no bias between their readings and the Modal age.

Figure 6.1 (Annex 6) shows age bias plots with the mean age recorded and the standard deviation of each reader and all readers combined plotted against the modal age. Readers 1, 6, 13 and 14, showed an underestimation in older ages regarding the modal age. Readers 2, 3, 4 and 5 showed an overestimation in most ages regarding the modal age. Reader 9 showed an overestimation in younger ages and an overestimation in older ages, regarding the modal age. The rest of the readers showed a better estimation regarding the modal age. The standard deviation showed an increment of its values with the age for all readers combined (Annex 6, Figure 6.2).

3.2.2. Portugal set.

Overall age reading results are shown in Annex 2. From the total of 25 images of chub mackerel otoliths of the Portugal set, 13 readers estimated the age of all images and 1 reader estimated the age of 17 images. The results showed modal ages from 1 to 6 for this set.

The overall agreement for the Portugal set was 55.3% (Annex 7, Table 7.1). The best agreement was reached for age 1 (92.4%) and the lowest agreement was reached for age 5 (44.4%).

The analysis of the Portugal set, including all readers, revealed a coefficient of variation (CV) of 22.8% (Annex 7, Table 7.1). CV peaked at 46.8% for modal age 1. The lowest CV was revealed for modal age 6 (11.8%). The overall relative bias was 0.12. (Annex 7, Table 7.1).

Table 7.2 (Annex 7) shows the mean length at age of all readers of the Portugal set of otoliths.

Table 7.3 (Annex 7) shows the results of the inter-reader bias test and reader against Modal age bias test for the Portugal set of otoliths. Readers 1, 3, 4, 7, 13 and 14 showed bias between their readings and the Modal age.

Figure 7.1 (Annex 7) shows age bias plots with the mean age recorded and the standard deviation of each reader an all readers combined against modal age for the Portugal set of otoliths. Readers 1, 6, 8, 10, 13 and 14, showed an underestimation in older ages regarding the modal age. Readers 2, 3, 4 and 5 showed an overestimation in most ages regarding the modal age. Reader 9 showed an overestimation in younger ages and an overestimation in older ages, regarding the modal age. The rest of the readers showed a better estimation regarding the modal age. The standard deviation showed an increment of its values with the age for all readers combined (Annex 7, Figure 7.2).

3.2.3. Mediterranean set.

Overall age reading results are shown in Annex 2. From the total of 50 images of chub mackerel otoliths of the Mediterranean set, 10 readers estimated the age of all images, 2 readers estimated the age of 49 images, 1 reader estimated the age of 47 images and 1 reader estimated the age of 43 images. The results showed modal ages from 0 to 4 for this set.

The overall agreement for the Mediterranean set was 62.1% (Annex 8, Table 8.1). The best agreement was reached for age 1 (70.5%) and the lowest agreement was reached for age 4 (48.4%). The analysis of the Mediterranean set, including all readers, revealed a CV of 35,2% (Annex 8, Table 8.1). CV peaked at 119.8% for modal age 0, which vas due mostly to the difficulty that the formula shows when analyzing different values for modal age 0 (age 0 of some readers opposite to age 1 of the other readers). The lowest CV was revealed for modal age 3 (17.5%). The overall relative bias was 0.14. (Annex 8, Table 8.1).

Table 8.2 (Annex 8) shows the mean length at age of all readers of the Mediterranean set of otoliths.

Table 8.3 (Annex 8) shows the results of the inter-reader bias test and reader against Modal age bias test for the Mediterranean set of otoliths. Readers 8, 10, 11 and 12 showed no bias between their readings and the Modal age.

Figure 8.1 (Annex 8) shows age bias plots with the mean age recorded and the standard deviation of each reader an all readers combined against modal age for the Mediterranean set of otoliths. Readers 1, 6, 13 and 14, showed an underestimation in older ages regarding the modal age. Readers 2, 3, 4 and 5 showed an overestimation in most ages regarding the modal age. Reader 9 showed an overestimation in younger ages and an overestimation in older ages, regarding the modal age. The rest of the readers showed a better estimation regarding the modal age. The standard deviation showed an increment of its values with the age for all readers combined (Annex 8, Figure 8.2).

3.3. GROWTH PATTERN ANALYSIS.

The growth pattern of Mediterranean and Portugal Sets seems to represent a standard growth pattern of Chub mackerel, which is characterized by high growth rate in small age groups. The Mediterranean and Portugal sets seems to have higher growths at ages 0 to 1, and 1 to 2 and a drastic drop in growth from ages 4 and onwards (Annex 9, fig. 9.1; Annex 3, Table 3.2). For the Portugal set, all readers show a consistent growth trajectory, especially readers 1 and 6. The most difficult interpretation of North Portugal ages seems to be in ages 2, 3 and 4 years. Most readers (readers 2, 3, 5, 7, 8, 9, 10, 11 and 12) indicate a decrease in growth trajectory at ages 2 and 3 and a higher growth from age 4 and onwards (Annex 9, fig. 9.2; Annex 7, Table 7.2).

Most of the readers do not reflect a constant and consistent growth in Bay of Biscay, only Readers 1, 2 and 10 present a gradual decline of growth with age for this area. Reader 1 is the principal reader of this area but readers2 and 10 are not an expert in Chub Mackerel otoliths. Readers 6, 8 and 12 seemed to have difficulty in the identification of the first ring in the Bay of Biscay area (Annex 9, fig. 9.2; Annex 6, Table 6.2).

All readers present a good growth trajectory for the Mediterranean area, except reader 9 which indicate a difficulty in the identification of age groups 0 and 1(Annex 9, fig. 9.2; Annex 8, Table 8.2).

The trajectory indicated by Readers 1 and 10 is smooth and reflects a consistent gradual decline of growth with age for all of the areas (Annex 9, fig. 9.2; Annex 3, Table 3.2).

4. DISCUSSION.

The exchange was carried out by using the WebGR application, which made the whole exchange process quite easy. For some readers this was the first time using the WebGR application but once all readers became familiar with the use of the tool it proved to be very useful. The exclusive use of images has the disadvantage that the readers find more difficult to identify the nature of the otolith edge, which can make the age interpretation more difficult in some cases. However, the use of images allows a better comparison between the readers' estimations and a better identification of the problems in locating false rings, as well as to speed up the process.

Average percentage of agreement (57.3%) and CV (29.6%) for all areas and all readers does not seem to be satisfactory (Annex 3, Table 3.1). The results of the intermediate readers were slightly worse than the results of all readers (53.3% of agreement, 31.0% CV), whereas the results of the trainee readers were slightly better than the results of all readers (63.7% of agreement, 25.4% CV) (Annex 4 and 5, Tables 4.1 and 5.1). The results by set of otoliths seems to be slightly better for the Mediterranean set of otoliths (62.1% of agreement, 35.2% CV), whereas worst results were for the Bay of Biscay set (53.5% of agreement, 27.4% CV) (Annex 6, 7 and 8, Tables 6.1, 7.1 and 8.1).

When comparing this exchange results with the previous exchange (2013), there has been a small decrease in the level of agreement:

	% Agreement	CV
2013	60.4	22.7
2015	57.3	29.6

The results of the recent exchange show a slight decline of the % agreement and CV, which makes it more important the carry out of the Workshop on Age Reading of Chub Mackerel (*Scomber colias*) [WKARCM].

Only 4 readers of the participants in the 2013 exchange have also participated in the current exchange (readers 1, 3, 4 and 6). Three of them were included in the intermediate readers' group. However, the results of this group analysis, like the inter-reader bias test and reader against Modal age bias test, showed big differences between them (Annex 3 and 4, Tables 3.1 and 4.2).

Six readers of the present exchange did not have any experience with chub mackerel otoliths before starting the exchange. However, the results of the trainee readers' group were slightly better than the results of the intermediate group.

There seem to be different groups of readers with similar age reading criteria, which in turn differ from the other groups' criteria. Thereby, readers 1, 6, 13 and 14 showed an underestimation in older ages regarding the Modal age (Annex 3, Figure 3.1). This tendency can be observed as well in the mean length at age table (Annex 3, Table 3.2). Also, this group of readers showed no bias in the inter-reader bias test (with the exception of the test between

readers 6 and 13) (Annex 3, Table 3.3) and have similarities in the growth pattern (Annex 9, Figure 9.2). This could be explained due that readers 1 and 6 were trained in 2011 by the expert reader (now retired) and, in turn, readers 13 and 14 were trained by reader 1. This way this group of readers has similar age reading criteria for chub mackerel age estimation.

A second group of readers seems to be formed by readers 3 and 4. Both readers showed an overestimation in most ages regarding the Modal age (Annex 3, Figure 3.1). Also, both readers showed no bias in the inter-reader bias test (Annex 3, Table 3.3). Also they have similar growth patterns (Annex 9, Figure 9.2).Both readers belong to the same laboratory, which can explain the similar age reading criteria between them.

A third group of readers seems to be formed by readers 2, 5, 7 and 9, which showed no bias between them in the inter-reader bias test (Annex 3, Table 5.3).

The last group of readers seems to be formed by readers 8, 10, 11 and 12. This group showed a better estimation regarding the Modal age (Annex 3, Figure 3.1). Readers 8, 11 and 12 showed no bias with the Modal age in the reader against Modal age bias test (Annex 3, Table 3.3). Readers 8, 11 and 12 showed no bias between them in the inter-reader bias test. Reader 11 also showed no bias against reader 10 in the inter-reader bias test. It draws attention the fact that even when readers 10, 11 and 12 had no experience reading chub mackerel otoliths before this exchange they showed the best estimation regarding the Modal age, showing similar age reading criteria between them. Also, these readers seems to have similar growth patterns (Annex 9, Figure 9.2)

Only 14 otoliths from the 125 otoliths of the exchange had an agreement of more than 80% (Annex 2). From these, only 2 otoliths had 100% of agreement (Annex 10, Figures 10.1 and 10.2). For the other 12 otoliths with more than 80% agreement, the differences between all readers' age estimations were of only one year (Annex 10, Figures 10.3 and 10.4).

The otolith with the lowest agreement was otolith number 7 (29%), which was aged from 3 to 8 (Annex 11, Figure 11.1). Otoliths with low agreement usually coincide with otoliths with false rings (checks), which are not well identified by some readers. Also, the first annulus is not well identified by some readers (Annex 11, Figures 11.1 to 11.6), especially in the Bay of Biscay area (Annex 9, Figure 9.1; Annex 6, Table 6.2).

To sum up, the overall agreement was low and slightly lower than the previous exchange. There is not a unique criterion that is followed by all readers. However, there seems to be four groups of readers, each of which with a different criterion. Only 14 otoliths from the 125 otoliths of the exchange have more than 80% agreement, and only two of them have 100% agreement. Major problems are the identification of the first annulus, as well as the identification of false rings (checks).

The results of this exchange will be discussed during next Workshop on Age Reading of Chub Mackerel (*Scomber colias*) [WKARCM], which will take place the 2-6 November 2015 in Lisbon, Portugal.

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ANNEX I: Participants and set of otoliths

Table 1.1. Participants of the Small Exchange of *Scomber colias* Otoliths.

Country	Institute & postal address	Participants	Email	Readers or Not ?	Age reading expertise level Chub mackerel			Age reading expertise level Other species			Chub mackerel Stock/Area of expertise
					Level	Years	No. Of otoliths	Species	Years	No. Of otoliths	
Spain-IEO (C.O. Santander)	Instituto Español de Oceanografia (IEO) Promontorio de San Martin, s/n 39004 Santander (Cantabria) Spain	Rosario (Charo) Navarro	charo.navarro@st.ieo.es	Yes - WKARCM Co-chair	Intermediate	2011-2014	5000	Atlantic mackerel Anchovy	2007-2014 2008-2012	> 20000 > 10000	Bay of Biscay (ICES Subarea VIII) + ICES IXaN
		Begoña Villamor	begona.villamor@st.ieo.es	No - Coordinator	-	-	-				
		Clara Dueñas	clara.duenas@st.ieo.es	Yes	Trainee	-	0	Horse mackerel Anchovy Atlantic mackerel	2007-2014 2007-2014 2007-2011	> 20000 > 15000 > 10000	
		Ana Antolínez	ana.antolinez@st.ieo.es	Yes	Trainee	-	0	Anchovy Horse mackerel Atlantic mackerel	1 year 1 year 1 year	300 600 700	
Portugal-IPMA	Instituto Português do Mar e Atmosfera (IPMA) Avenida de Brasilia, 1449-006 Lisbon, Portugal	Andreia V. Silva	avsilva@ipma.pt	Yes - WKARCM Co-chair	Trainee	2013-2014	900	Atlantic sardine Anchovy	2010-2014 2013-2014	> 10000 500	ICES IXa
		Alexandra Silva	asilva@ipma.pt	No - Coordinator	-	-	-				
		Eduardo Soares	esoares@ipma.pt	Yes – Coordinator	Trainee	-	0	Atlantic sardine Anchovy	1990-2014 2011-2014		
		Sandra Dores	sdores@ipma.pt	yes	Trainee	-	0	Merlucius merlucius	2004-2014	> 20000	
		Dina Silva	dsilva@ipma.pt	yes	Trainee	-	0	Trisopterus luscus	2014	> 1000	
		Delfina Morais	dmorais@ipma.pt	yes	Trainee	2013-2014	1000	Atlanctic sardine	2000-2014	>20000	
		Maria João Ferreira	mjferreira@ipma.pt	Yes	Trainee	-	0	Trachurus spp	2000-2014	> 20000	
Spain-IEO (C.O. Tenerife)	Instituto Español de Oceanografia (IEO) Dársena Pesquera, Pcl. 8 38180 S/C Tenerife (Canary Islands) Spain	Alba Jurado Ruzafa	alba.jurado@ca.ieo.es	Yes	Intermediate	2005-2011	2000	Trachurus picturatus Sardina pilchardus	2005-2006 2010-2011	>3000 >2000	CECAF-Canary Islands CECAF-Mauritania
Spain-IEO (C.O. Murcia)	Instituto Español de Oceanografia (IEO) Calle Varadero, Nº1 30740 San Pedro del Pinatar (Murcia) Spain	Miguel Vivas	miguel.vivas@mu.ieo.es	Yes	Intermediate	2011-2014	2000	mackerel blue whiting sardine	2010-2014	6000	Mediterranean
		Encarnación García	encarnacion.garcia@mu.ieo.es	Yes	Intermediate	2011-2015	2000	mackerel blue whiting	2010-2015	3000	
Italy-COISPA	COISPA Tecnologia & Ricerca - Stazione Sperimentale per lo Studio delle Risorse del Mare, Via dei Trulli 18/20. 70126 Bari - Torre a Mare Italy	Carbonara Pierluigi	carbonara@coispa.it	Yes	Trainee	2010-2014	1000	Hake, red mullet, stripped red mullet, anchovy, sardine, horse mackerel, Atlantic mackerel, Mediterranean horse Mackerel, anglerfish	2006-2014	>30000	FAO-GSA: 10, 18, 19
Italy-CIBM	CIBM, Centro Interuniversitario di Biologia Marina ed Ecologia Applicata, Vialen N. Sauro, 4 57128 Livorno, Italy	Andrea Massaro	andreamassaro@live.it	Yes	Trainee	2013-2014	100	Hake, red mullet, stripped red mullet, horse mackerel, Atlantic mackerel, Mediterranean horse Mackerel, common sole	2011	8000	FAO-GSA: 9

Table 1.2. Readers experience scale in *Scomber colias* otoliths age reading.

READER NAME	READER CODE	EXPERIENCE: YEARS	EXPERIENCE: Nº OTOLITHS	EXPERTISE LEVEL
Rosario (Charo) Navarro	1	2011-2014	5000	Intermediate
Alba Jurado	2	2005-2011	2000	Intermediate
Encarnación García	3	2011-2014	2000	Intermediate
Miguel Vivas	4	2011-2014	2000	Intermediate
Pierluigi Carbonara	5	2010-2014	1000	Trainee
Delfina Morais	6	2013-2014	1000	Trainee
Andreia Silva	7	2013-2014	900	Trainee
Andrea Massaro	8	2013-2014	100	Trainee
Eduardo Soares	9		0	Trainee
Sandra Dores	10		0	Trainee
Dina Silva	11		0	Trainee
Maria João Ferreira	12		0	Trainee
Clara Dueñas	13		0	Trainee
Ana Antolínez	14		0	Trainee

Table 1.3. Set of otoliths used in the Small Exchange of *Scomber colias* Otoliths.

Institute providing data	Areas	Nº images by set and month				Length rate
		Fist half of the year		Second half of the year		
		Nº images	Months	Nº images	Months	
IEO - Murcia (Spain)	GSA06, Western Mediterranean	24	January, March, April	26	July, November, December	18-39 cm
IEO - Santander (Spain)	VIIIcE, Bay of Biscay	25	January, March, April, June	25	August - November	27-39 cm
IPMA (Portugal)	IXa, Portugal waters	16	January-May	9	July	19-38 cm
	Total images	65		60		
		125				

ANNEX II: RESULTS

ANNEX 2: Overall readings of all participants.

Stratum	year	Sample no	Fish no	Fish length	Sex	Landing month	Sp CN Reader 1	Sp AJ Reader 2	Sp EG Reader 3	Sp MV Reader 4	It PC Reader 5	Pt DM Reader 6	Pt AS Reader 7	It AM Reader 8	Pt ES Reader 9	Pt SD Reader 10	Pt DS Reader 11	Pt MJF Reader 12	Sp CD Reader 13	Sp AA Reader 14	MODAL age	Percent agreeme	Precision CV
GSA06	2011	1-O-IEO-M-1	-	34.7	-	1	3	4	4	5	3	3	4	3	4	4	3	3	3	3	3	57%	19%
GSA06	2011	2-O-IEO-M-2	-	35.8	-	1	3	4	4	5	4	3	5	4	4	4	4	3	3	4	4	57%	17%
GSA06	2011	3-O-IEO-M-3	-	34.5	-	1	4	4	4	5	4	4	4	4	3	4	4	4	3	4	4	79%	12%
GSA06	2011	4-O-IEO-M-4	-	33.7	-	1	3	3	3	4	3	3	4	3	3	3	3	3	3	3	3	86%	12%
GSA06	2011	5-O-IEO-M-5	-	37.6	-	1	3	4	5	6	10	3	4	-	4	5	3	4	4	3	4	38%	43%
GSA06	2011	6-O-IEO-M-6	-	32.0	-	3	4	5	3	5	-	4	4	4	5	3	5	5	3	4	4	38%	19%
GSA06	2011	7-O-IEO-M-7	-	37.3	-	3	4	6	8	8	4	4	4	3	5	5	3	5	3	3	4	29%	36%
GSA06	2011	8-O-IEO-M-8	-	30.5	-	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	93%	9%
GSA06	2011	9-O-IEO-M-9	-	34.6	-	3	4	4	4	5	5	3	4	4	4	3	4	3	3	4	4	57%	17%
GSA06	2011	10-O-IEO-M-10	-	29.6	-	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3	93%	9%
GSA06	2011	11-O-IEO-M-11	-	33.4	-	3	3	3	3	3	3	3	4	3	4	3	3	3	3	3	3	86%	12%
GSA06	2011	12-O-IEO-M-12	-	30.2	-	3	3	4	3	3	3	3	4	3	3	3	3	3	3	3	3	86%	12%
GSA06	2011	13-O-IEO-M-13	-	30.6	-	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	100%	0%
GSA06	2011	14-O-IEO-M-14	-	32.5	-	3	3	3	4	3	3	3	3	3	4	3	3	3	3	3	3	86%	12%
GSA06	2011	15-O-IEO-M-16	-	25.7	-	4	1	1	1	1	1	1	1	-	3	1	1	1	1	1	1	92%	48%
GSA06	2011	16-O-IEO-M-17	-	28.4	-	4	3	3	3	2	2	2	3	3	4	2	3	2	3	2	3	50%	24%
GSA06	2011	17-O-IEO-M-18	-	27.2	-	4	2	-	2	1	2	2	1	2	3	2	1	1	1	1	2	46%	40%
GSA06	2011	18-O-IEO-M-19	-	28.2	-	4	2	-	2	2	3	2	2	3	3	3	3	3	2	2	2	54%	21%
GSA06	2011	19-O-IEO-M-20	-	27.3	-	4	2	-	2	1	3	1	2	2	4	3	2	1	1	2	2	46%	46%
GSA06	2011	20-O-IEO-M-21	-	25.4	-	4	1	2	2	1	1	0	2	1	2	2	2	2	2	1	2	57%	43%
GSA06	2011	21-O-IEO-M-22	-	25.5	-	4	1	2	5	1	2	1	3	2	4	2	3	2	2	2	2	50%	50%
GSA06	2011	22-O-IEO-M-23	-	25.7	-	4	1	2	2	1	2	1	2	2	3	2	2	2	2	2	2	71%	29%
GSA06	2011	23-O-IEO-M-24	-	28.1	-	4	3	3	2	3	2	2	3	3	4	3	3	3	3	3	3	71%	19%
GSA06	2011	24-O-IEO-M-25	-	27.0	-	4	1	-	2	1	1	1	1	-	3	1	2	1	1	1	1	75%	49%
GSA06	2011	25-O-IEO-M-26	-	32.8	-	7	3	4	3	3	3	2	4	3	3	3	3	3	3	3	3	79%	15%
GSA06	2011	26-O-IEO-M-27	-	31.7	-	7	2	3	3	4	3	2	3	2	5	3	2	3	2	2	2	43%	32%
GSA06	2011	27-O-IEO-M-28	-	36.5	-	7	3	4	5	5	5	3	3	4	3	4	4	4	3	3	3	43%	21%
GSA06	2011	28-O-IEO-M-29	-	34.2	-	7	2	4	3	3	2	2	3	2	3	3	3	3	2	2	3	50%	24%
GSA06	2011	29-O-IEO-M-30	-	30.4	-	7	1	2	3	1	1	1	1	2	5	2	1	1	1	1	1	64%	70%
GSA06	2011	30-O-IEO-M-31	-	33.2	-	7	2	2	3	3	3	2	3	3	5	3	3	2	2	2	3	50%	30%
GSA06	2011	31-O-IEO-M-32	-	32.0	-	7	3	3	3	3	2	2	3	2	4	2	2	2	2	2	2	57%	26%
GSA06	2011	32-O-IEO-M-33	-	26.0	-	7	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	93%	47%
GSA06	2011	33-O-IEO-M-34	-	32.7	-	7	3	3	3	4	3	2	3	2	3	2	3	3	2	3	3	64%	21%
GSA06	2011	34-O-IEO-M-35	-	31.7	-	7	1	2	3	2	2	2	2	1	2	1	2	2	1	2	2	64%	32%
GSA06	2011	35-O-IEO-M-36	-	39.0	-	7	4	-	4	6	4	3	3	2	4	3	3	3	2	4	4	38%	30%
GSA06	2011	36-O-IEO-M-37	-	33.7	-	7	2	-	3	5	3	2	3	2	3	3	2	2	2	2	2	54%	33%
GSA06	2011	37-O-IEO-M-38	-	32.2	-	11	2	3	4	5	4	3	4	2	4	3	3	3	2	2	3	36%	30%
GSA06	2011	38-O-IEO-M-39	-	35.5	-	11	3	2	5	4	3	3	5	3	3	4	4	3	2	3	3	50%	28%
GSA06	2011	39-O-IEO-M-40	-	33.6	-	11	2	3	3	3	3	3	4	3	2	3	3	3	2	2	3	64%	21%
GSA06	2011	40-O-IEO-M-41	-	30.3	-	11	2	2	4	4	4	2	4	3	4	3	3	3	2	2	2	36%	29%
GSA06	2011	41-O-IEO-M-42	-	31.0	-	11	1	-	4	3	2	2	2	1	2	2	1	1	1	1	1	46%	52%
GSA06	2011	42-O-IEO-M-43	-	33.6	-	11	2	2	3	3	3	2	4	2	3	3	3	2	2	2	2	50%	25%
GSA06	2011	43-O-IEO-M-44	-	23.7	-	12	0	1	-	1	2	0	1	1	2	1	1	1	1	0	1	62%	69%
GSA06	2011	44-O-IEO-M-45	-	20.8	-	12	0	0	1	0	0	0	1	0	1	1	1	0	1	0	0	57%	120%
GSA06	2011	45-O-IEO-M-46	-	24.2	-	12	0	1	1	0	1	0	1	0	0	1	1	1	1	0	1	57%	90%
GSA06	2011	46-O-IEO-M-47	-	20.1	-	12	0	1	1	0	1	1	1	1	1	0	1	1	1	1	1	79%	54%
GSA06	2011	47-O-IEO-M-48	-	18.4	-	12	0	1	0	0	1	1	1	0	1	0	1	0	0	0	0	57%	120%
GSA06	2011	48-O-IEO-M-49	-	26.2	-	12	1	1	1	2	1	1	2	1	1	1	1	1	1	1	1	86%	32%
GSA06	2011	49-O-IEO-M-50	-	28.0	-	12	2	2	1	2	2	1	3	1	1	2	1	1	1	1	1	57%	43%
GSA06	2011	50-O-IEO-M-51	-	24.4	-	12	0	1	1	1	1	1	1	1	2	1	2	0	1	0	1	64%	66%
VIIIcE	2011	51-Sc-IEO-S-1	-	29.6	-	1	3	2	3	3	2	2	3	1	3	2	2	2	2	2	2	57%	27%
VIIIcE	2011	52-Sc-IEO-S-2	-	34.0	-	1	2	-	7	3	2	2	3	2	2	3	2	2	2	2	2	69%	53%
VIIIcE	2011	53-Sc-IEO-S-3	-	32.3	-	1	2	4	5	4	4	2	4	3	3	3	3	3	2	2	3	36%	30%
VIIIcE	2011	54-Sc-IEO-S-4	-	34.0	-	1	3	-	5	6	3	3	4	3	3	3	3	3	3	3	3	77%	28%
VIIIcE	2011	55-Sc-IEO-S-5	-	27.5	-	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	100%	0%
VIIIcE	2011	56-Sc-IEO-S-6	-	31.0	-	1	2	2	4	3	3	3	3	2	3	2	2	3	-	3	3	54%	23%
VIIIcE	2011	57-Sc-IEO-S-11	-	34.2	-	3	2	3	5	4	3	2	3	3	3	3	3	3	2	3	3	64%	26%
VIIIcE	2011	58-Sc-IEO-S-12	-	37.4	-	3	4	6	6	7	-	5	6	6	4	5	5	6	5	5	6	38%	16%
VIIIcE	2011	59-Sc-IEO-S-13	-	36.0	-	3	4	5	6	6	5	3	5	5	3	5	5	5	4	4	5	50%	20%
VIIIcE	2011	60-Sc-IEO-S-14	-	36.1	-	3	2	-	5	5	7	3	4	6	3	5	5	3	3	3	3	38%	35%
VIIIcE	2011	61-Sc-IEO-S-15	-	37.2	-	3	3	-	6	5	3	3	4	-	3	4	3	3	3	3	3	67%	28%
VIIIcE	2011	62-Sc-IEO-S-16	-	37.8	-	3	5	6	7	5	4	3	5	5	3	5	5	5	4	5	5	57%	22%
VIIIcE	2011	63-Sc-IEO-S-21	-	33.8	-	4	3	3	4	3	3	3	3	-	3	2	2	3	2	3	3	69%	19%
VIIIcE	2011	64-Sc-IEO-S-22	-	34.5	-	4	2	3	4	3	2	2	3	3	3	3	-	3	2	2	3	54%	23%
VIIIcE	2011	65-Sc-IEO-S-23	-	32.5	-	4	2	3	4	4	2	2	3	3	4	2	2	2	2	2	2	57%	32%
VIIIcE	2011	66-Sc-IEO-S-24	-	34.2	-	4	3	3	5	4	3	2	3	3	3	2	3	2	2	2	3	50%	30%
VIIIcE	2011	67-Sc-IEO-S-25	-	35.8	-	4	4	5	5	5	6	4	5	5	5	4	4	5	4	4	5	50%	14%
VIIIcE	2011	68-Sc-IEO-S-26	-	36.4	-	4	3	-	5	7	2	2	3	2	3	2	3	3	2	2	2	46%	49%
VIIIcE	2011	69-Sc-IEO-S-31	-	35.7	-	6	3	4	6	6	3	3	3	3	2	3	4	4	3	3	3	57%	32%
VIIIcE	2011	70-Sc-IEO-S-32	-	34.8	-	6	2	3	5	3	2	3	4	3	3	3	3	0	2	2	3	50%	42%
VIIIcE	2011	71-Sc-IEO-S-33	-	36.7	-	6	3	5	4	6	4	4	4	5	4	4	5	4	3	4	4	57%	19%
VIIIcE	2011	72-Sc-IEO-S-34	-	37.1	-	6	3	4	4	3	3	3	4	3	3	3	3	4	3	3	3	71%	14%
VIIIcE	2011	73-Sc-IEO-S-35	-	37.9	-	6	4	5	5	5	4	3	3	4	3	4	3	4	4	4	4	50%	19%
VIIIcE	2011	74-Sc-IEO-S-36	-	36.4	-	6	5	5	6	6	6	6	6	5	6	5	5	5	5	5	5	57%	9%
VIIIcE	2011	75-Sc-IEO-S-37	-	35.9	-	6	4	4	5	5	6	5	4	5	5	5	5	5	4	4	5	57%	13%
VIIIcE	2011	76-Sc-IEO-S-41	-	38.5	-	8	4	5	5	7	5	4	4	3	-	3	4	3	3	3	3	38%	29%
VIIIcE	2011	77-Sc-IEO-S-42	-	37.2	-	8	2	-	4	6	5	3	3	2	3	3	4	3	2	3	3	46%	36%
VIIIcE	2011	78-Sc-IEO-S-43	-	37.4	-	8	3	5	7	6	5	3	4	3	4	3	3	3	3	3	3	57%	34%
VIIIcE	2011	79-Sc-IEO-S-44	-	36.8	-	8	3	4	6	7	5	3	4	3	5	4	4	3	3	3	3	43%	31%
VIIIcE	2011	80-Sc-IEO-S-45	-	38.0	-	8	2	6	5	5	4	0	4	2	2	4	4	4	3	2	4	36%	48%
VIIIcE	2011	81-Sc-IEO-S-46	-	39.3	-	8	3	5	5	5	4	2	3	-	2	4	3	4	2	3	3	31%	33%
VIIIcE	2011	82-Sc-IEO-S-47	-	35.9	-	8	3	7	5	6	6	5	6	5	5	5	5	4	3	3	5	43%	25%
VIIIcE	2011	83-Sc-IEO-S-51	-	37.6	-	9	5	6	6	7	-	5	6	4	5	5	4	5	4	5	5	46%	17%
VIIIcE	2011	84-Sc-IEO-S-52	-	39.6	-	9	3	6	4	7	6	4	4	4	3	4	4	4	3	3	4	50%	30%
VIIIcE	2011	85-Sc-IEO-S-53	-	37.3	-	9	2	3	3	6	2	2	2	2	2	2	2	2	2	2	2	79%	45%
VIIIcE	2011	86-Sc-IEO-S-54	-	36.6	-	9	3	-	-	6	4	5	4	3	4	4	5	2	3	3	3	33%	29%
VIIIcE	2011	87-Sc-IEO-S-55	-	38.4	-	9	3	-	-	7	3	2	2	3	3	4	4	3	3	3	3	58%	39%
VIIIcE	2011	88-Sc-IEO-S-56	-	39.0	-	9	4	7	-	6	6	5	-	5	5	5	5	5	3	5	5	58%	20%
VIIIcE	2011	89-Sc-IEO-S-61	-	39.2	-	10	5	7	7	7	6	6	5	5	4	5	5	4	3	5	5	43%	23%
VIIIcE	2011	90-Sc-IEO-S-62	-	37.7	-	10	2	-	5	5	3	2	2	2	3	3	2	3	2	2	2	54%	39%
VIIIcE	2011	91-Sc-IEO-S-63	-	38.4	-	10	3	6	5	8	6	4	5	4	5	5	4	4	4	3	4	36%	28%
VIIIcE	2011	92-Sc-IEO-S-64	-	38.0	-	10	2	6	5	7	5	2	3	2	5	3	3	3	3	2	3	36%	45%
VIIIcE	2011	93-Sc-IEO-S-65	-	39.3	-	10	3	5	4	5	4	3	3	4	3	4	3	4	4	3	3	43%	20%
VIIIcE	2011	94-Sc-IEO-S-66	-	38.8	-	10	4	5	5	5	5	3	4	4	4	3	4	4	4	4	4	57%	16%
VIIIcE	2011	95-Sc-IEO-S-71	-	37.6	-	11	3	4	4	4	4	4	5	3	4	3	3	4	3	3	4	50%	17%
VIIIcE	2011	96-Sc-IEO-S-72	-	36.9	-	11	2	3	5	4	2	2	2	2	3	2	2	2	2	2	2	71%	38%
VIIIcE	2011	97-Sc-IEO-S-73	-	38.7	-	11	3	-	6	6	3	3	3	3	3	3	3	3	3	3	3	85%	33%
VIIIcE	2011	98-Sc-IEO-S-74	-	38.5	-	11	4	5	6	7	5	4	4	3	5	5	4	4	4	4	4	50%	22%
VIIIcE	2011	99-Sc-IEO-S-75	-	38.4	-	11	4	6	6	7	6	6	5	4	6	5	5	5	3	4	6	36%	21%
VIIIcE	2011	100-Sc-IEO-S-76	-	38.0	-	11	3	4	6	6	4	3	3	3	3	4	3	3	3	3	3	64%	30%
IXaCN	2011	101-Mas MAT21	-	27.9	-	1	3	3	2	3	2	3	2	2	2	3	2	2	2	2	2	64%	21%
IXaCN	2011	102-Mas MAT22	-	27.7	-	1	2	4	4	3	3	3	4	3	3	3	3	3	3	3	3	71%	17%
IXaCN	2011	103-Mas MAT101	-	34.9	-	1	4	5	5	5	4	5	4	4	4	4	4	4	4	4	4	71%	11%
IXaCN	2011	104-Mas MAT102	-	34.1	-	1	3	-	5	5	4	5	6	4	4	5	5	4	4	4	4	46%	17%
IXaCN	2011	105-Mas MAT105	-	34.4	-	2	3	3	5	5	4	4	4	4	4	4	4	3	4	3	4	57%	17%
IXaCN	2011	106-Mas MAT110	-	35.2	-	2	3	5	4	3	4	3	3	4	4	5	4	4	3	3	3	43%	20%
IXaCN	2011	107-Mas MAT121	-	19.8	-	3	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	93%	47%
IXaCN	2011	108-Mas MAT122	-	20.5	-	3	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	93%	47%
IXaCN	2011	109-Mas MAT241	-	36.0	-	4	3	5	7	4	3	3	5	4	4	4	3	4	4	3	4	43%	28%
IXaCN	2011	110-Mas MAT272	-	35.5	-	5	4	-	6	6	6	6	6	6	4	6	6	5	5	5	6	62%	14%
IXaCN	2011	111-Mas MAT282	-	36.7	-	5	3	6	7	6	6	4	5	4	5	5	4	4	4	4	4	43%	23%
IXaCN	2011	112-Mas MAT286	-	36.5	-	5	3	-	8	8	5	7	6	4	5	5	3	4	3	3	3	31%	38%
IXaCN	2011	113-Mas MAT287	-	37.1	-	5	4	6	5	4	4	5	5	4	4	4	4	3	3	4	4	57%	19%
IXaCN	2011	114-Mas MAT292	-	38.7	-	5	6	7	7	7	6	6	7	6	6	6	6	6	5	6	6	64%	9%
IXaCN	2011	115-Mas MAT293	-	38.3	-	5	4	-	7	5	5	5	6	5	5	6	5	5	3	4	5	54%	20%
IXaCN	2011	116-Mas MAT294	-	38.8	-	5	4	-	6	5	5	3	6	6	5	6	3	4	4	4	4	31%	24%
IXaCN	2011	117-Mas MAT361	-	33.5	-	7	3	3	5	5	5	4	5	4	4	4	4	5	3	3	5	36%	20%
IXaCN	2011	118-Mas MAT362	-	33.0	-	7	2	3	3	3	5	2	4	4	3	3	2	3	2	2	3	43%	31%
IXaCN	2011	119-Mas MAT363	-	33.3	-	7	3	-	5	5	5	4	4	4	4	4	4	4	3	3	4	54%	18%
IXaCN	2011	120-Mas MAT366	-	34.0	-	7	3	-	4	4	4	3	4	3	4	3	3	3	2	3	3	54%	19%
IXaCN	2011	121-Mas MAT367	-	34.0	-	7	3	3	4	4	4	3	4	4	4	3	4	4	2	3	4	57%	19%
IXaCN	2011	122-Mas MAT378	-	27.9	-	7	2	2	3	3	3	2	3	3	4	3	3	3	2	2	3	57%	23%
IXaCN	2011	123-Mas MAT379	-	28.6	-	7	2	3	3	3	2	2	3	3	3	2	3	3	2	2	3	57%	20%
IXaCN	2011	124-Mas MAT380	-	28.7	-	7	2	2	3	3	3	2	2	4	3	3	3	3	2	2	3	50%	24%
IXaCN	2011	125-Mas MAT381	-	28.9	-	7	2	-	4	4	3	2	3	3	4	3	3	3	2	2	3	46%	26%
						Total read	125	100	121	125	122	125	124	119	124	125	124	125	124	125		57.2%	29.6%
						Total NOT read	-121	-96	-117	-121	-118	-121	-120	-115	-120	-121	-120	-121	-120	-121			

ANNEX 3: All readers' analysis; tables and figures.

Table 3.1. Summary of the average percentage of agreement, CV and relative bias by age for all readers.

Modal Age	Otolith No	% Agreement	CV	Bias
0	2	57.1	119.8	0.43
1	13	74.0	55.0	0.16
2	21	58.5	33.8	0.36
3	50	58.5	24.5	0.24
4	24	49.4	22.9	0.12
5	11	50.0	18.5	-0.13
6	4	50.0	15.3	-0.44
Total	**125**	**57.3**	**29.6**	**0.18**

Table 3.2. Mean length at age of all readers

Age	Sp CN Reader 1	Sp AJ Reader 2	Sp EG Reader 3	Sp MV Reader 4	It PC Reader 5	Pt DM Reader 6	Pt AS Reader 7	It AM Reader 8	Pt ES Reader 9	Pt SD Reader 10	Pt DS Reader 11	Pt MJF Reader 12	Sp CD Reader 13	Sp AA Reader 14	ALL
0	21.9	20.8	18.4	20.9	20.8	26.4	-	21.1	24.2	19.3	-	24.6	18.4	22.3	22.4
1	26.2	22.9	23.6	25.3	24.0	24.6	23.7	25.5	22.7	24.5	24.4	25.5	25.5	25.6	24.7
2	32.4	29.6	27.1	28.3	30.7	32.5	30.7	32.8	31.4	30.7	31.0	31.4	32.5	32.0	31.5
3	34.7	32.5	31.7	31.8	32.9	34.9	33.3	33.5	33.0	33.2	33.7	33.6	35.2	35.0	33.7
4	36.9	34.8	34.3	33.9	35.9	36.2	34.9	35.6	33.8	36.5	36.4	36.9	37.0	36.5	35.6
5	37.8	36.8	35.7	36.0	36.6	36.7	36.8	37.1	36.2	37.1	36.7	36.4	37.0	37.6	36.5
6	38.7	37.8	37.3	36.9	37.5	37.6	36.7	37.3	37.8	37.8	37.1	38.1	-	38.7	37.4
7	-	38.2	37.3	38.1	36.1	36.5	38.7	-	-	-	-	-	-	-	37.8
8	-	-	36.9	37.4	-	-	-	-	-	-	-	-	-	-	37.2
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	37.6	-	-	-	-	-	-	-	-	-	37.6

Table 3.3. Inter-reader bias test and reader against Modal age bias test (for all readers). (where: - = no sign of bias (p>0.05), * = possibility of bias (0.01<p<0.05) and ** = certainty of bias (p<0.01).

	Sp CN Reader 1	Sp AJ Reader 2	Sp EG Reader 3	Sp MV Reader 4	It PC Reader 5	Pt DM Reader 6	Pt AS Reader 7	It AM Reader 8	Pt ES Reader 9	Pt SD Reader 10	Pt DS Reader 11	Pt MJF Reader 12	Sp CD Reader 13	Sp AA Reader 14
Reader 1														
Reader 2	**													
Reader 3	**	**												
Reader 4	**	**	–											
Reader 5	**	–	**	**										
Reader 6	–	**	**	**	**									
Reader 7	**	–	**	**	–	**								
Reader 8	**	**	**	**	**	*	**							
Reader 9	**	–	**	**	–	**	–	**						
Reader 10	**	**	**	**	**	**	**	**	*					
Reader 11	**	**	**	**	**	**	**	–	**	–				
Reader 12	**	**	**	**	**	*	**	–	**	**	–			
Reader 13	–	**	**	**	**	*	**	**	**	**	**	**		
Reader 14	–	**	**	**	**	–	**	**	**	**	**	**	–	
MODAL age	**	**	**	**	**	**	**	–	**	*	–	–	**	**

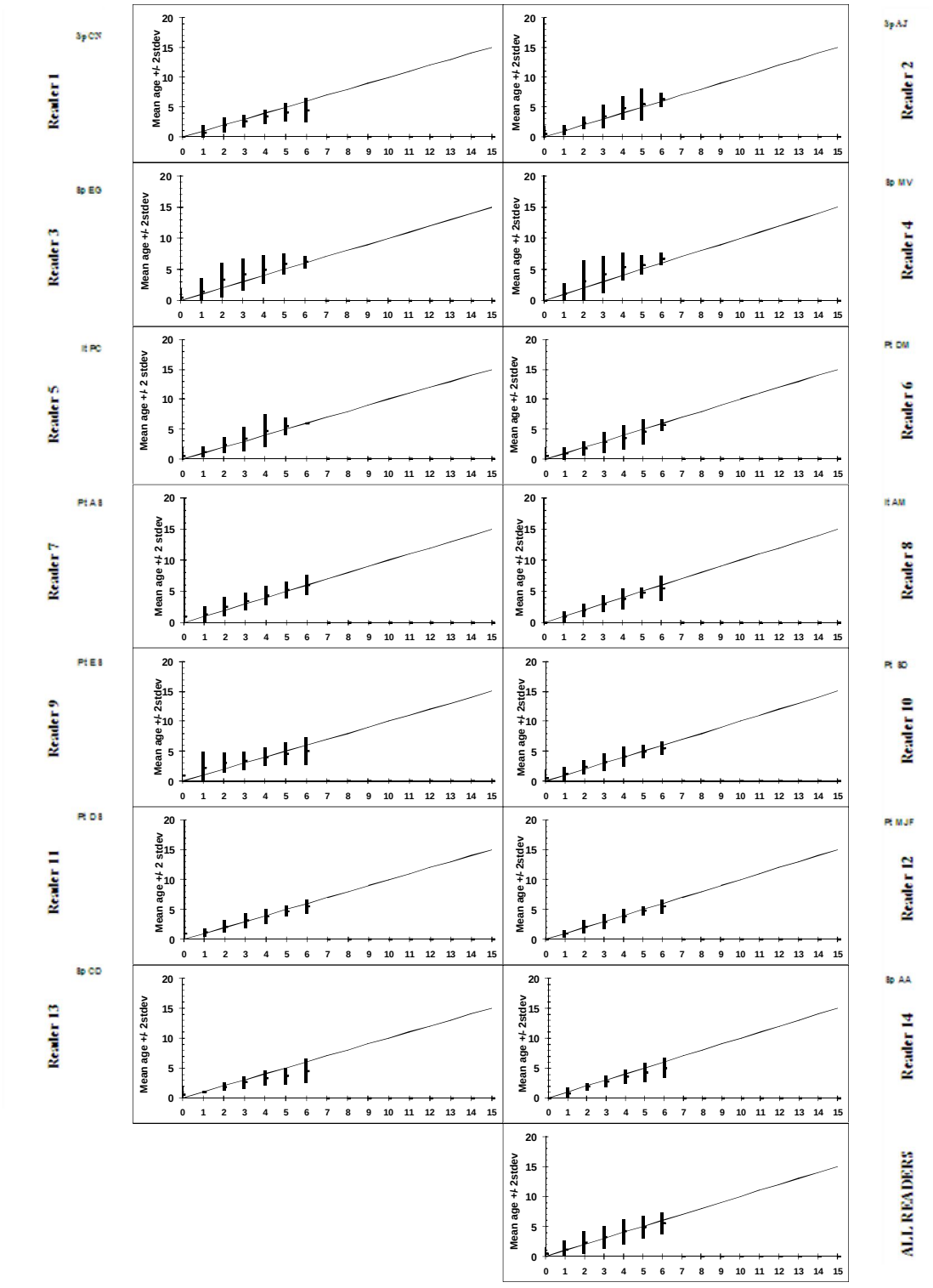

Figure 3.1. Age bias plots with the mean age recorded +/- 2stdev of each age reader and all readers combined are plotted against the MODAL age (all readers).

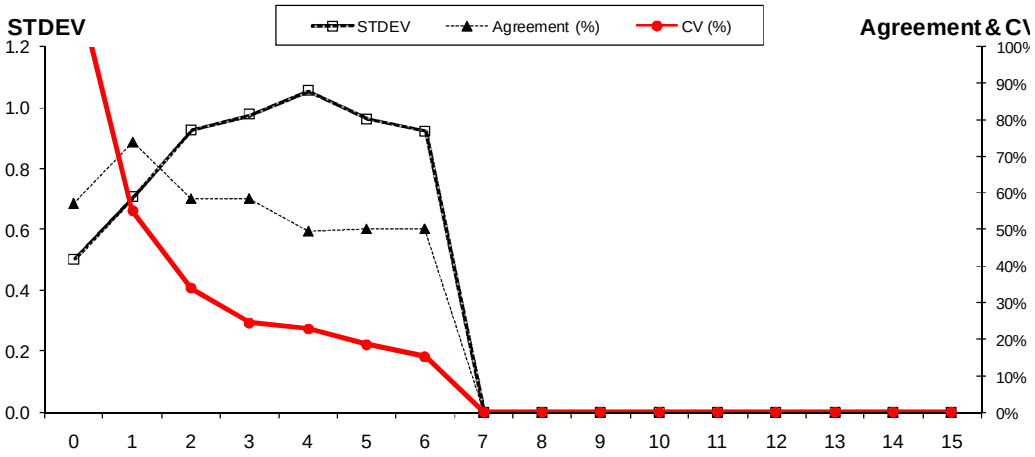

Figure 3.2. Coefficient of variation (CV%), percent agreement and the standard deviation (STDEV) plotted against MODAL age for all readers combined.

ANNEX 4: Intermediate readers' analysis; tables and figures.

Table 4.1. Summary of the average percentage of agreement, CV and relative bias by age for Intermediate readers.

Modal Age	Otolith No	% Agreement	CV	Bias
0	4	62.5	157.7	0.38
1	12	73.9	37.7	0.26
2	12	62.2	25.4	0.27
3	31	69.8	18.3	0.17
4	19	54.5	26.3	-0.04
5	31	50.0	27.0	-0.26
6	12	52.9	25.2	-0.65
7	2	75.0	11.4	-0.38
8	2	57.1	37.5	-1.57
Total	**125**	**53.3**	**31.0**	**-0.02**

Table 4.2. Intermediate readers against Modal age bias test. (where: - = no sign of bias ($p>0.05$), * = possibility of bias ($0.01<p<0.05$) and ** = certainty of bias ($p<0.01$).

	Sp CN Reader 1	Sp AJ Reader 2	Sp EG Reader 3	Sp MV Reader 4
MODAL age	* *	* *	* *	* *

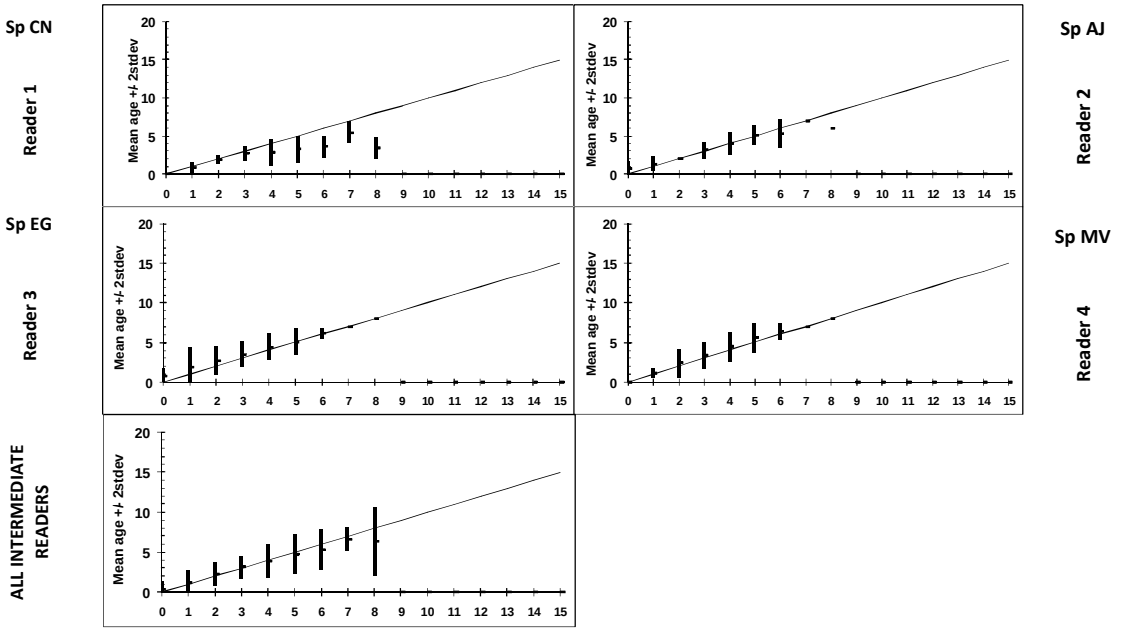

Figure 4.1. Age bias plots with the mean age recorded +/- 2stdev of each Intermediate age reader and all Intermediate readers combined are plotted against the MODAL age (intermediate readers).

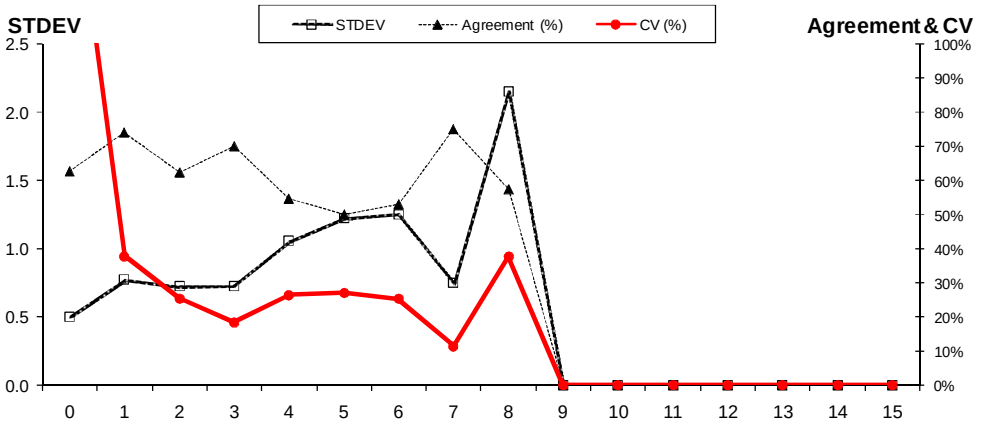

Figure 4.2. Coefficient of variation (CV%), percent agreement and the standard deviation (STDEV) plotted against MODAL age for Intermediate readers combined.

ANNEX 5: Trainee readers' analysis; tables and figures.

Table 5.1. Summary of the average percentage of agreement, CV and relative bias by age for trainee readers.

Modal Age	Otolith No	% Agreement	CV	Bias
0	1	50.0	-	0.50
1	14	73.9	59.1	0.13
2	23	65.2	25.5	0.24
3	46	66.2	19.4	0.07
4	26	58.0	19.3	-0.10
5	12	54.7	17.8	-0.20
6	3	56.7	15.4	-0.63
Total	**125**	**63.7**	**25.4**	**0.03**

Table 5.2. Trainee readers against Modal age bias test. (Where: - = no sign of bias (p>0.05), * = possibility of bias (0.01<p<0.05) and ** = certainty of bias (p<0.01)).

	It PC Reader 5	Pt DM Reader 6	Pt AS Reader 7	It AM Reader 8	Pt ES Reader 9	Pt SD Reader 10	Pt DS Reader 11	Pt MJF Reader 12	Sp CD Reader 13	Sp AA Reader 14
MODAL age	* *	* *	* *	–	* *	* *	–	–	* *	* *

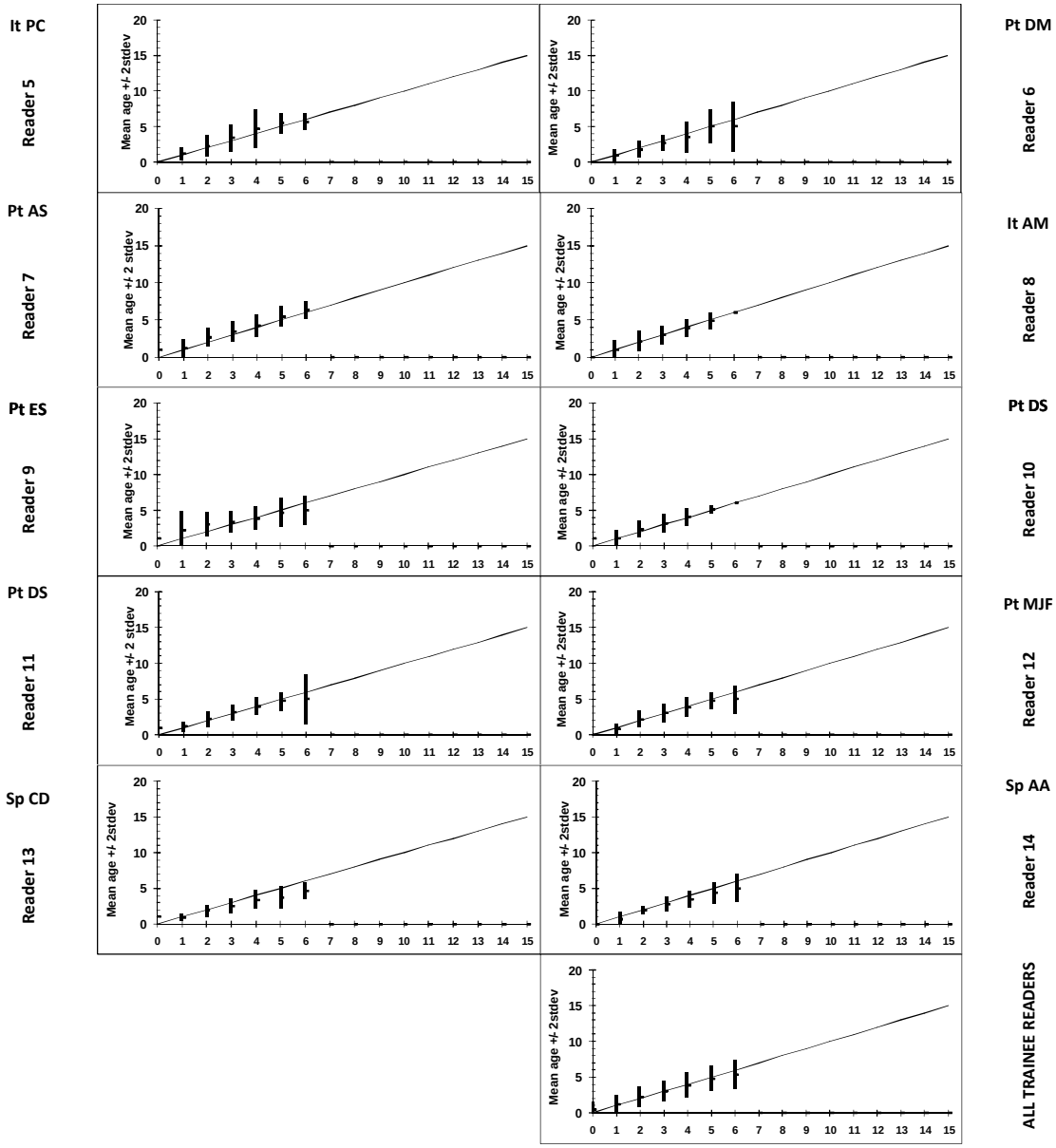

Figure 5.1. Age bias plots with the mean age recorded +/- 2stdev of each Trainee age reader and all Trainee readers combined are plotted against the MODAL age (trainee readers).

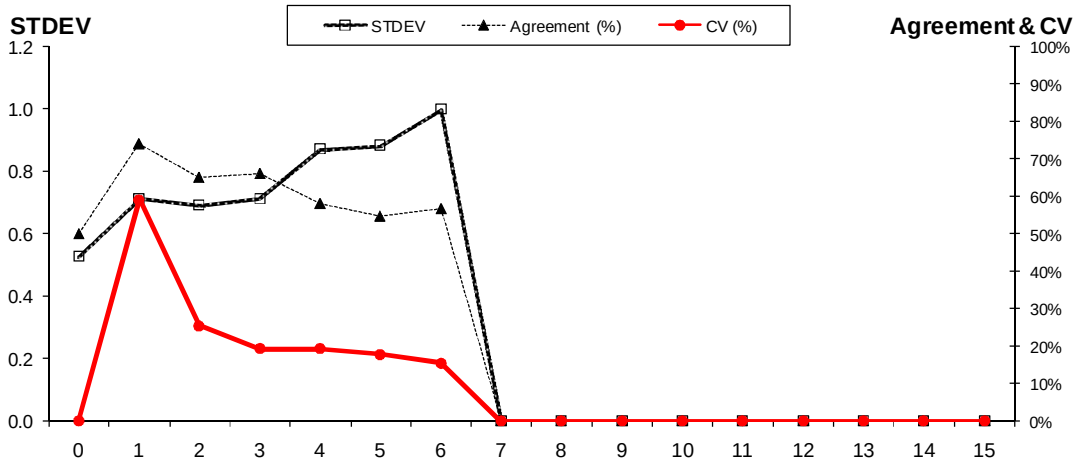

Figure 5.2. Coefficient of variation (CV%), percent agreement and the standard deviation (STDEV) plotted against MODAL age for Trainee readers combined.

ANNEX 6: Bay of Biscay set analysis; tables and figures.

Table 6.1. Summary of the average percentage of agreement, CV and relative bias by age for the Bay of Biscay set (all readers included).

Modal Age	Otolith No	% Agreement	CV	Bias
0	-	-	-	-
1	-	-	-	-
2	8	67.0	35.3	0.52
3	23	53.1	30.0	0.41
4	8	48.2	24.8	0.10
5	9	51.2	18.1	-0.05
6	2	37.0	18.8	-0.74
Total	**50**	**53.5**	**27.4**	**0.25**

Table 6.2. Mean length at age of the Bay of Biscay set (all readers)

Age	Sp CN Reader 1	Sp AJ Reader 2	Sp EG Reader 3	Sp MV Reader 4	It PC Reader 5	Pt DM Reader 6	Pt AS Reader 7	It AM Reader 8	Pt ES Reader 9	Pt SD Reader 10	Pt DS Reader 11	Pt MJF Reader 12	Sp CD Reader 13	Sp AA Reader 14	ALL
0	-	-	-	-	-	38.00	-	-	-	-	-	34.80	-	-	36.40
1	-	-	-	-	-	-	-	29.60	-	-	-	-	-	-	29.60
2	34.80	29.37	27.50	27.50	33.72	34.85	35.56	35.40	35.30	33.24	33.37	33.58	34.51	34.55	34.21
3	36.70	34.78	33.45	33.54	35.64	36.53	35.55	36.10	35.95	36.28	36.65	36.12	37.47	36.85	36.22
4	37.62	36.20	35.93	34.62	37.35	37.87	36.77	38.57	37.03	37.80	37.78	38.00	37.60	37.25	37.25
5	37.75	37.69	36.48	37.62	37.65	37.07	37.60	36.97	37.32	37.43	37.12	37.11	36.90	37.90	37.26
6	-	38.15	37.34	36.84	37.62	38.00	36.83	36.75	37.40	-	-	37.40	-	-	37.37
7	-	38.03	37.10	38.07	36.10	-	-	-	-	-	-	-	-	-	37.76
8	-	-	-	38.40	-	-	-	-	-	-	-	-	-	-	38.40
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 6.3. Inter-reader bias test and reader against Modal age bias test (Bay of Biscay set). (where: - = no sign of bias (p>0.05), * = possibility of bias (0.01<p<0.05) and ** = certainty of bias (p<0.01).

	Sp CN Reader 1	Sp AJ Reader 2	Sp EG Reader 3	Sp MV Reader 4	It PC Reader 5	Pt DM Reader 6	Pt AS Reader 7	It AM Reader 8	Pt ES Reader 9	Pt SD Reader 10	Pt DS Reader 11	Pt MJF Reader 12	Sp CD Reader 13	Sp AA Reader 14
Reader 1														
Reader 2	**													
Reader 3	**	*												
Reader 4	**	**	–											
Reader 5	**	*	**	**										
Reader 6	–	**	**	**	**									
Reader 7	**	**	**	**	–	**								
Reader 8	*	**	**	**	**	–	**							
Reader 9	**	**	**	**	**	*	–	–						
Reader 10	**	**	**	**	**	*	–	–	–					
Reader 11	**	**	**	**	**	*	–	–	–	–				
Reader 12	**	**	**	**	**	–	*	–	–	–	–			
Reader 13	–	**	**	**	**	–	**	**	**	**	**	**		
Reader 14	–	**	**	**	**	–	**	*	*	**	**	**	–	
MODAL Age	**	**	**	**	**	*	**	–	–	–	–	–	**	**

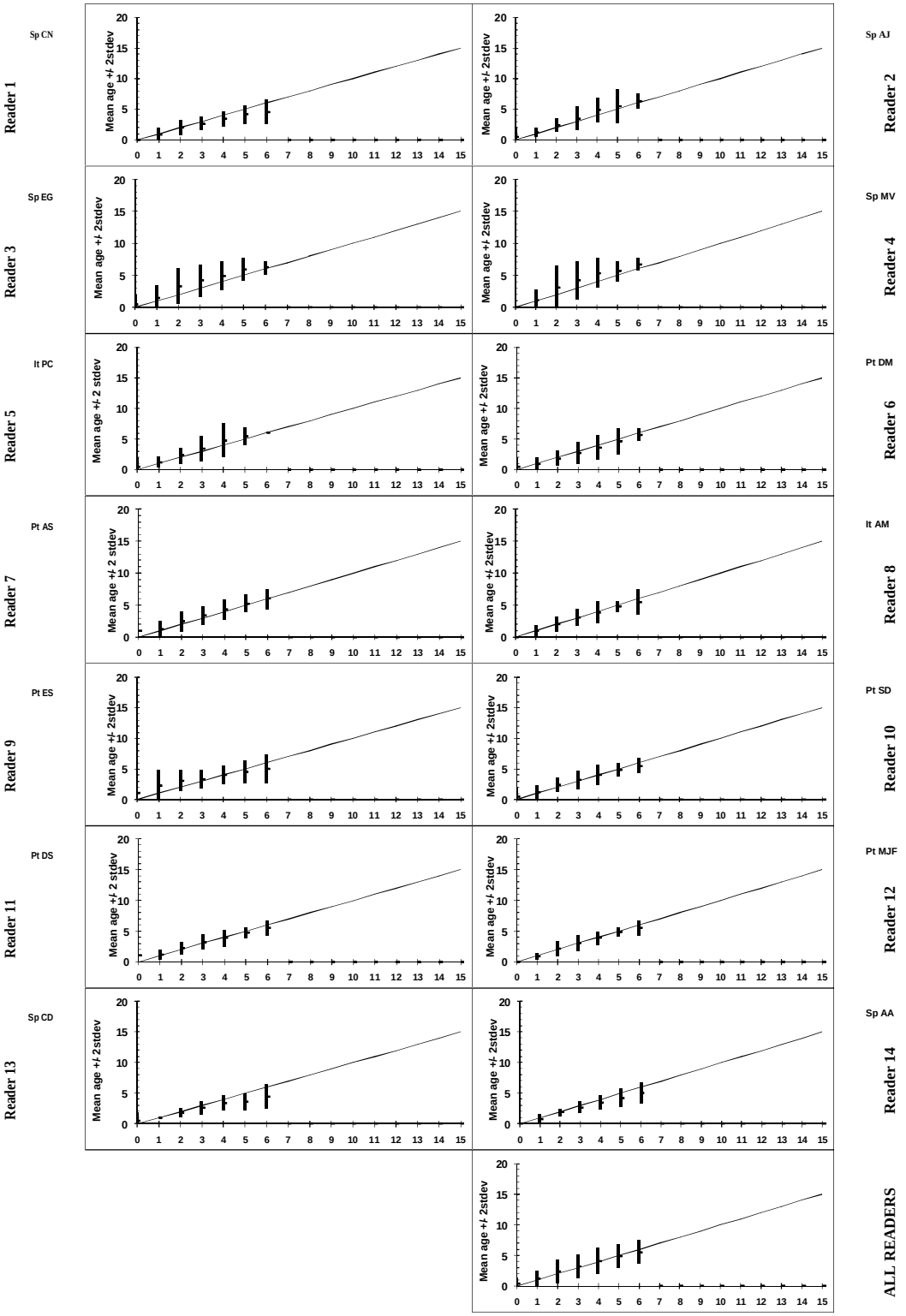

Figure 6.1. Age bias plots with the mean age recorded +/- 2stdev of each age reader and all readers combined plotted against the MODAL age (Bay of Biscay set).

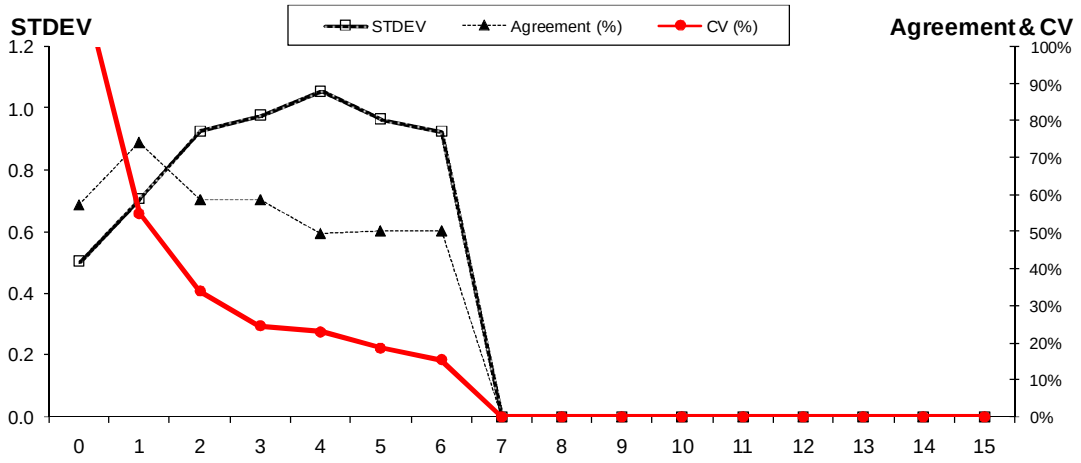

Figure 6.2. Coefficient of variation (CV%), percent agreement and the standard deviation (STDEV) plotted against MODAL age for all readers combined (Bay of Biscay set).

ANNEX 7: Portugal set analysis; tables and figures.

Table 7.1. Summary of the average percentage of agreement, CV and relative bias by age for the Portugal set of otoliths (all readers included).

Modal Age	Otolith No	% Agreement	CV	Bias
0	-	-	-	-
1	2	92.9	46.8	0.14
2	1	64.3	-	0.36
3	9	50.4	24.1	0.20
4	9	51.2	19.5	0.20
5	2	44.4	20.2	-0.48
6	2	63.0	11.8	-0.15
Total	**25**	**55.3**	**22.8**	**0.12**

Table 7.2. Mean length at age of the Portugal set (all readers)

Age	Sp CN Reader 1	Sp AJ Reader 2	Sp EG Reader 3	Sp MV Reader 4	It PC Reader 5	Pt DM Reader 6	Pt AS Reader 7	It AM Reader 8	Pt ES Reader 9	Pt SD Reader 10	Pt DS Reader 11	Pt MJF Reader 12	Sp CD Reader 13	Sp AA Reader 14	ALL
0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	20.15	20.15	20.15	20.15	20.15	20.15	20.15	20.15	-	20.15	20.15	20.15	20.15	20.15	20.15
2	29.13	28.30	27.90	-	28.25	29.42	28.30	27.90	27.90	28.60	30.45	27.90	30.38	29.17	29.23
3	34.15	31.90	29.55	29.86	29.84	33.37	30.15	29.42	26.38	30.26	31.90	31.14	34.51	33.84	31.53
4	36.92	27.70	31.96	34.00	34.81	34.48	33.04	34.42	33.75	34.87	34.89	35.50	35.82	36.65	34.57
5	-	35.37	34.55	35.33	35.57	36.10	35.83	38.30	37.58	35.63	36.20	35.77	37.10	35.50	35.79
6	38.70	36.90	37.15	36.10	36.97	37.10	36.64	37.67	38.70	37.83	37.10	38.70	-	38.70	37.31
7	-	38.70	37.43	38.70	-	36.50	38.70	-	-	-	-	-	-	-	37.79
8	-	-	36.50	36.50	-	-	-	-	-	-	-	-	-	-	36.50
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 7.2. Inter-reader bias test and reader against Modal age bias test (Portugal set). (Where: - = no sign of bias ($p>0.05$), * = possibility of bias ($0.01<p<0.05$) and ** = certainty of bias ($p<0.01$).

	Sp CN Reader 1	Sp AJ Reader 2	Sp EG Reader 3	Sp MV Reader 4	It PC Reader 5	Pt DM Reader 6	Pt AS Reader 7	It AM Reader 8	Pt ES Reader 9	Pt SD Reader 10	Pt DS Reader 11	Pt MJF Reader 12	Sp CD Reader 13	Sp AA Reader 14
Reader 1														
Reader 2	**													
Reader 3	**	–												
Reader 4	**	–	*											
Reader 5	**	–	*	–										
Reader 6	**	*	**	**	–									
Reader 7	**	–	*	–	–	**								
Reader 8	**	–	**	–	–	–	–							
Reader 9	**	–	*	–	–	–	–	–						
Reader 10	**	–	**	–	–	–	–	–	–					
Reader 11	**	–	**	**	–	**	**	–	*	–				
Reader 12	**	–	**	**	*	–	**	–	*	–	–			
Reader 13	–	**	**	**	**	**	**	**	**	**	**	**		
Reader 14	–	**	**	**	**	**	**	**	**	**	**	**	–	
MODAL Age	**	–	**	**	–	–	**	–	–	–	–	–	**	**

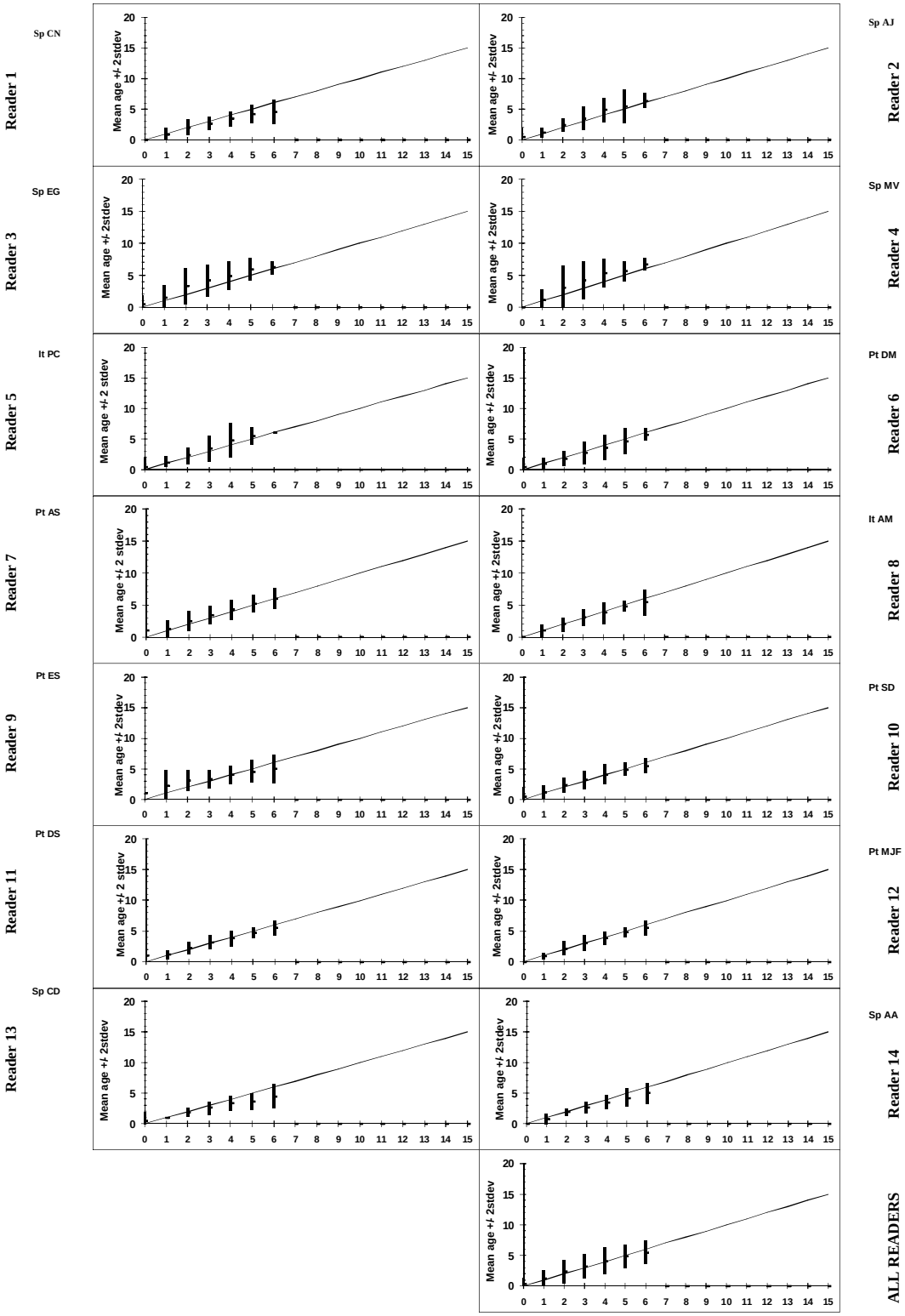

Figure 7.1. Age bias plots with the mean age recorded +/- 2stdev of each age reader and all readers combined plotted against the MODAL age (Portugal set).

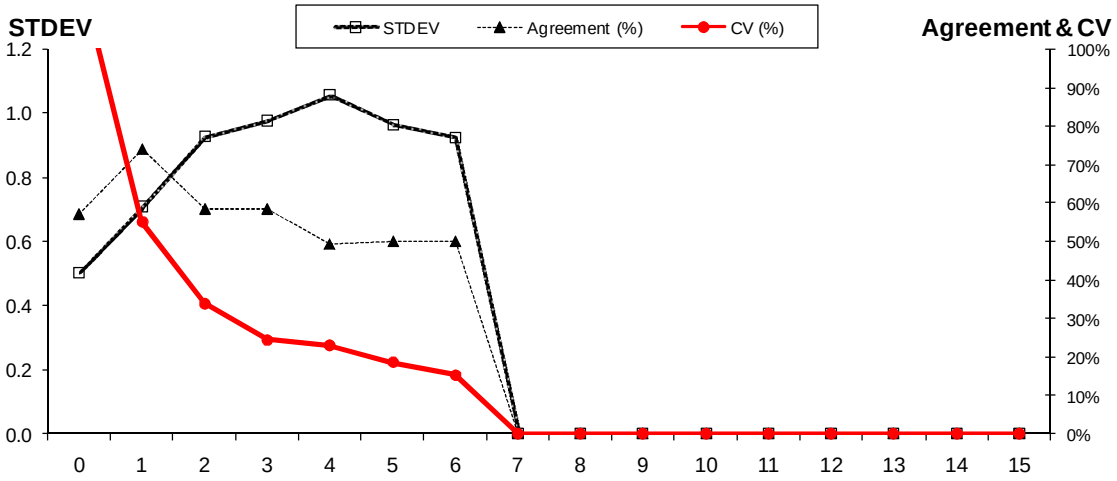

Figure 7.2. Coefficient of variation (CV%), percent agreement and the standard deviation (STDEV) plotted against MODAL age for all readers combined (Portugal set).

ANNEX 8: Mediterranean set analysis; tables and figures.

Table 8.1. Summary of the average percentage of agreement, CV and relative bias by age for the Mediterranean set of otoliths (all readers included).

Modal Age	Otolith No	% Agreement	CV	Bias
0	2	57.1	119.8	0.43
1	11	70.5	56.5	0.17
2	12	52.4	33.9	0.25
3	18	69.0	17.5	0.05
4	7	48.4	25.0	0.05
Total	**50**	**62.1**	**35.2**	**0.14**

Table 8.2. Mean length at age of the Mediterranean set (all readers)

Age	Sp CN Reader 1	Sp AJ Reader 2	Sp EG Reader 3	Sp MV Reader 4	It PC Reader 5	Pt DM Reader 6	Pt AS Reader 7	It AM Reader 8	Pt ES Reader 9	Pt SD Reader 10	Pt DS Reader 11	Pt MJF Reader 12	Sp CD Reader 13	Sp AA Reader 14	ALL
0	21.93	20.80	18.40	20.88	20.80	23.53	-	21.13	24.20	19.25	-	21.20	18.40	22.30	21.53
1	27.46	23.59	24.43	26.21	24.78	25.39	24.35	26.28	22.70	25.52	25.14	26.40	26.25	26.70	25.54
2	31.10	29.93	26.99	28.50	28.68	31.25	27.93	31.17	28.61	28.63	28.77	29.91	31.66	30.75	29.94
3	32.62	31.46	32.00	31.81	32.08	33.75	31.64	31.92	31.05	32.05	32.26	32.57	32.66	33.05	32.22
4	35.48	34.54	33.84	32.78	34.85	34.60	33.61	34.68	32.07	35.40	35.38	36.20	37.60	35.18	34.12
5	-	32.00	33.78	34.25	35.55	-	35.65	-	32.92	37.45	32.00	34.65	-	-	34.23
6	-	37.30	-	38.30	-	-	-	-	-	-	-	-	-	-	37.97
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	-	-	37.30	37.30	-	-	-	-	-	-	-	-	-	-	37.30
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	37.60	-	-	-	-	-	-	-	-	-	37.60
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 8.3. Inter-reader bias test and reader against Modal age bias test (Mediterranean set). (Where: - = no sign of bias (p>0.05), * = possibility of bias (0.01<p<0.05) and ** = certainty of bias (p<0.01).

	Sp CN Reader 1	Sp AJ Reader 2	Sp EG Reader 3	Sp MV Reader 4	It PC Reader 5	Pt DM Reader 6	Pt AS Reader 7	It AM Reader 8	Pt ES Reader 9	Pt SD Reader 10	Pt DS Reader 11	Pt MJF Reader 12	Sp CD Reader 13	Sp AA Reader 14
Reader 1														
Reader 2	**													
Reader 3	**	–												
Reader 4	**	–	–											
Reader 5	**	–	–	–										
Reader 6	–	**	**	**	**									
Reader 7	**	–	–	–	–	**								
Reader 8	–	**	**	**	**	–	**							
Reader 9	**	*	–	–	*	**	–	**						
Reader 10	**	–	**	*	–	**	*	*	**					
Reader 11	**	–	*	–	–	**	*	**	**	–				
Reader 12	–	*	**	**	**	*	**	–	**	–	–			
Reader 13	–	**	**	**	**	–	**	*	**	**	**	*		
Reader 14	–	**	**	**	**	–	**	–	**	**	**	*	–	
MODAL Age	**	*	**	**	*	**	**	–	**	–	–	–	**	**

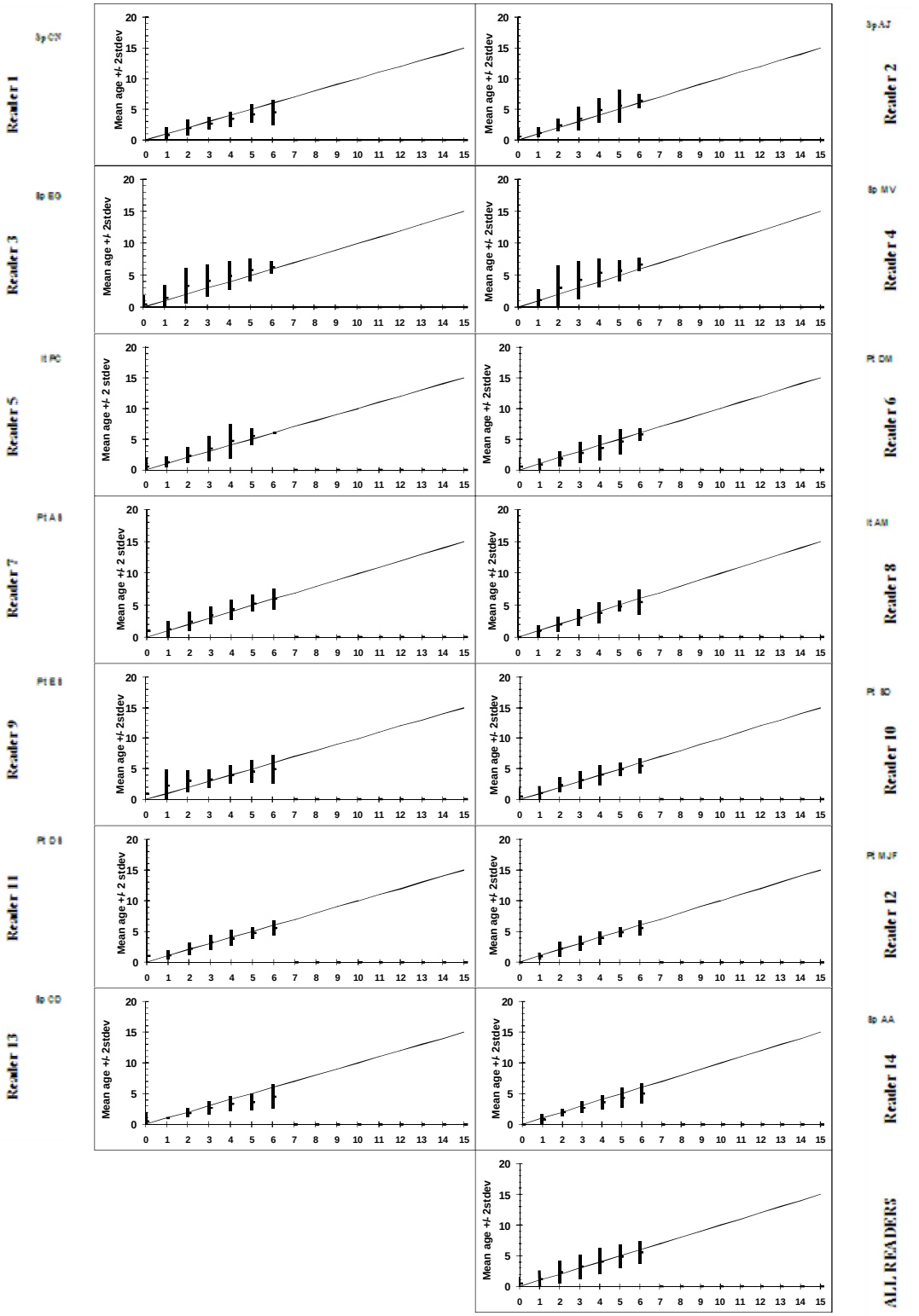

Figure 8.1. Age bias plots with the mean age recorded +/- 2stdev of each age reader and all readers combined plotted against the MODAL age (Mediterranean set).

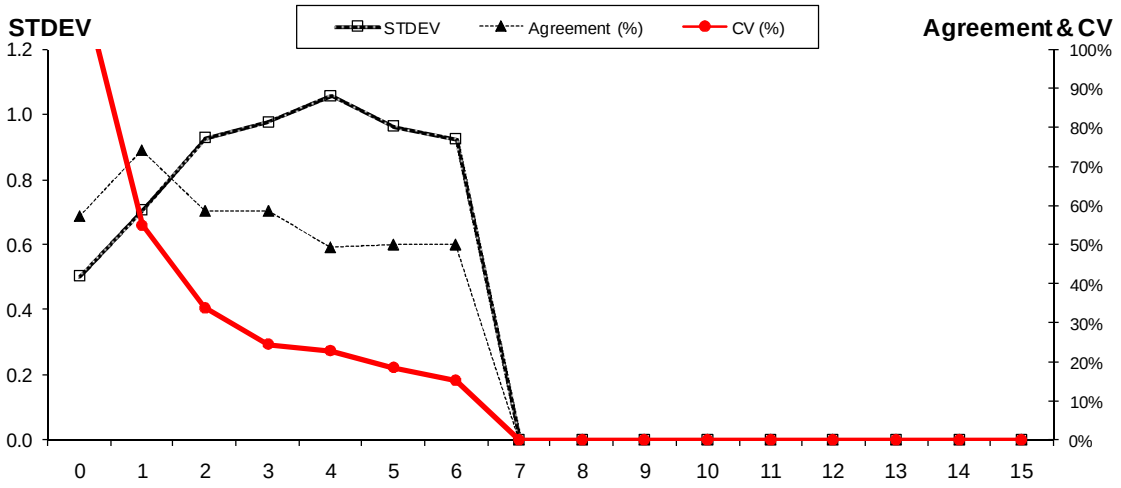

Figure 8.2. Coefficient of variation (CV%), percent agreement and the standard deviation (STDEV) plotted against MODAL age for all readers combined (Mediterranean set).

ANNEX 9: Chub mackerel growth pattern

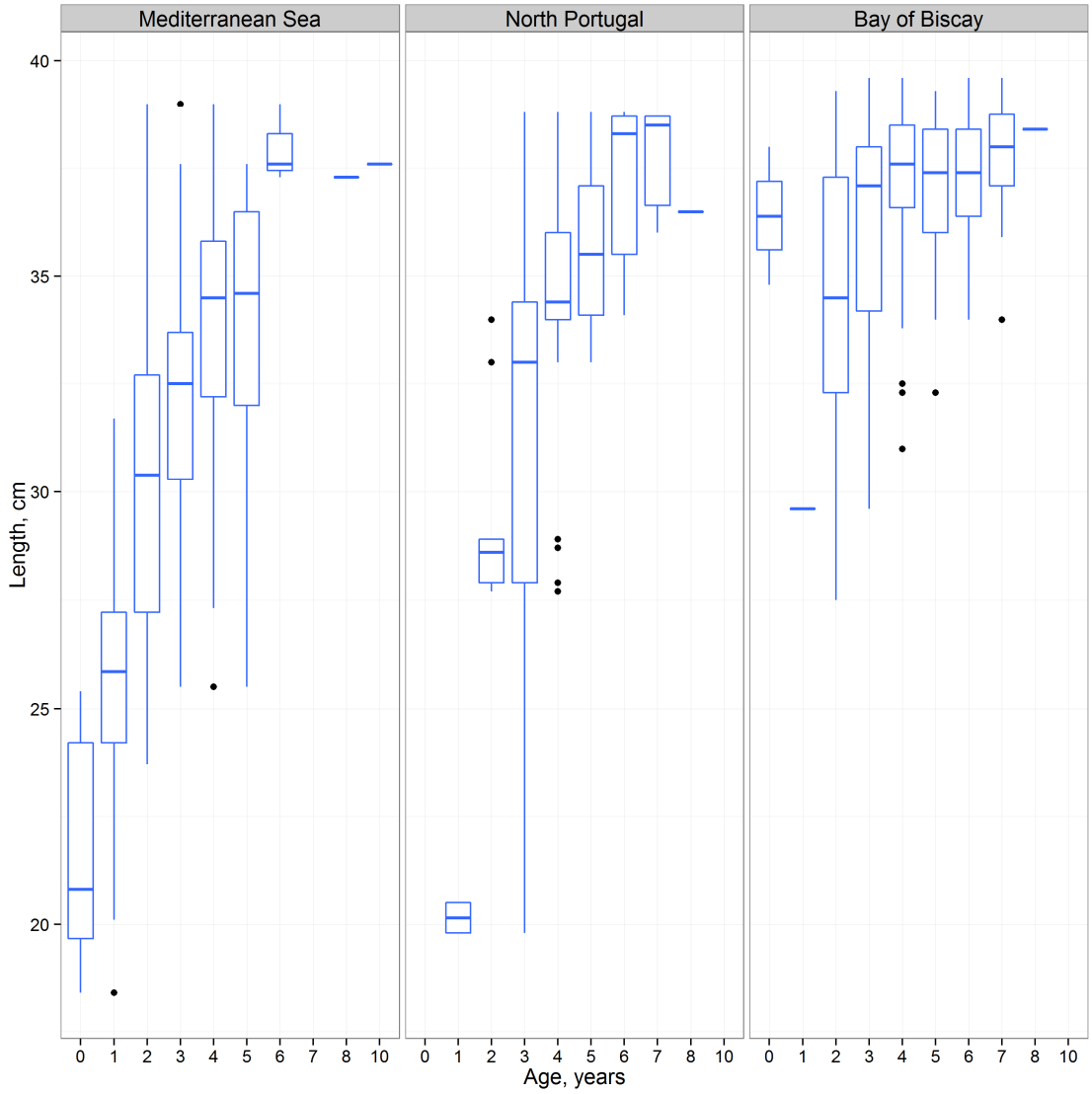

Figure 9.1. Chub mackerel growth pattern by area, given by the average age of all readers.

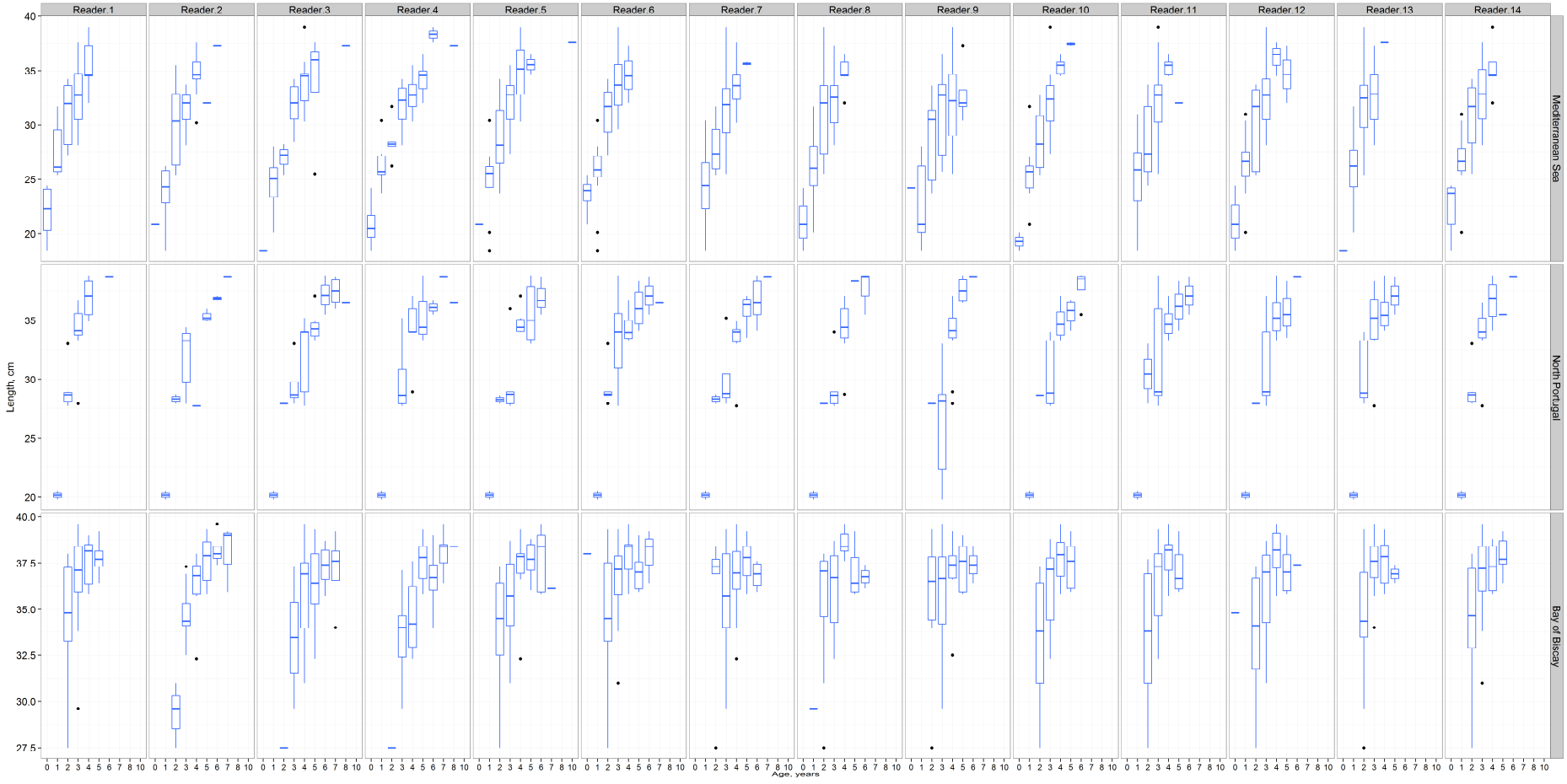

Figure 9.2. Chub mackerel growth pattern by area and by reader

ANNEX III: IMAGES OF REFERENCE

ANNEX 10: Otolith images with >80% of agreement

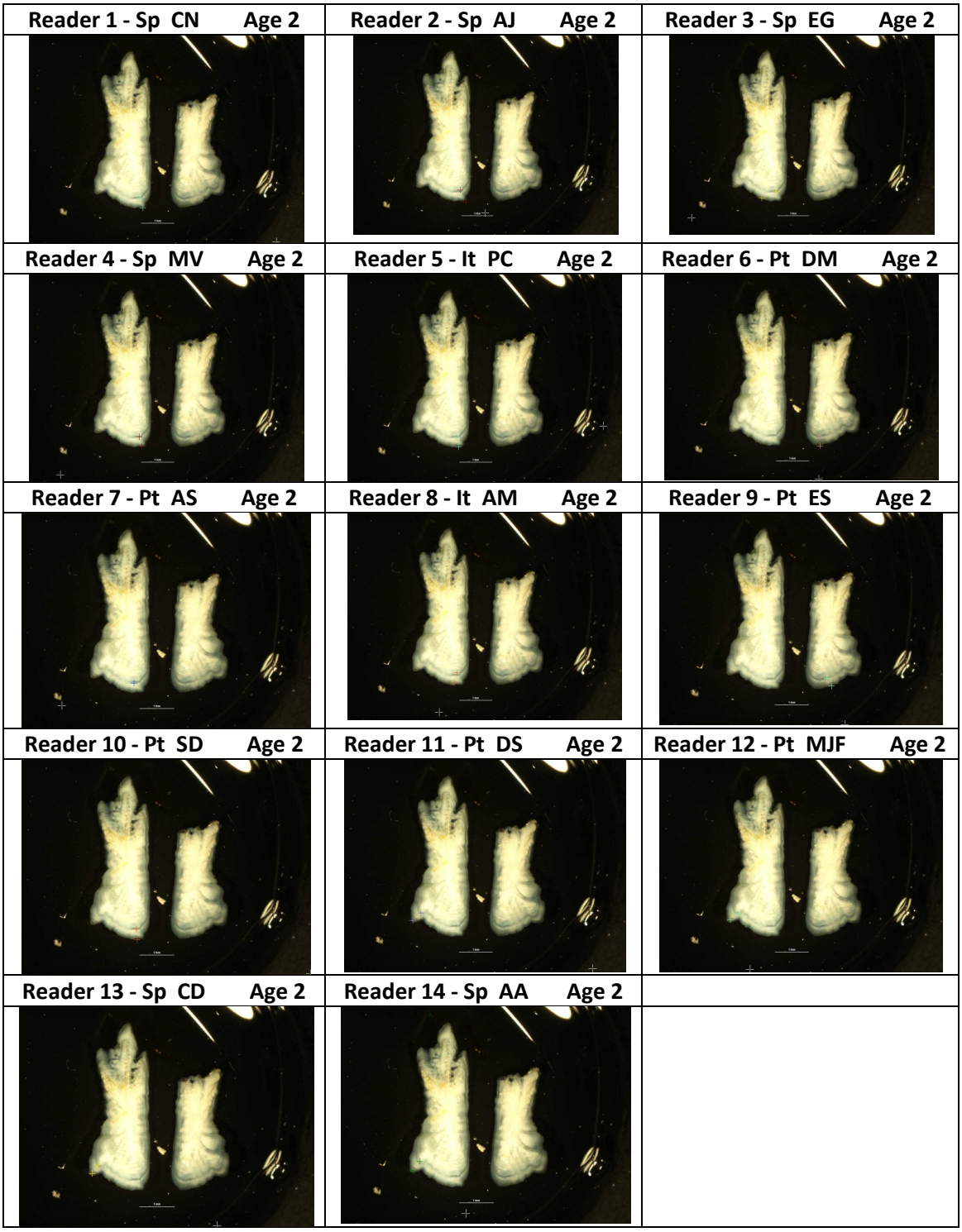

Figure 10.1. Otolith 55-Sc-IEO-S-5 with 100% of agreement for all readers (Fish length = 27.5 cm, Modal age = 2; captured in January 2011, in the Bay of Biscay, ICES VIIIcE).

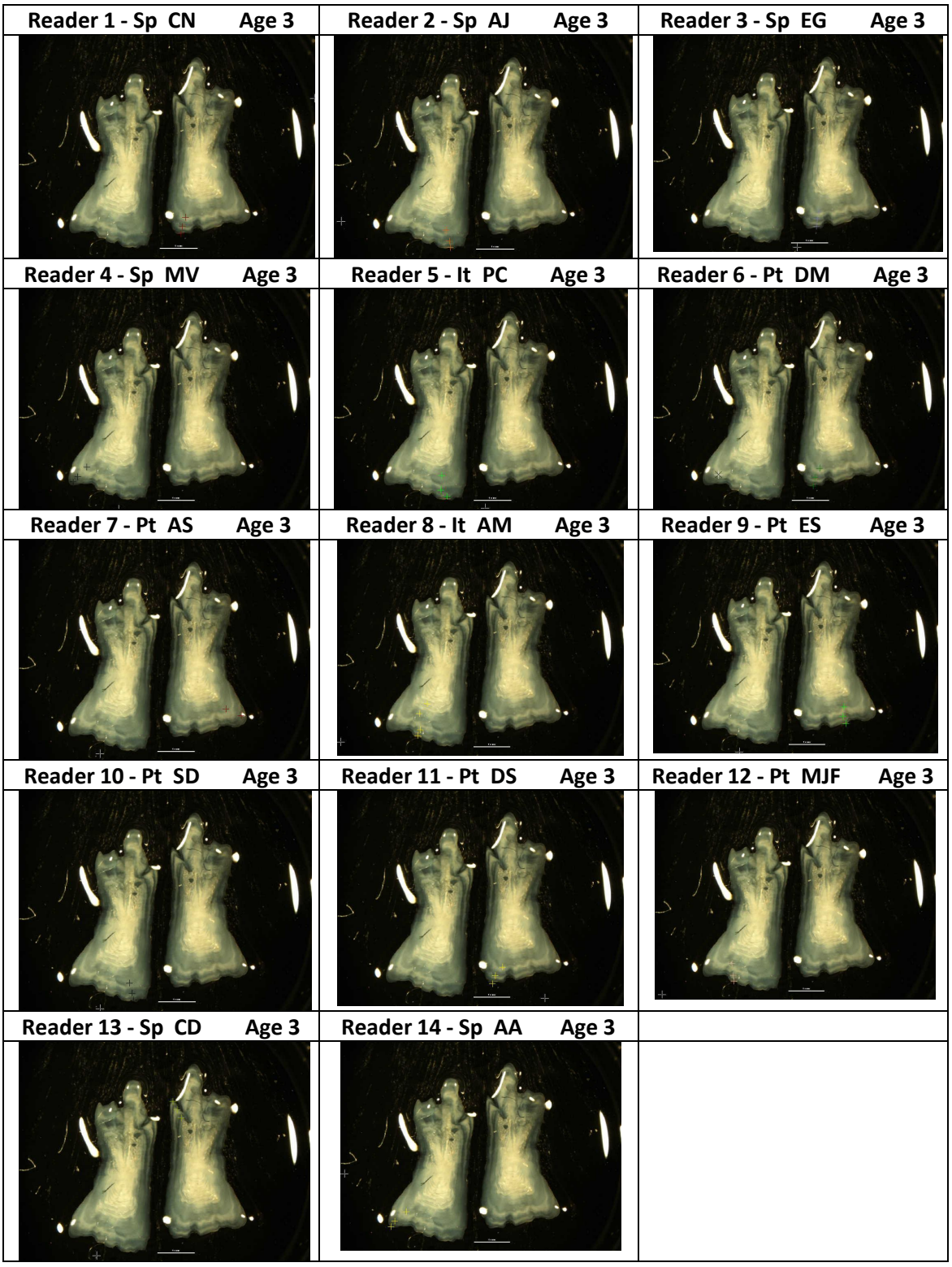

Figure 10.2. Otolith 13-O-IEO-M-13 with 100% of agreement for all readers (Fish length = 30.6 cm, Modal age = 3; caught in March 2011, in the Mediterranean Sea, GSA06).

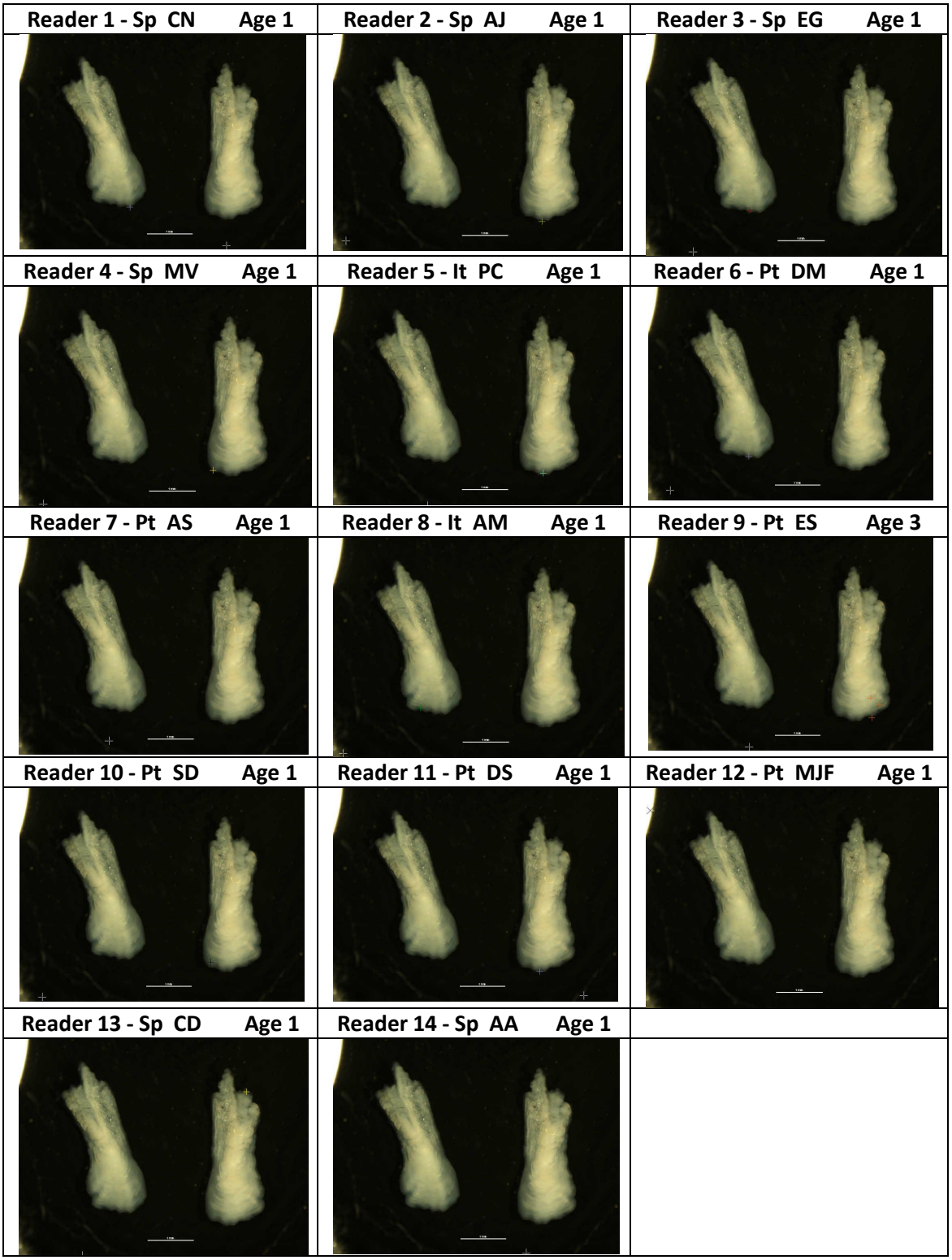

Figure 10.3. Otolith 107-Mas_MAT121_2011Mar with 93% of agreement for all readers (Fish length = 19.8 cm, Modal age = 1; caught in March 2011, in Portugal waters, ICES IXaC).

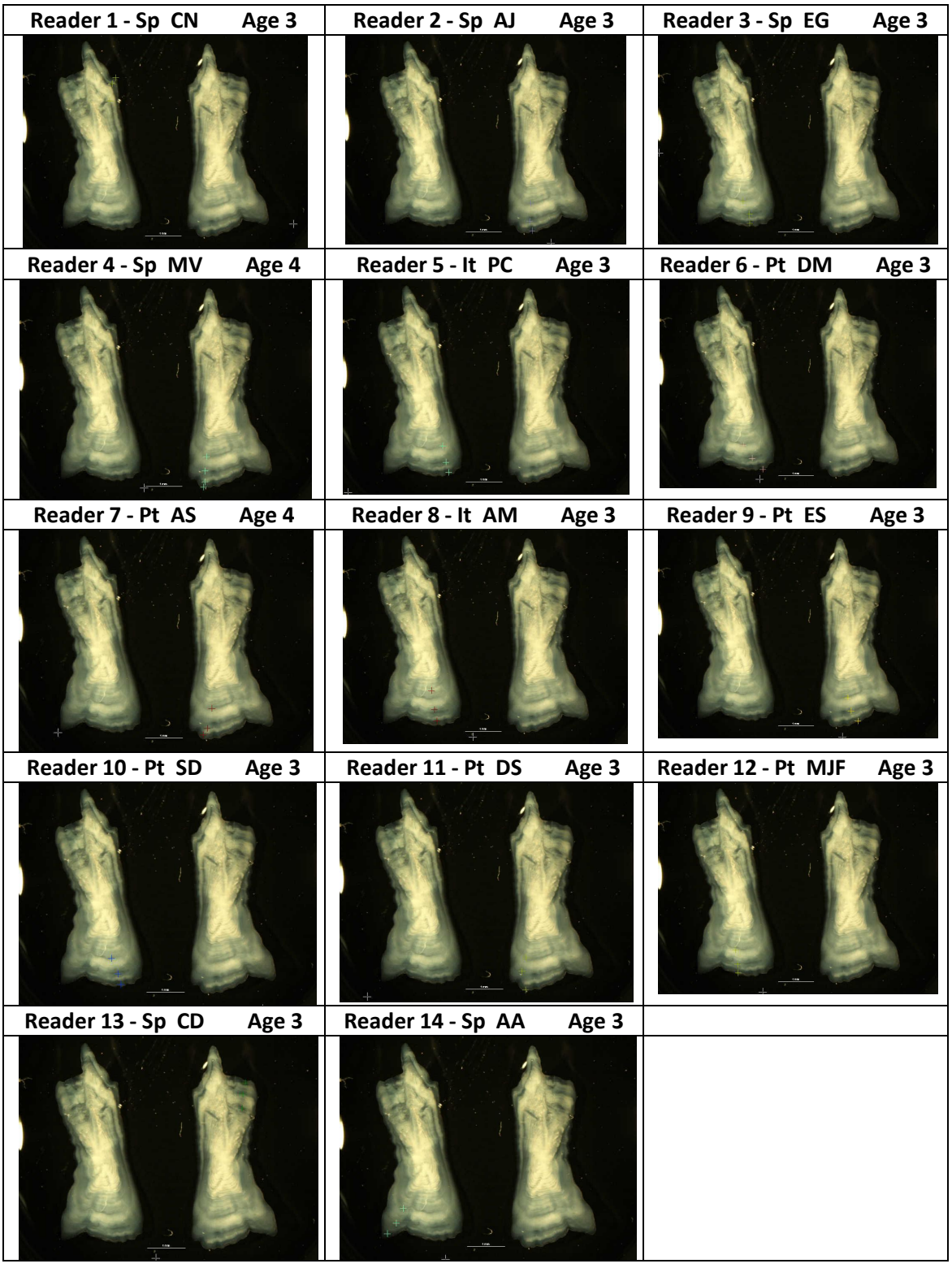

Figure 10.4. Otolith 4-O-IEO-M-4 with 86% of agreement of all readers (Fish length = 33.7 cm, Modal age = 3; caught in January 2011, in the Mediterranean Sea, GSA06).

ANNEX 11: Otolith images with <80% of agreement

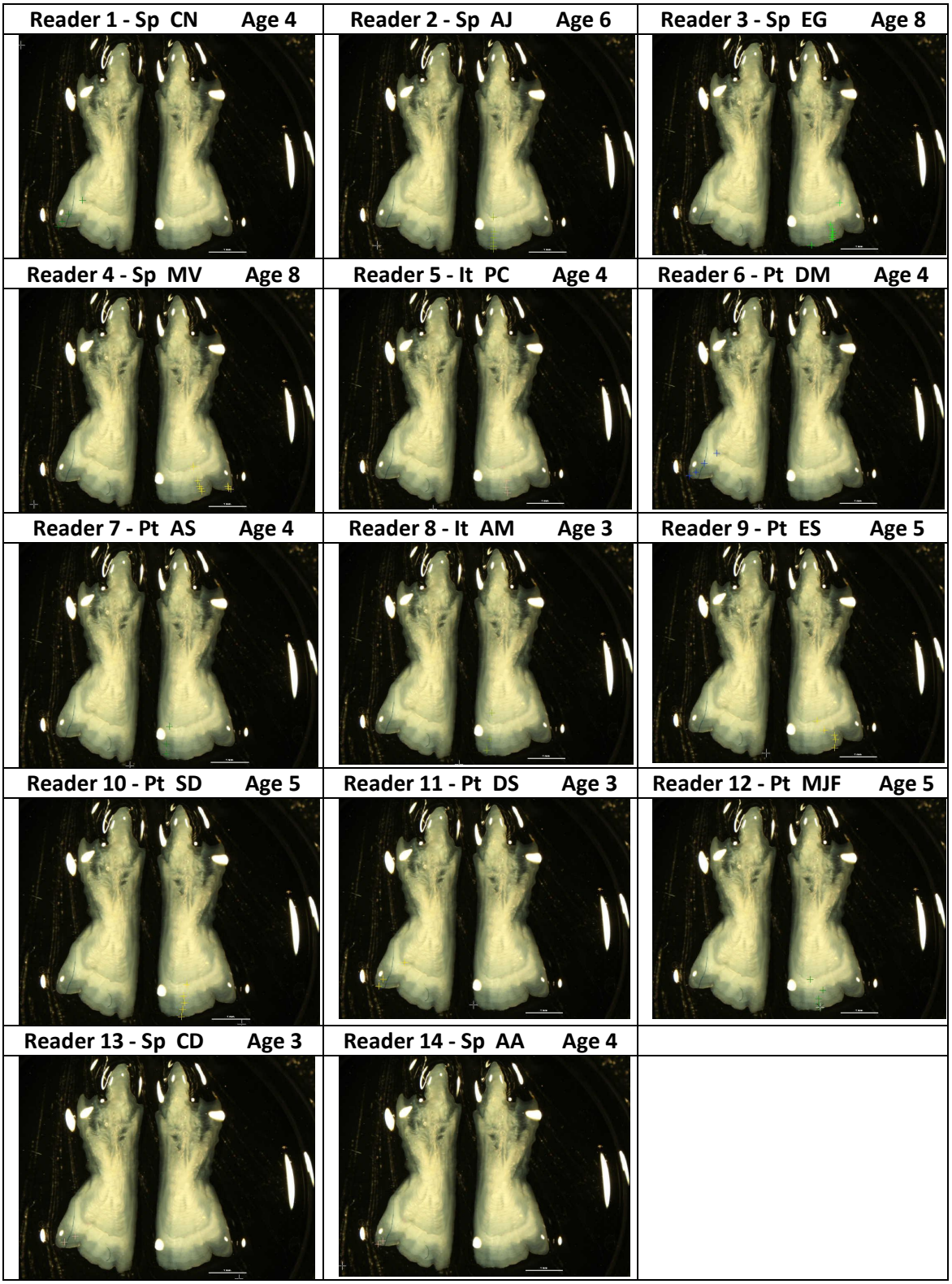

Figure 11.1. Otolith 7-O-IEO-M-7 with 29% of agreement for all readers (Fish length = 37.3 cm, Modal age = 4; caught in March 2011, in the Mediterranean Sea, GSA06).

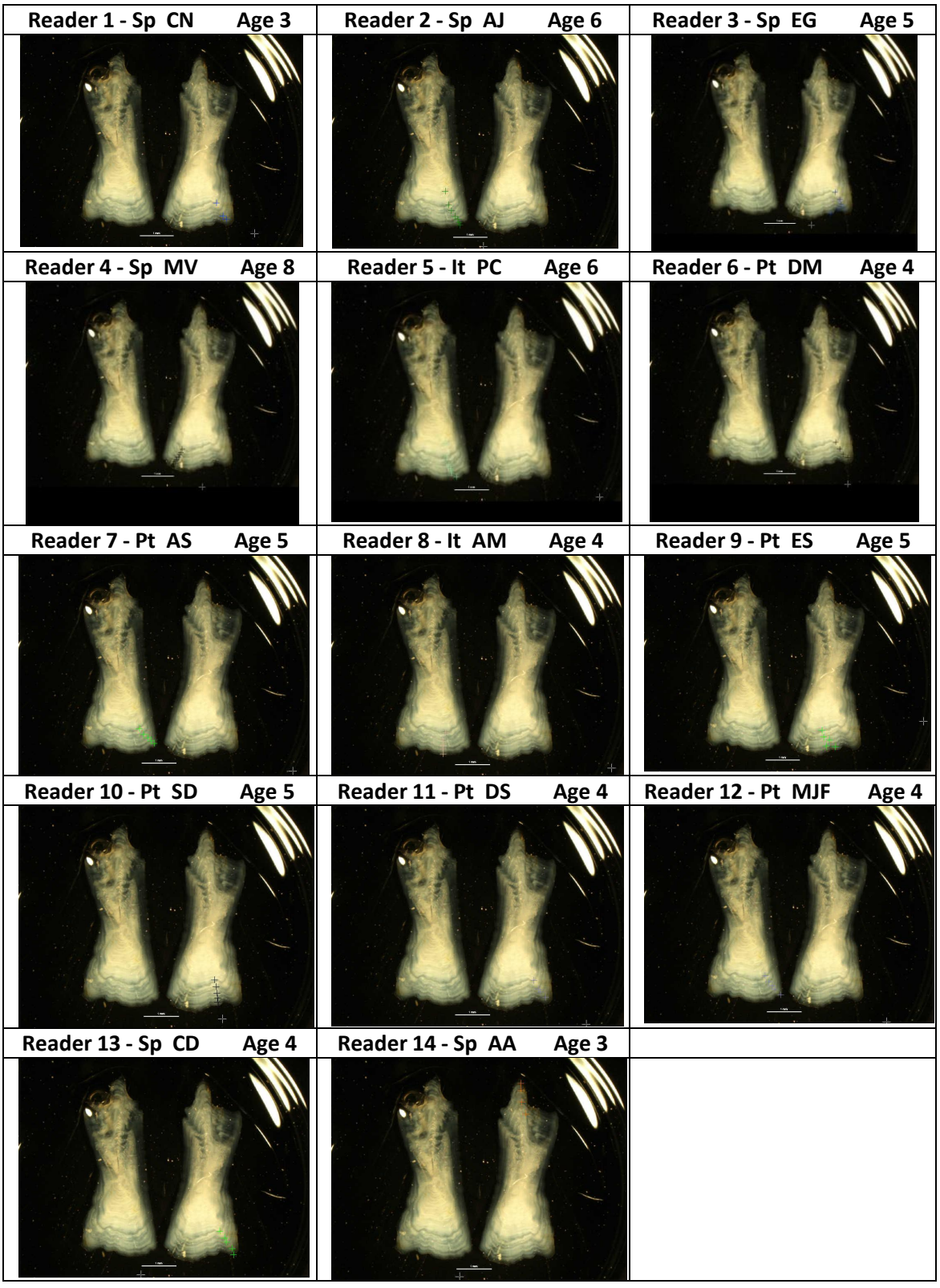

Figure 11.2. Otolith 91-Sc-IEO-S-63 with 36% agreement (Fish length = 38.4 cm, Modal age = 4; caught in October 2011, in the Bay of Biscay, ICES VIIIcE).

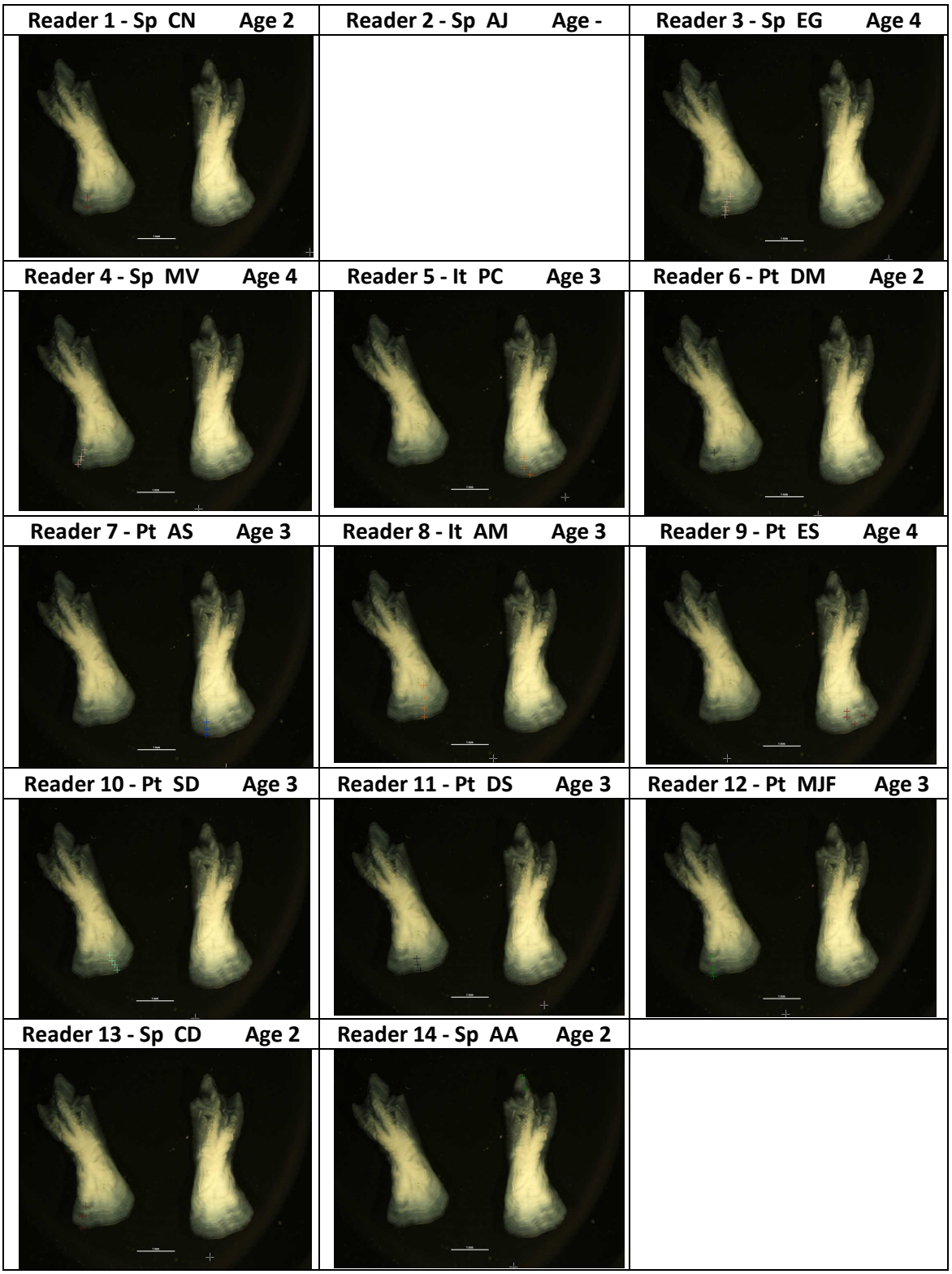

Figure 11.3. Otolith 125-Mas_MAT381_2011Jul with 46% agreement for all readers (Fish length = 28.9 cm, Modal age = 3; caught in July 2011, in Portugal waters, ICES IXaCN).

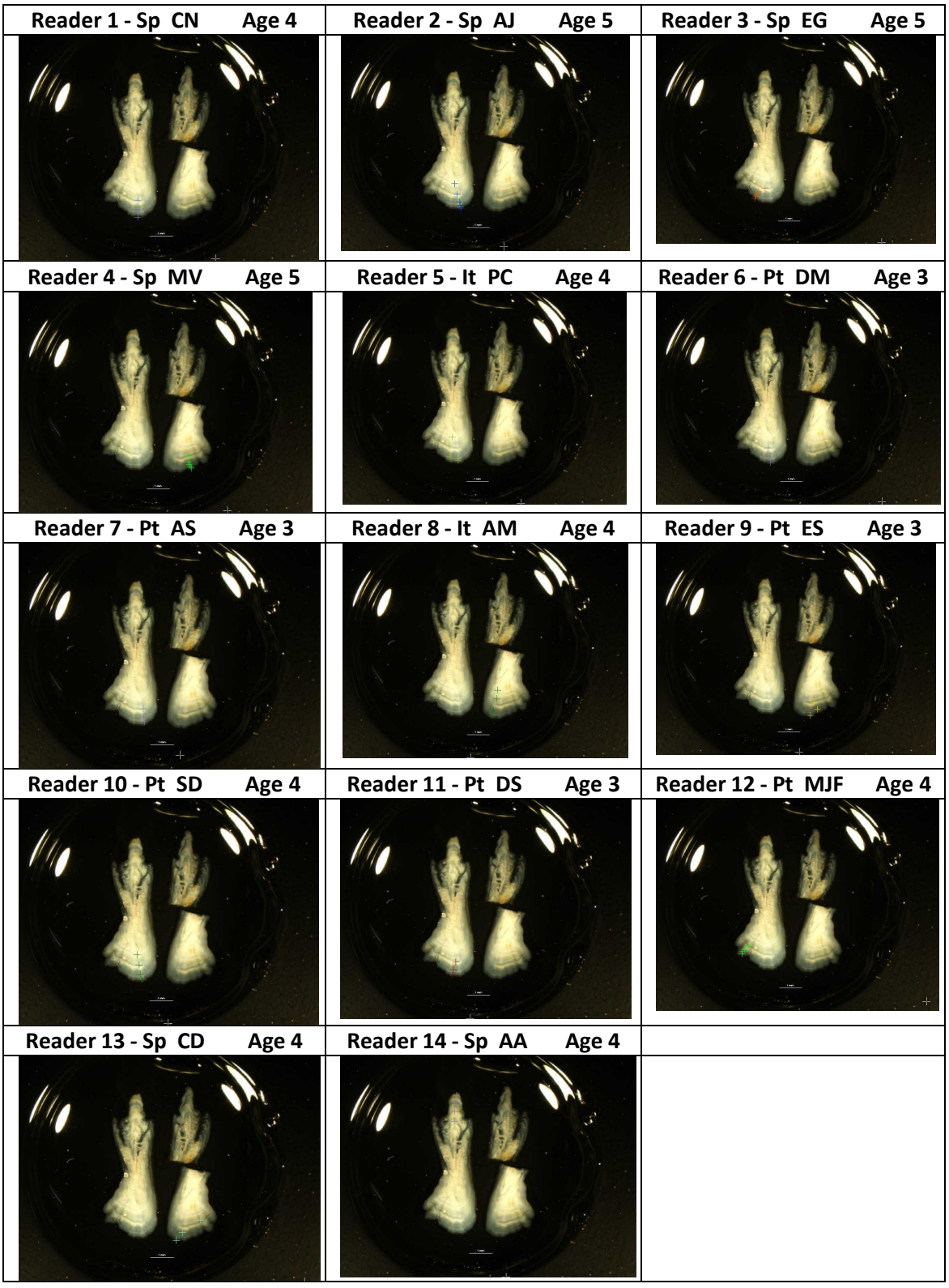

Figure 11.4. Otolith 73-Sc-IEO-S-35 with 50% agreement for all readers (Fish length = 37.9 cm, Modal age = 4; caught in June 2011, in the Bay of Biscay, ICES VIIIcE).

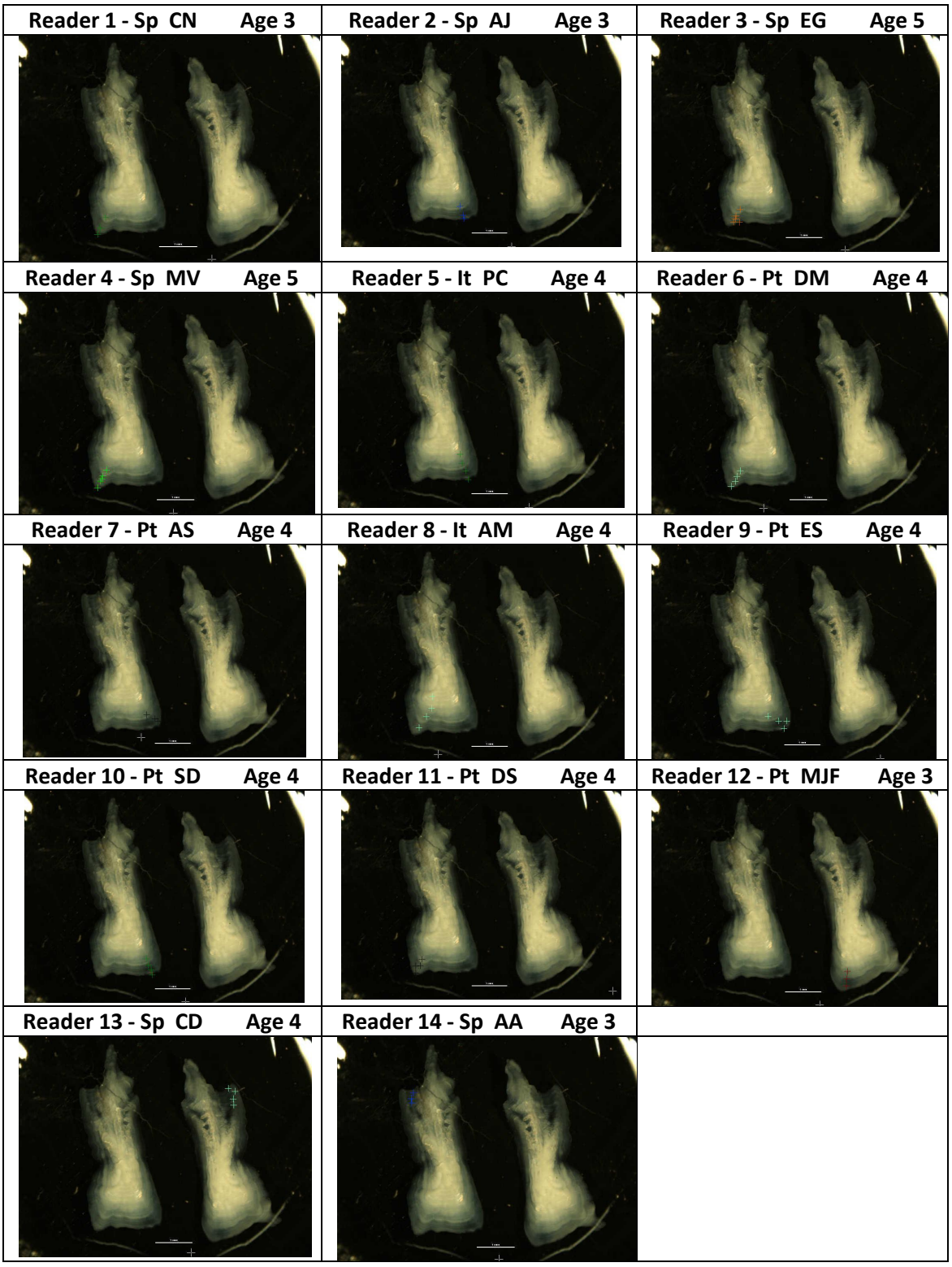

Figure 11.5. Otolith 105-Mas_MAT109_2011Jan with 57% agreement (Fish length = 34.4 cm, Modal age = 4; caught in February 2011, in Portugal waters, ICES IXaCN).

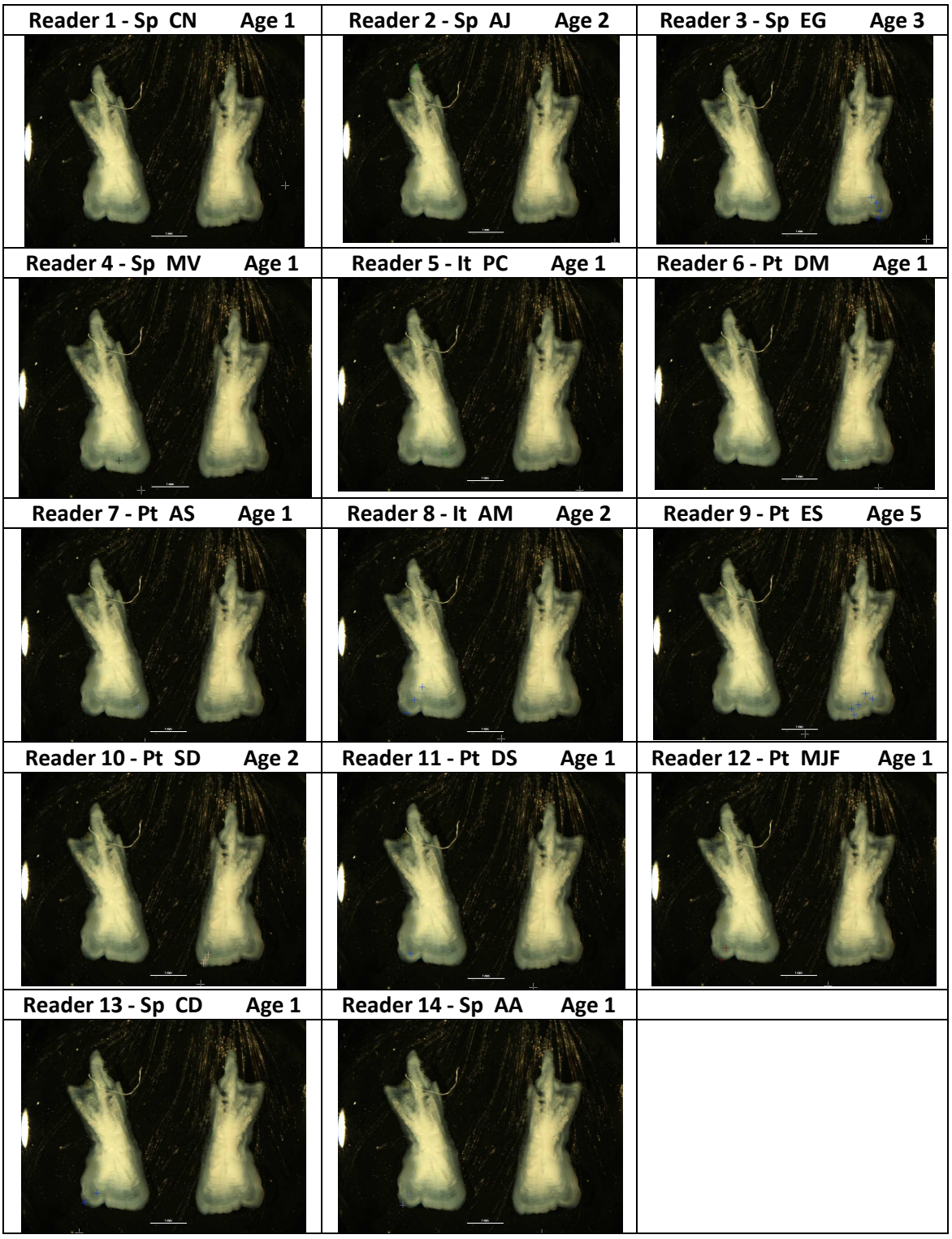

Figure 11.6. Otolith 29-O-IEO-M-30 with 64% agreement (Fish length = 30.4 cm, Modal age = 1; caught in July, in the Mediterranean Sea, GSA06).