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Report of the Workshop on Age Reading of Sea Bass *(Dicentrarchus labrax*) (WKARDL)

15–19 June 2015

Lowestoft, UK

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

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Executive summary

The Workshop on Age reading of Sea bass (*Dicentrarchus labrax*) (WKARDL) was held in Lowestoft, England, UK, from the 15th to 19th June 2015. The meeting was chaired by Kélig Mahé (France) and Mary Brown (England UK), and included seven age readers from three countries. The objectives of this first workshop were to review, document and make recommendations on current methods of ageing sea bass. This workshop was preceded by otolith exchanges in 2011 and 2013, which were undertaken using WebGR. Participants, who had not taken part in the exchange were asked to annotate the images in the months prior to the workshop. However, due to problems with accessing WebGR only a limited number of the readers managed to do this in time.

Seven readers participated in a scale calibration exercise during this workshop which showed an overall agreement of 78.2% (ranging between 29 and 100%) with a precision of 5.2% CV (ranging from 0 to 13%). Of the 55 scales, 24 (43%) were read with 100% agreement. The image analysis exercise clarified that the lack of agreement can be due to the difficulty identifying the position of the first *annulus*, the presence of checks and the dates of sample collection.

The workshop achieved quite a lot in terms of ironing out, through discussion and calibration, some of the major difficulties in ageing otoliths of sea bass. This group recommend use of scales for sea bass ageing. For future exchanges, it would be beneficial to compare unstained otolith sections with transmitted and reflected lights and stained otolith sections, with the scales. For scale exchanges, the group recommend the use of multiple scale images (or videos) for each fish. The group reached agreement on a definition of an ageing guideline and a reference collection presented in this report and the aim is to employ these tools for all laboratories.

1 Introduction

1.1 Terms of reference

The **Workshop on Age reading of Sea bass (*Dicentrarchus labrax*)** (WKARDL), chaired by Kélig Mahé, France, and Mary Brown, UK, will be held Lowestoft, England, UK from 15–19 June 2015 to:

a) Review information on sea bass age estimations, otolith exchanges, workshops and validation work done so far;

b) Analyse the results of the exchanges of 2013 and 2011;

c) Clarify the better calcified structure (otolith or scale) to estimate the age;

d) Analyse growth increment patterns and compile the guideline for the interpretation of Sea bass otoliths;

e) Create a reference collection of well-defined otoliths;

f) Address the generic ToRs adopted for workshops on age calibration.

WKARDL will report by 3 July 2015 for the attention of SSGIEOM, WGBIOP, WGCSE, WGBIE, SCICOM and ACOM.

1.2 Participants

Name	Country	Expertise	Assessment	2011 exchange	2013 exchange
Abi Carroll	England UK	Trainee			
Alison Holmes	England UK	Expert	X	X	X
Benjamin Hatton	England UK	Expert	X		
Ciara Wögerbauer	Ireland	Expert			
David Pettengell	England UK	Expert	X		
Kélig Mahé Chair	France	Coordinator			
Mary Brown Chair	England UK	Expert			
Romain Elleboode	France	Expert		X	

WKARDL-participants in Lowestoft. From left to right: Romain Elleboode, Kélig Mahé, Benjamin Hatton, Ciara Wögerbauer, David Pettengell, Mary Brown, Alison Holmes and Abi Carroll.

2 Review information on Sea bass age estimations, otolith exchanges, workshops and validation work done so far (ToR a)

2.1 Otolith exchanges

Only two exchanges have been executed to date (Table 1).

Table 1. Past Sea bass otolith/scales exchanges.

YEAR START	YEAR END	EXCHANGE / WORKSHOP	CALCIFIED PIECES	REFERENCE
2011	2011	Exchange	Otolith section/ scales	Report of the Sea bass (*Dicentrachus labrax*) Otolith and Scale Exchange Scheme 2011 Mahé *et al.*, 2012
2013	2013	Exchange	Otolith section / scales	Report of the Sea bass (*Dicentrarchus labrax*) Otolith and Scale Exchange Scheme 2013 Mahé *et al.*, 2014

2.2 Workshops

This is the first workshop arranged on sea bass by ICES.

2.3 Validation

There are some publications on sea bass growth (Kennedy and Fitzmaurice, 1972; Claridge and Potter, 1983; Pawson and Pickett, 1987; Morales-Nin *et al.*, 2011; Carroll, 2014; Cardoso *et al.*, 2015) but none of these present much information on the age validation of sea bass.

2.4 Life history

A synthesis of the sea bass life history was presented in 2014 (Carroll, 2014). The sea bass life cycle (Figure 1) can be split into four broad phases: eggs and larvae, juvenile, adolescent and adult (Dando and Demir, 1985). Sea bass reach maturity at between 4 and 7 years of age (~35 and 42 cm) and can continue to reproduce for up to 20 years (Pawson and Pickett, 1987). The oldest sea bass recorded was thought to be 28 years old (ICES, 2013). Sea bass exhibit sexual growth dimorphism where female bass mature at a greater size and age than males (Kennedy and Fitzmaurice, 1972). The juvenile stage occurs approximately two months after spawning which occurs between December to April (Kelley, 1988; Prat *et al.*, 1999) during which time larval bass remain in the plankton and are transported inshore by currents into post-larval habitats in estuaries and shallow coastal waters, where they arrive at a total length of around 10–15 mm (Jennings and Pawson, 1992). Sea bass can tolerate brackish water habitats such as those in estuaries and river mouths where they spend much of their juvenile stage (Kennedy and Fitzmaurice, 1972).

Fully mature bass undertake seasonal migrations from summer coastal feeding grounds to winter offshore spawning grounds (Pawson *et al.*, 2007) coinciding with the decrease in coastal water temperature (Pawson and Pickett, 1987) that generally occurs in October. Numerous tagging studies have shown that sea bass have a strong fidelity to summer feeding grounds, where they will return year on year (Claridge and Potter, 1983; Pawson *et al.*, 1987; Kelley, 1988; Pawson and *et al.*, 2007). Some sea bass have been recaptured on the very same rock where they were first caught and tagged, but most recaptures have been within 80 km of their first release (Pickett *et al.*, 2004; Quayle and Righton, 2007).

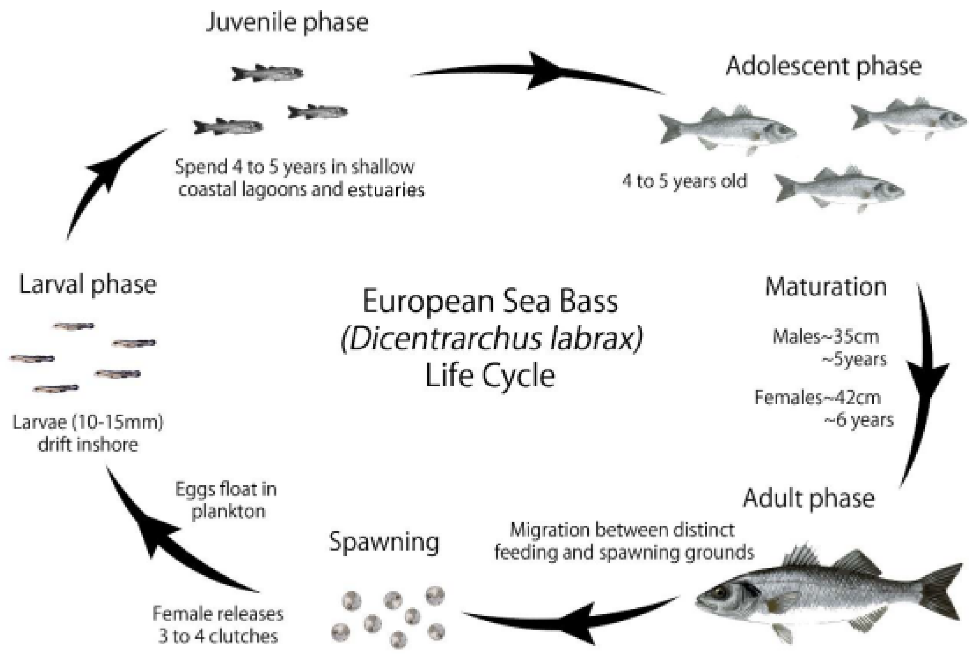


Figure 1. Illustration of the European Sea bass (*Dicentrarchus labrax*) life cycle (*In* Carroll, 2014 from Dando and Demir, 1985; Pawson *et al.*, 1987; Jennings and Pawson, 1992; Pawson *et al.*, 2007).

3 Review of ageing techniques

During the WKARDL meeting, the data compiled by the WKNARC 1 meeting (ICES, 2011) was extracted and updated. All institutes used scales as ageing structures for sea bass except Northern Ireland UK which used otoliths (Table 2).

Table 2. Calcified structures used for Sea bass ageing by institutes and areas.

Institutes (Country)	Ecoregion	ICES division	otolith (section)	scale (whole)
AFBI (Northern Ireland UK)	Celtic Sea	27.7a	X	
Inland Fisheries Ireland (Ireland)	Celtic Sea	27.7a		X
Cefas (England UK)	Celtic Sea	27.7		X
	North Sea	27.4		X
Ifremer (France)	Celtic Sea	27.7		X
	North Sea	27.4bc		X
	English Channel	27.7d		X
	South European Atlantic Shelf	27.8		X

4 Analysis of results of the exchanges in 2011 and 2013 (ToR b)

To date only two exchanges of sea bass otoliths and scales have been carried out with both otolith sections and scale images from the same sampling to compare the calcified pieces.

4.1 Exchange 2011

The otolith and Scale Exchange Scheme of 2011 was the first exchange. A total of 155 fish from the Eastern English Channel (ICES Area: VIId) were sampled onboard French research vessels (Gwen-Drez and Thalassa) during two international surveys (Channel Ground Fish Survey and International Bottom Trawl Survey). The length range of the fish was between 17 and 74 cm, with a mean length at 46.99 cm. For each fish, the *Sagittae* otoliths and a few scales were used to compare the age estimation between both calcified structures.

Four readers participated: one reader from England UK and three readers from France. Only images were used during this exchange. It was noted by the readers that it was very difficult to obtain an image of the scale with the same quality on its whole surface. Of four readers, two used transmitted light for the otoliths and two used reflected light. There was no preference to the type of light.

The analyses did not show a high mean precision of age estimate for individual fish with Coefficient of Variation (CV) of 13.1% and percentage agreement to modal age of 54.1%. Among 155 fish, only two were read with 100% agreement (1.3%) and thus a CV of 0% (Figures 2 and 3):

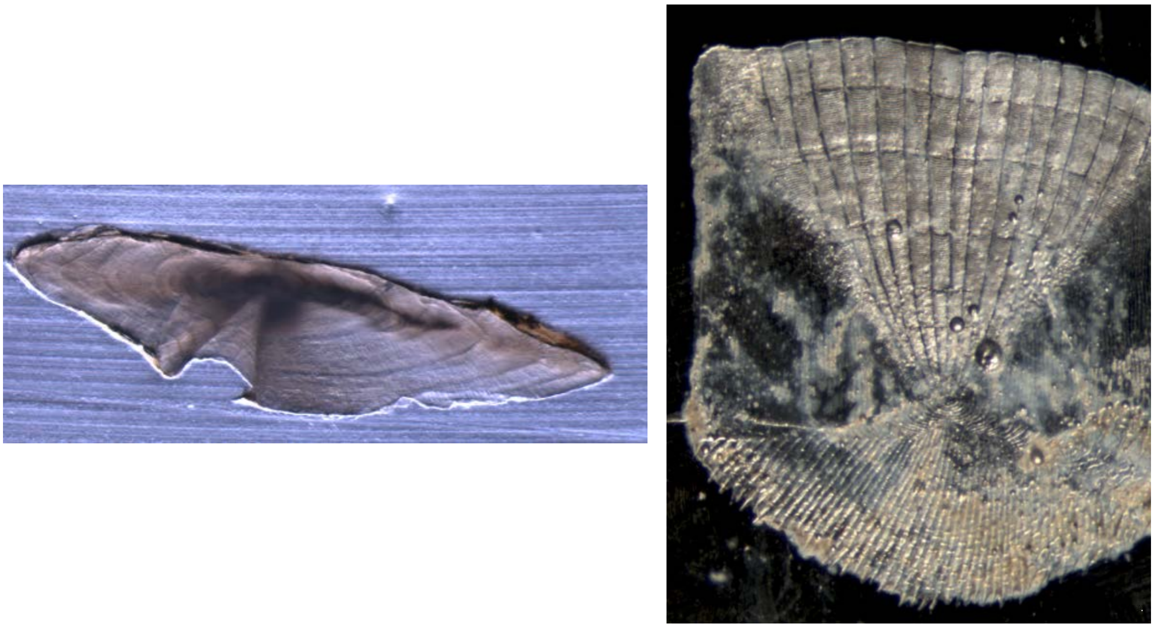


Figure 2. Both otolith and scale from the same fish shown above were estimated as five years old by all readers. This Sea bass was sampled on the 28th January 2011 in the Eastern English Channel (VIId) during the International Bottom Trawl Survey. This is a male of 33 cm TL.

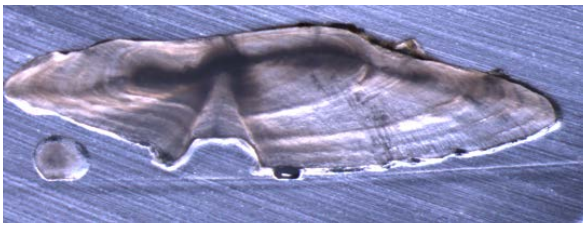
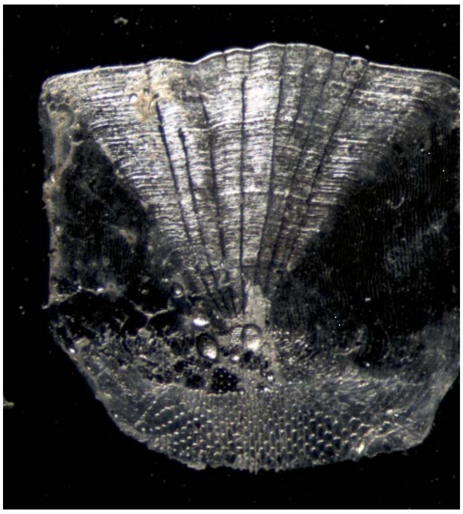



Figure 3. Both otolith and scale from the same fish shown above were estimated as five years old by all readers. This Sea bass was sampled on the 28th January 2011 in the Eastern English Channel (VIId) during the International Bottom Trawl Survey. This is a male of 42 cm TL.

During this exchange, two different calcified structures (otolith and scale) from the same sampling were analysed. The results showed similar precision of age estimation between otoliths (percentage agreement = 60.1; CV = 12) and scales (percentage agreement = 62.3; CV = 12). However, this exchange showed that the age estimation from otoliths was different from that of scales.

4.2 Exchange 2013

A second Otolith and Scale Exchange Scheme took place in 2013. A total of 223 fish from the Bay of Biscay (ICES Area: VIII, N=29), the Eastern English Channel (ICES Area: VIId, N=149) and the North Sea (ICES Area: IV, N=45) were sampled onboard French research vessels (Gwen-Drez and Thalassa) during three international surveys (EVHOE, CGFS and IBTS). The length range of the fish was between 26 and 71 cm, with mean length of 42.3 cm. For each fish, the *saggital* otoliths and a few scales were used to compare the age estimation between the two calcified structures.

Only one representative from each of France, England UK and Belgium participated in the exchange. During the first exchange in 2011, there were only two countries (France and England UK). Only images were used during this exchange. The analyses did not show a high mean precision of age estimation for individual fish with a Coefficient of Variation (CV) of 9.4% and percentage agreement to modal age of 68.6%. Among 223 fish, 84 were read with 100% agreement (37%) and thus a CV of 0%.

During this exchange, both otoliths and scales from each fish were analysed. The results showed precision of age estimation from the scales (Agreement = 78.4%; CV=1.4) was more accurate than that of otoliths (Agreement = 55.7%; CV=13.4). However, the sample size for the otolith exercise (N=149) was twice that of the scale exercise (N=74, Table 3).

Table 3. Results of the 2013 exchange.

Calcified structure	Number	Percentage Agreement	CV (range)	Number of fish with 100% of agreement
Otolith	149	55.7%	13.4	22
Scale	74	78.4%	1.4	66
Both	223	68.6%	9.4	84

4.3 Conclusions

The statistical bias testing on the results of these exchanges shows a difference between age readings of scales and unstained otolith sections. Inter-reader and within reader differences were found. The second exchange showed a better precision of age estimation from the scales than those obtained from the otoliths. However, many readers used only scales and so it is more difficult for these readers to interpret otoliths.

5 Clarify the better calcified piece (otolith or scale) to estimate the age (ToR c)

5.1 Exercise of 55 new scales

Six out of seven readers have previous experience with scales only so it was decided to undertake the exercise using only scales as the lack of experience using otoliths for ageing could have an impact on the results.

Agreements between age-readers were calculated using the Guus Eltink spreadsheet (Eltink, 2000). The scale calibration exercise showed an overall agreement of 78.2% (ranging between 29 and 100%) with a precision of 5.2% CV (ranging from 0 to 13%). Of the 55 scales, 24 (43%) were read with 100% agreement. These results are comparable to the second exchange but a different set of images were used and a new group of readers participated.

There was relatively high inter-reader agreement and agreement between readers and modal age. Readers 1, 2 and 3 who age sea bass for ICES assessment purposes have bias between them (Figure 4; Annex 1). However, these results are based on one scale sample image per fish and this does not occur in practice.

	England Reader 1	England Reader 2	England Reader 3	England Reader 4	England Reader 5	Ireland Reader 6	France Reader 7
Reader 1							
Reader 2	∗						
Reader 3	–	∗∗					
Reader 4	–	–	∗				
Reader 5	–	–	–	–			
Reader 6	–	–	–	–	–		
Reader 7	–	∗∗	–	∗∗	–	∗	
MODAL age	–	∗	–	∗	–	–	–

Figure 4. Inter-reader bias test and reader against actual age bias test (- :no sign of bias (p>0.05); *: possibility of bias (0.01<p<0.05); ** : certainty of bias (p<0.01)). The first three England UK readers contribute to sea bass assessment.

The misinterpretation of growth structures is more evident in ages older than ten (Figure 5). However, after reviewing the images, the lack of agreement can be due to the difficulty identifying the position of the first annulus, the presence of checks and the dates of sample collection.

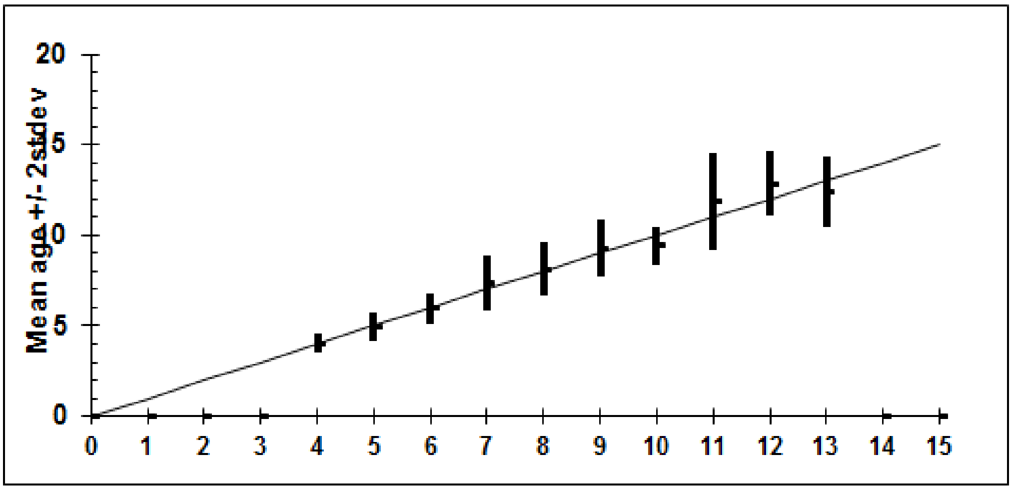


Figure 5. Age bias plots below the mean age recorded +/- 2stdev of all readers combined are plotted against the MODAL age. The estimated mean age corresponds to MODAL age, if the estimated mean age is on the 1:1 equilibrium line (solid line). RELATIVE bias is the age difference between estimated mean age and MODAL age.

During this exercise of 55 scales, nine fish had two scale images (18 images) from which intra-reader bias was observed (Table 4). Disagreement increased with fish over 60 cm in length.

Table 4. Ageing difference (years) between two scales of the same fish for each reader according to the total length.

TL (cm)	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7
39	0	0	0	0	1	0	0
41	0	0	1	0	0	0	0
42	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0
60	1	0	1	0	0	0	0
62	1	0	1	0	1	2	0

5.2 Analysis of growth increment patterns on scales

The exercise was done using the TNPC software (www.tnpc.fr) developed by the Ifremer Institute. Each *annulus* was manually identified and the distance to the *nucleus* was automatically measured on the determined reading axis (Figure 6). It was decided to analyse the new calibrated images set (N=25) of French scales during this workshop, with the ages agreed in plenary session by all readers.

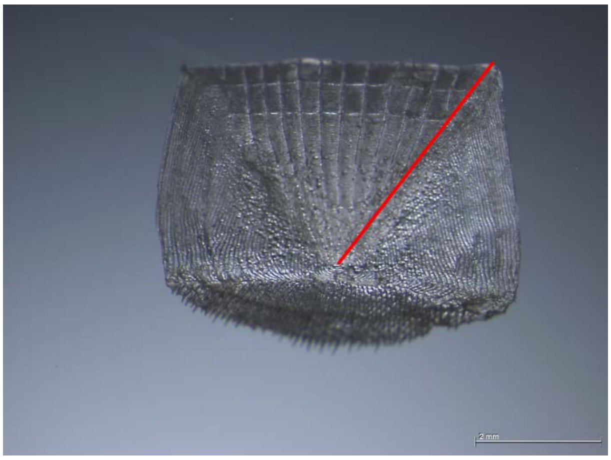


Figure 6. The measurements along the red axis on the calibrated images of sea bass scales from TNPC software.

The relationships between the age and the scale *radius* and the total length and the scale *radius* were significant (Figures 7 and 8, P<0.05). In fact, the measurements on the scales could be a good tool to help sea bass ageing.

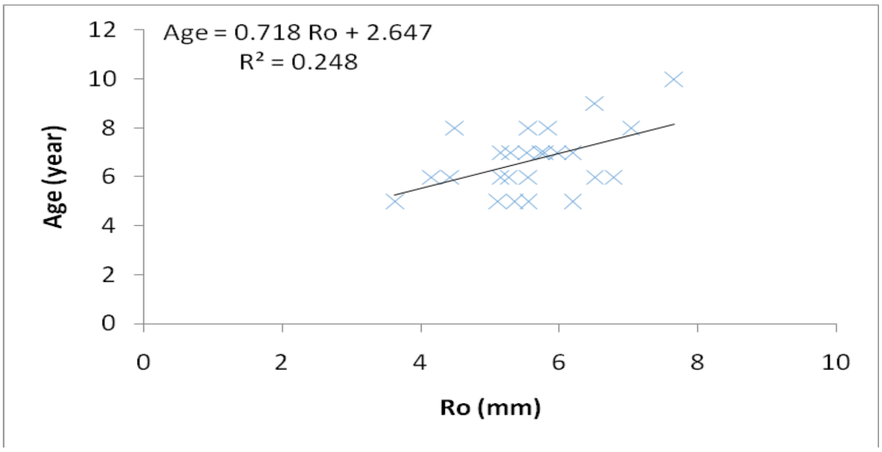


Figure 7. Relationship between age and the scale radius (Ro) of sea bass (N=25; P=0.000).

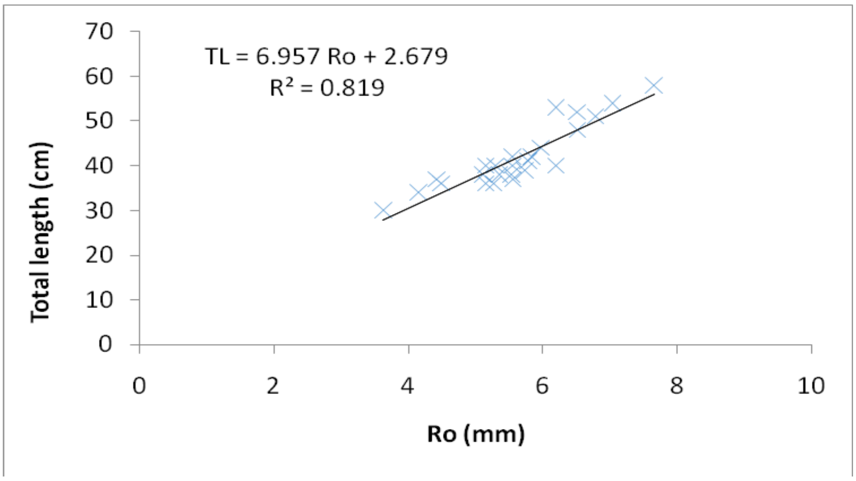


Figure 8. Relationship between total length and the scale radius (Ro) of sea bass (N=25; P=0.011).

The measurements of the scales showed how the width of the growth ring decreases with age. The first two growth rings could be clearly identified by the distance from the *nucleus* (the core). In this exercise the first growth ring in all images was between 0.8 mm and 1.8 mm (Figure 9). There was a similar trend found looking at the individual growth curves.

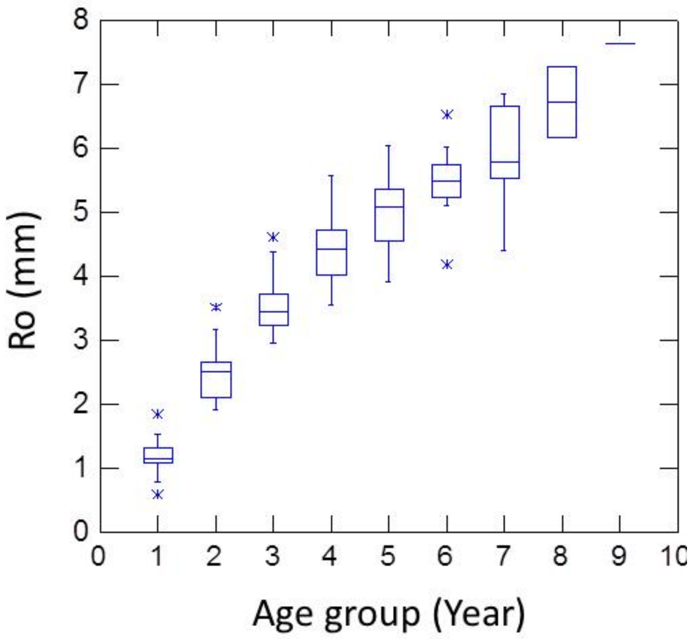
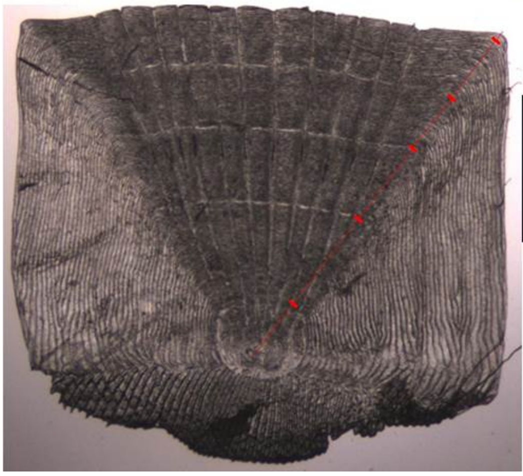


Figure 9. Box-plot of all rings identified as growth ring on 25 scales sea bass.

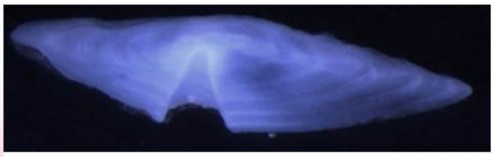
5.3 Scales vs otoliths

Otolith n°002
Date of catch : 17/01/13
Sex : Male
Length : 36cm
Weight: 0,475 kg

Stained



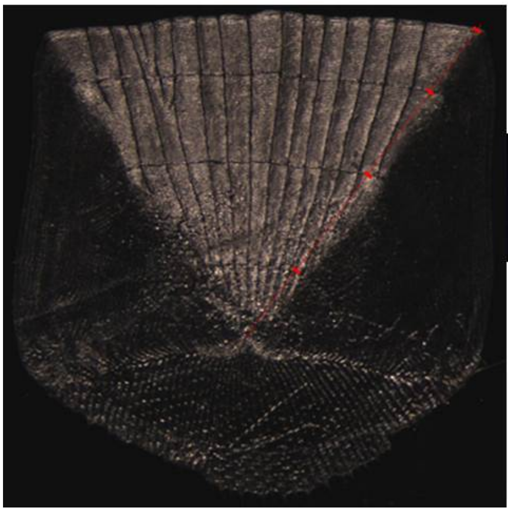
Reflected light



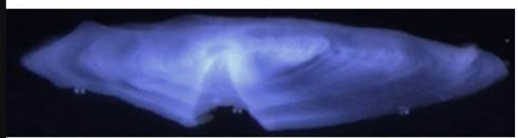
Transmited light

Otolith n°004
Date of catch : 17/01/13
Sex : Male
Length : 37cm
Weight : 0,57 kg

Stained



Reflected light

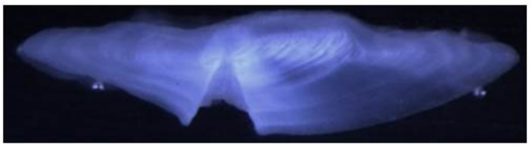


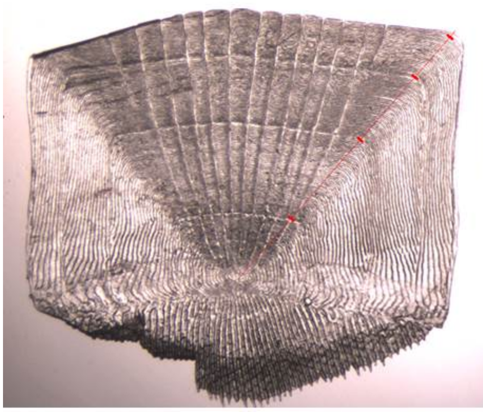
Transmited light

Otolith n°005
Date of catch : 17/01/13
Sex : Male
Length : 38cm
Weight : 0,61 kg

Stained

Reflected light

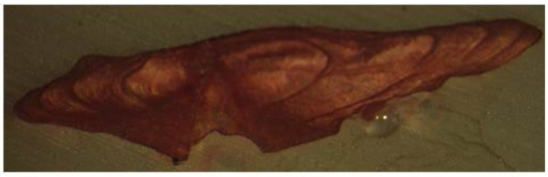




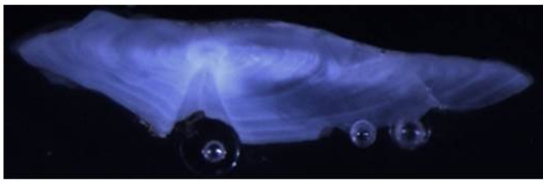
Transmited light

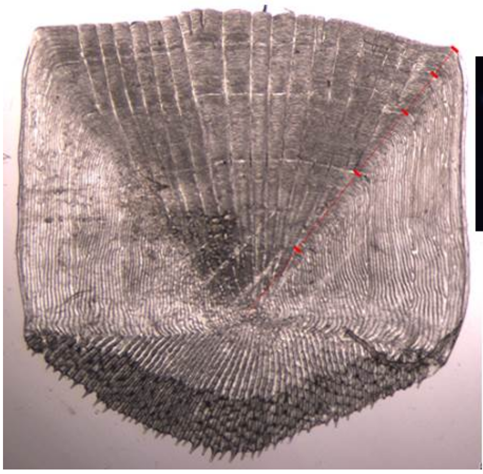
Otolith n°007
Date of catch : 17/01/13
Sex : Male
Length : 40cm
Weight : 0,68Kgr

Stained



Reflected light

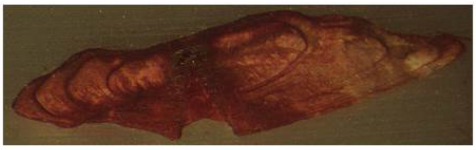


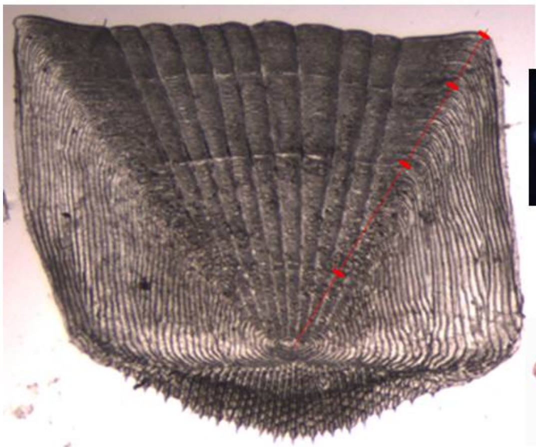


Transmited light

Otolith n°0011
Date of catch : 19/01/13
Sex : Male
Length : 30cm
Weight : 0,23 kg

Stained





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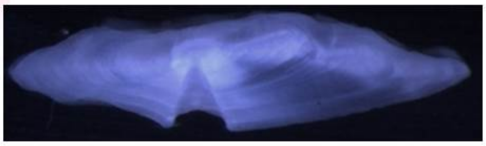

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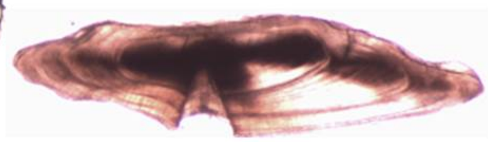
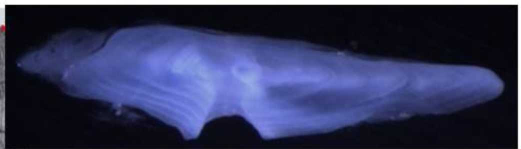
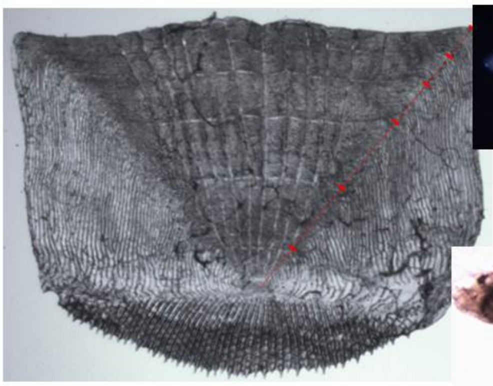


Otolith n°0017
Date of catch : 4/02/13
Sex : Male
Length : 36cm
Weight : 0,47 kg

Stained

Reflected light

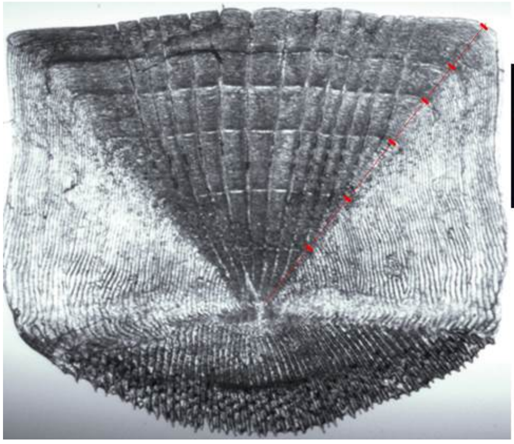




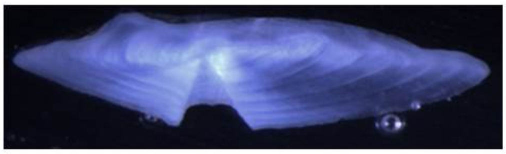
Transmited light

Otolith n°0018
Date of catch : 4/02/13
Sex : Female
Length : 40cm
Weight : 0,636 kg

Stained



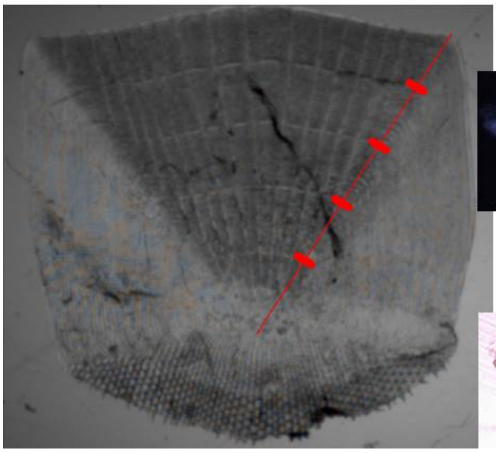
Reflected light



Transmited light

Otolith n°0024
Date of catch : 28/10/11
Sex : Female
Length : 40cm
Weight : 0,67 kg

Stained



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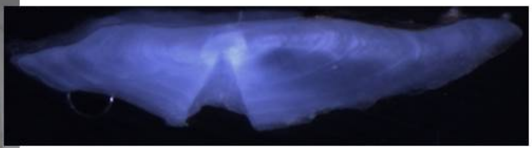


Transmited light

6 Guideline for scale sampling

Scales are readily available ageing structures that do not result in fish damage or mortality. Scales vary in size and growth patterns depending on the location on the fish they are collected from. Therefore it is important to remove sufficient scales to provide the reader ample opportunity for accurate age assessment. In the region of twelve scales are recommended to ensure a minimum of five readable scales. It has been found that the rings show best if the scales are taken from just behind the pectoral fin (Figure 11). Bass larvae do not bear any scales upon first hatching. Scales taken from the area indicated (Figure 10) are among the oldest on the fish as well as the most regularly shaped, largest and most clearly interpretable. Protected behind the pectoral fin they are also least likely to be replacement scales (Eaton, 1996). The ideal scale are regular in shape, almost square (Figure 12). If the shape of the scale is distorted, then the annual rings become indistinct.

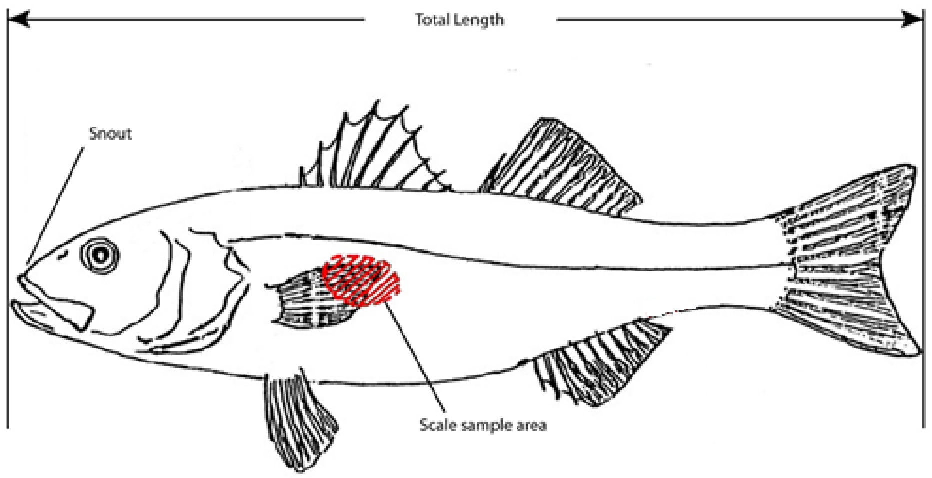


Figure 10. Removal of scales under the pectoral fin (removal area in red) for sea bass (*In* Carroll, 2014 adapted from Pickett and Pawson, 1994).

The removal of scales is done with a knife, with a clean inox blade or forceps (Figure 11). The person removing the scales passes the implement first from the front to the back in order to remove a maximum of mucus, impurities or detached scales which do not necessarily come from the fish. Then the blade is wiped with a clean cloth. Scales are gently scraped off using the edge of the implement and stored in a labelled envelope or packet. It is important to ensure tools and surfaces are kept clean and clear to prevent the transfer of scales between samples.

Figure 11. Removal of scales under the pectoral fin of a sea bass in fisheries market (*In* Mahé *et al.*, 2009).

7 Guidelines for scale interpretation (ToR d)

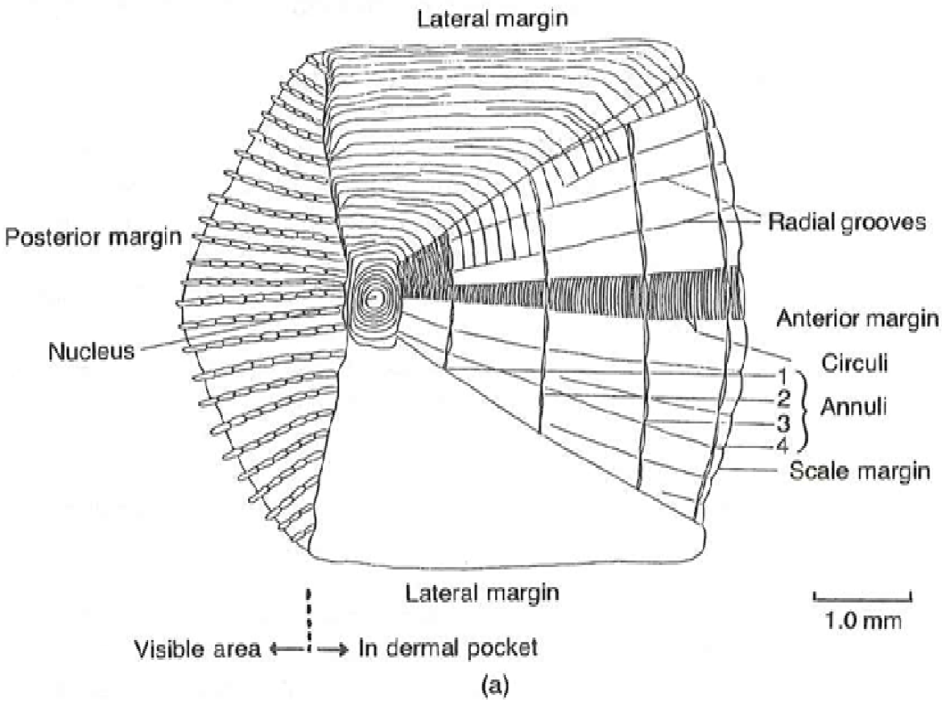


Figure 12. Diagram of a scale sea bass (*In* Pickett and Pawson, 1994).

Multiple good quality scales are required for accurate age estimation. A good quality scale is a whole scale, flat and without creases, clean with clear annuli and without regeneration (Figure 13).

Bass scales are comprised of fine, dark rings known as *circuli* interspersed between larger transparent rings called *annuli*. These rings are a function of seasonal growth and are laid down incrementally. *Annuli* appear in spring or early summer when active feeding and a consequent growth spurt occurs after the winter period with little food availability (environmental factors can occasionally affect the appearance of *annuli* and have been observed to delay the appearance of *annuli* until later in summer). Splits or false *annuli* can cause confusion to age determination. These are intermittent or discontinuous around three sides of the scale.

The first *annulus* may be obscured or partly obscured due to time spent in warmer water during the juvenile stage. As the fish grows thickening or scarring of the nucleus may occur. Several scales may need to be viewed to identify the location of the first *annulus*.

Time of sampling influences the age reading of each scale. Sea bass can have a period of rapid growth potentially achieving a full year's worth within a few months. Problems with ageing can occur when trying to identify the summer growth especially when sampling during summer has been poor or quantities of samples have been low. Summer growth is not counted until 1st January of the following year. Being able to identify summer growth and whether to include it or not is key to accurate age determination.

If ageing using images, multiple scales per fish and good quality images are required. The anterior margin and lateral margins must all be in view to confirm the presence of *annuli* (Figure 12). To take a good well-lit image a binocular microscope can be used and a mirror can also be employed to alternate contrast to view different *annuli*.

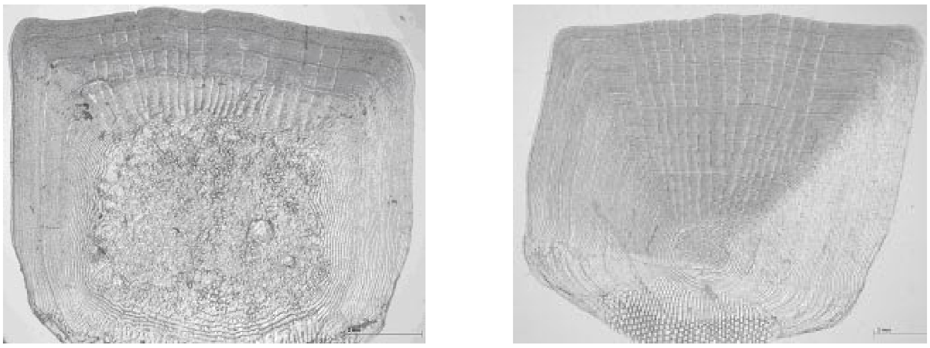
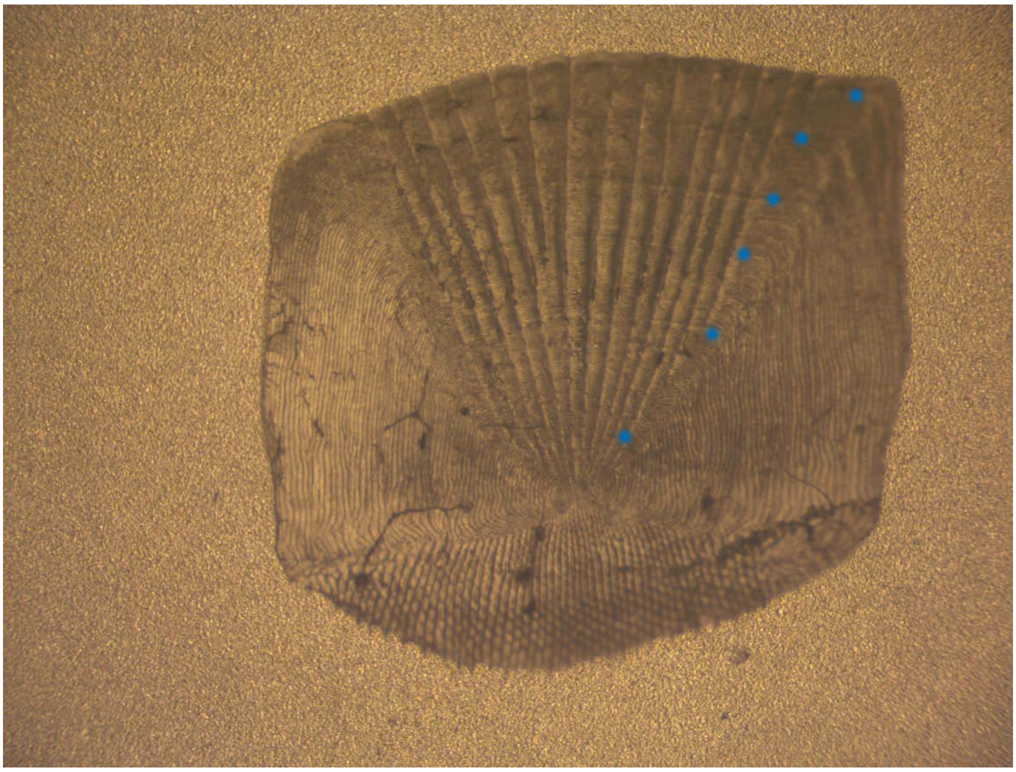
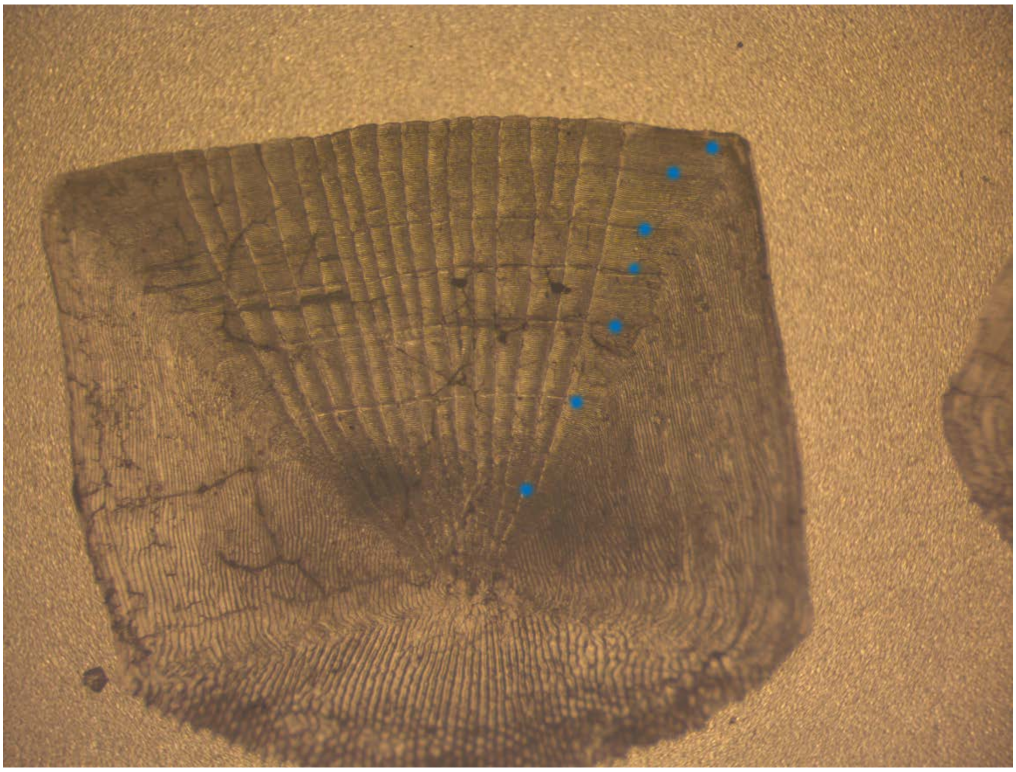


Figure 13. Two examples of regeneration in sea bass scales.

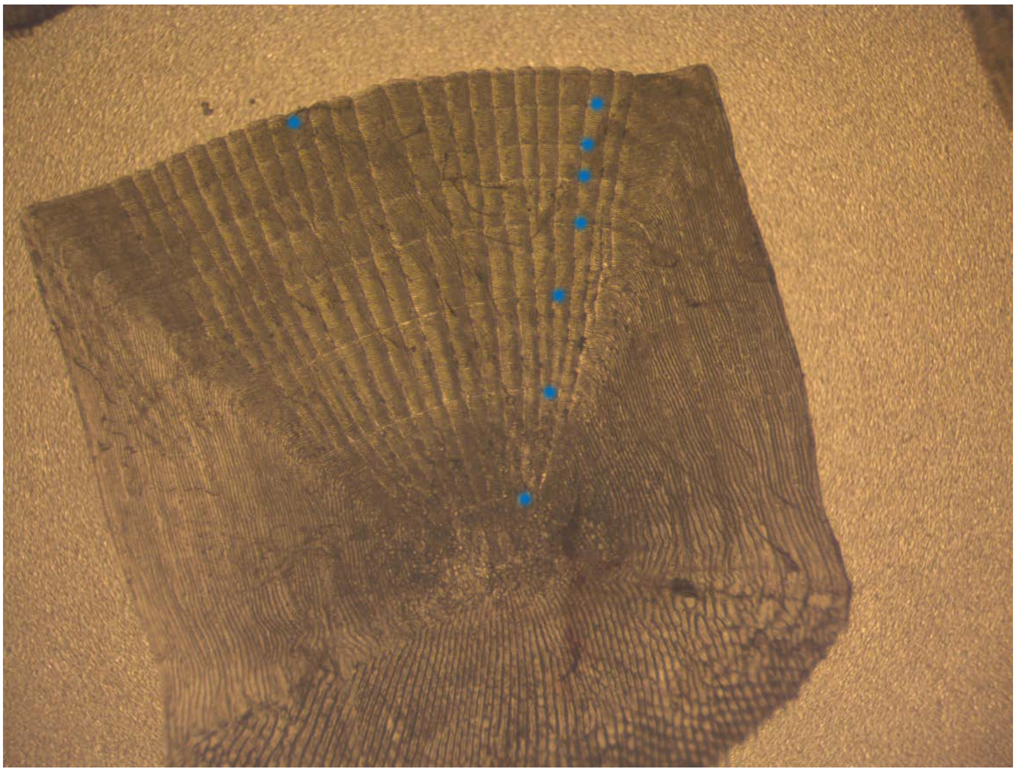
8 Reference collection of scales (ToR e)



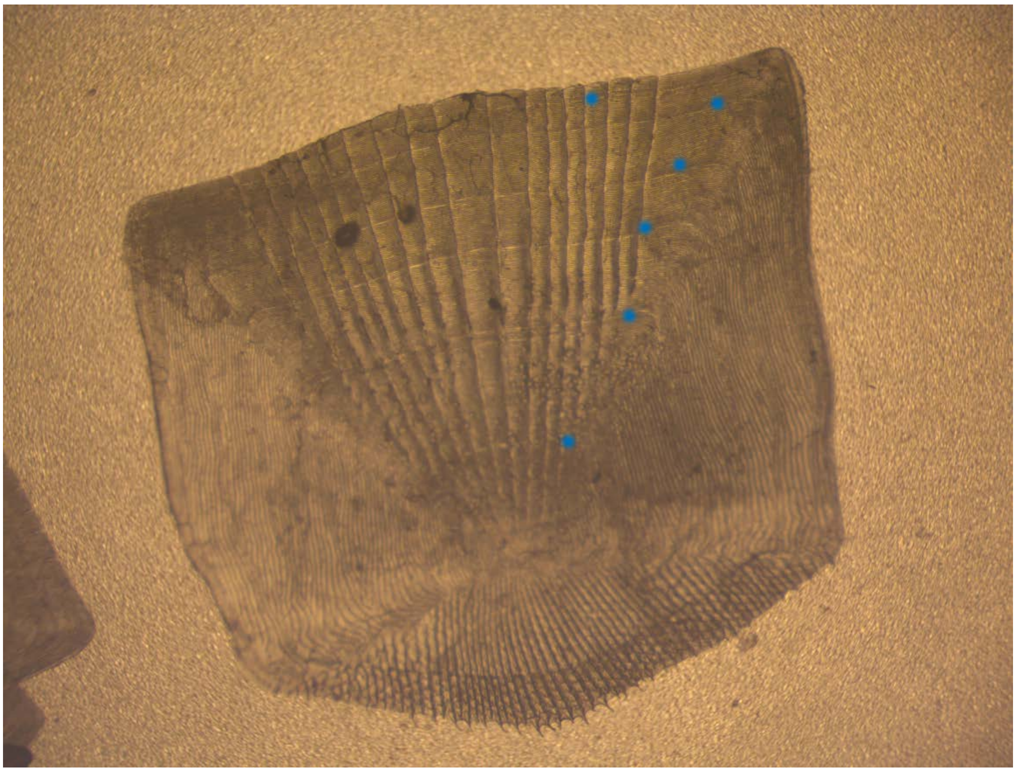
Total length: 42 cm; Sex: M; Weight: 0.764 kg; Date of catch: 15/07/2014.



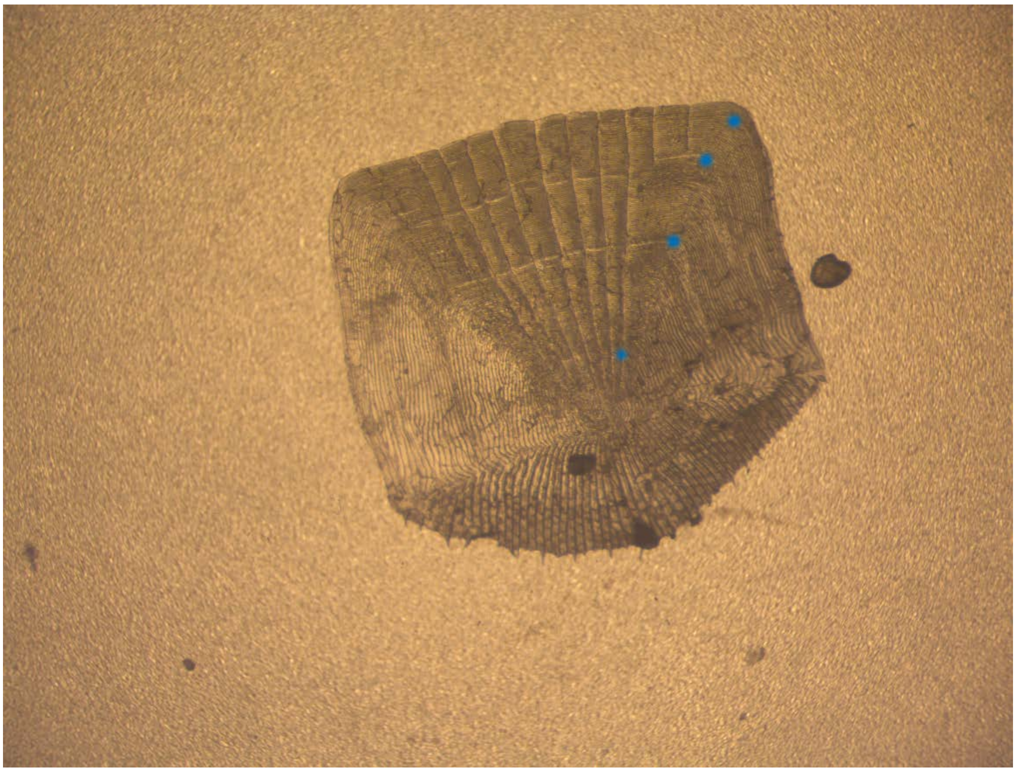
Total length: 55 cm; Sex: F; Weight: 1.562 kg; Date of catch: 15/07/2014.



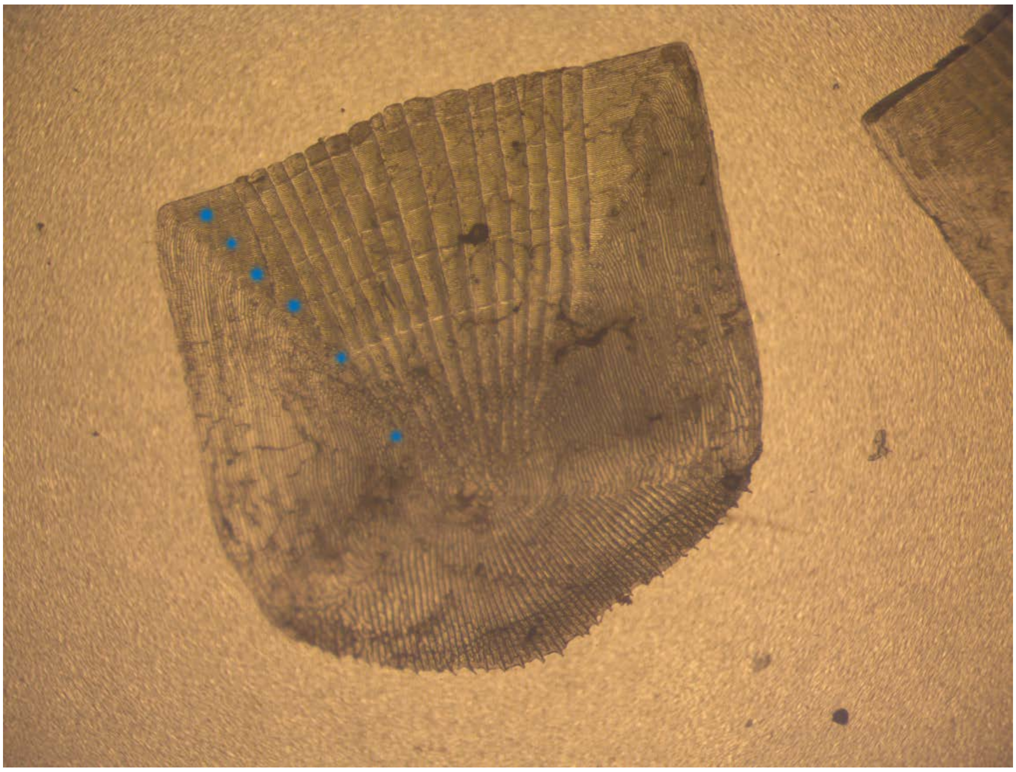
Total length: 54 cm; Sex: M; Weight: 1.410 kg; Date of catch: 15/07/2014.



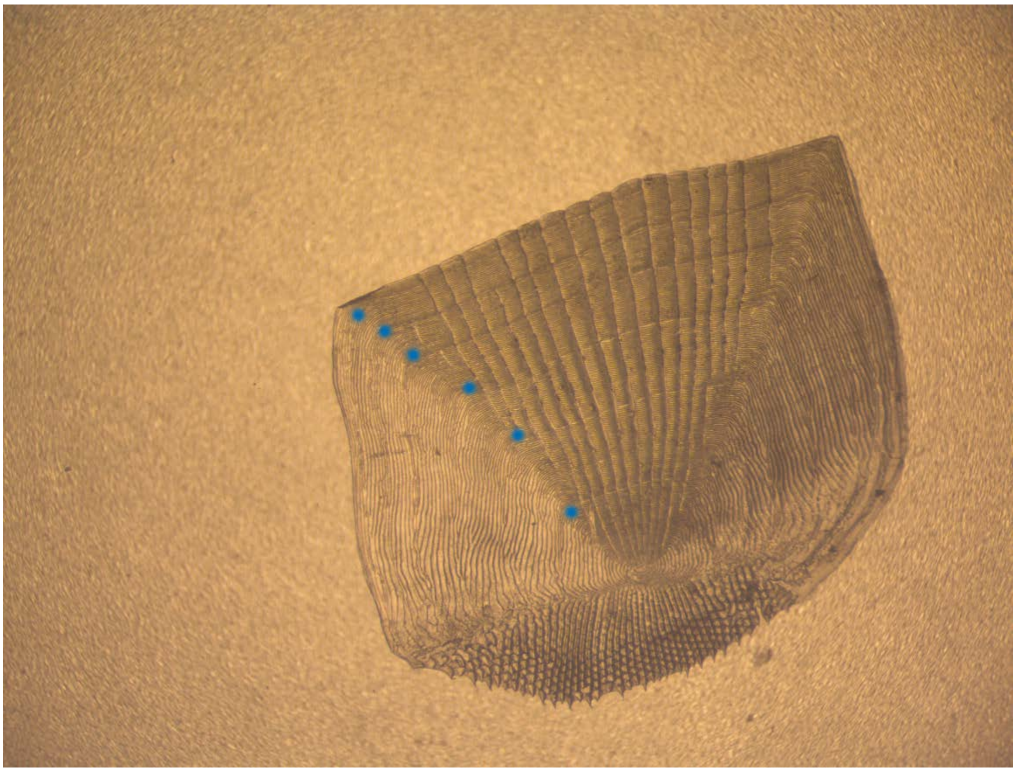
Total length: 50 cm; Sex: F; Weight: 1.304 kg; Date of catch: 15/07/2014.



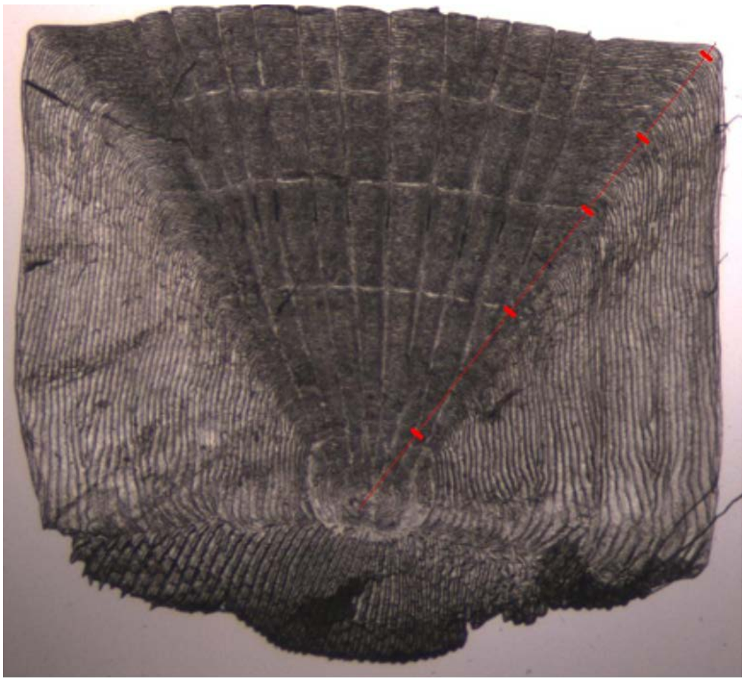
Total length: 39 cm; Sex: M; Weight: 0.536 kg; Date of catch: 15/07/2014.



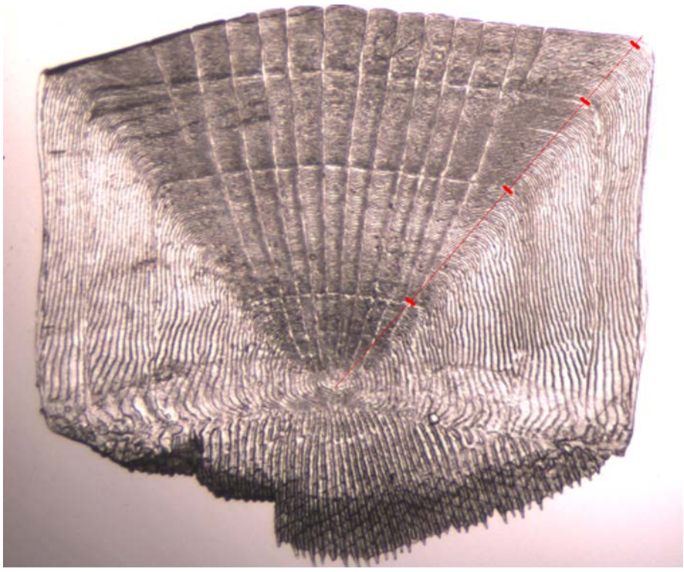
Total length: 41 cm; Sex: F; Weight: 0.698 kg; Date of catch: 15/07/2014.



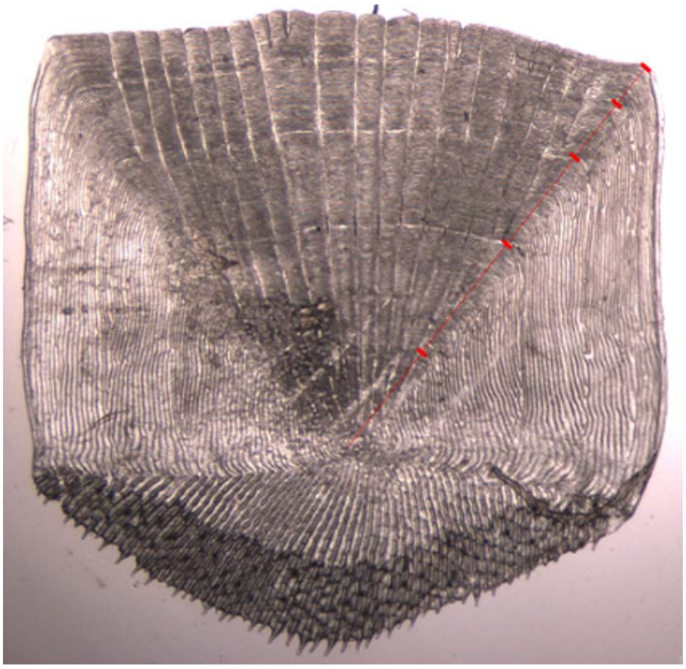
Total length: 46 cm; Sex: M; Weight: 1.036 kg; Date of catch: 15/07/2014.



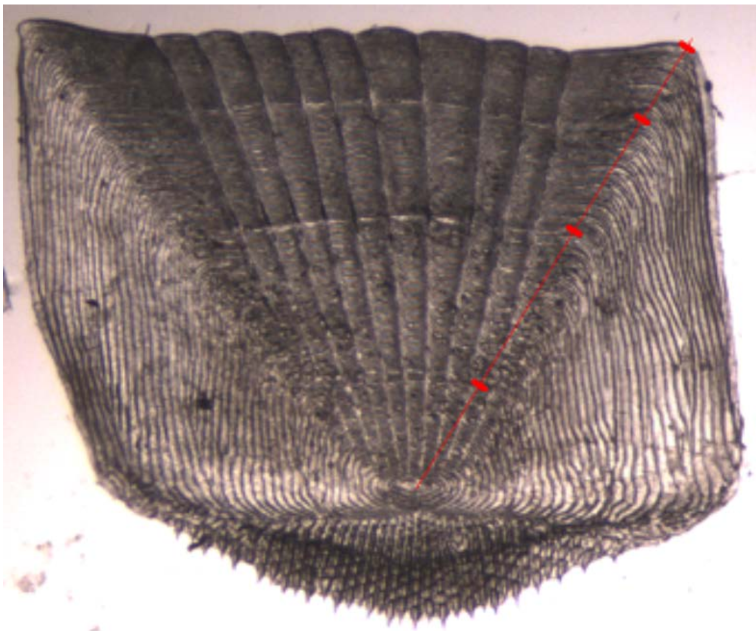
Total length: 37 cm; Sex: M; Weight: 0.57 kg; Date of catch: 17/01/13.



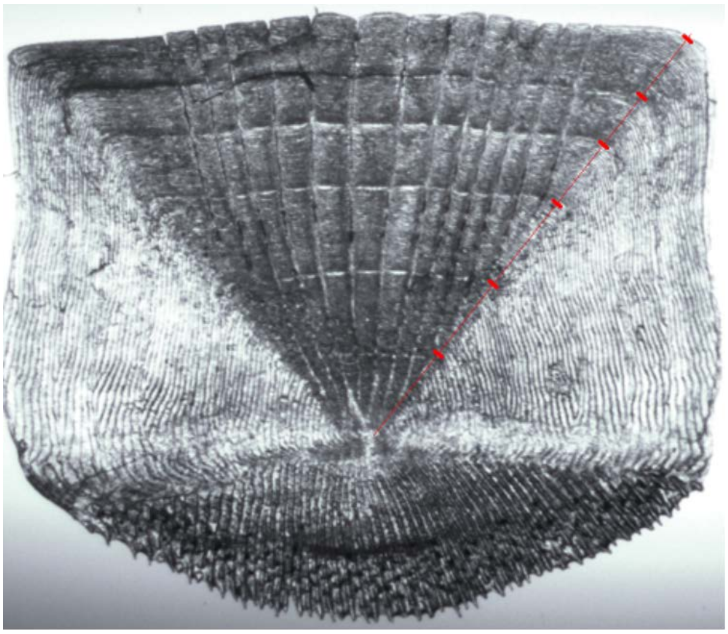
Total length: 38 cm; Sex: M; Weight: 0.61 kg; Date of catch: 17/01/13.



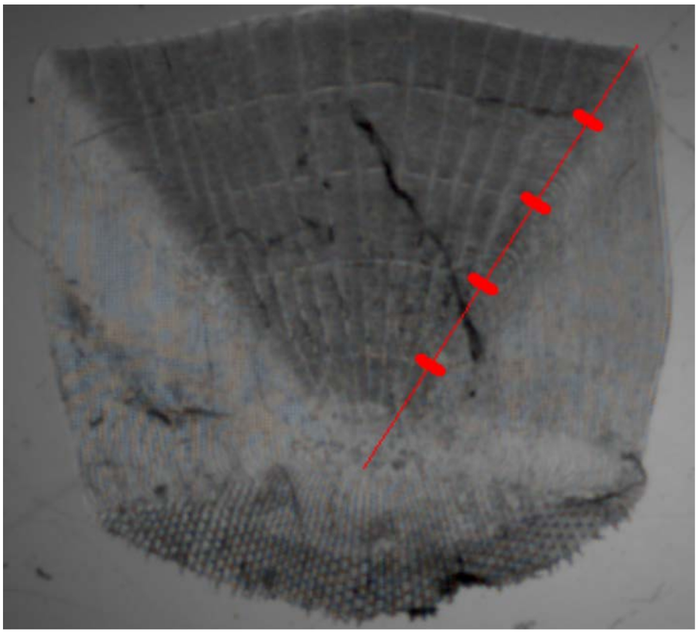
Total length: 40 cm; Sex: M; Weight: 0.68 kg; Date of catch: 17/01/13.



Total length: 30 cm; Sex: M; Weight: 0.23 kg; Date of catch: 19/01/13.



Total length: 40 cm; Sex: F; Weight: 0.636 kg; Date of catch: 04/02/13.



Total length: 40 cm; Sex: F; Weight: 0.67 kg; Date of catch: 28/10/11.

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*** Reading for assessment.**

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Annex 1: Detailed results of 55 scale exercise

The number of age readings, the coefficient of variation (CV), the percentage of agreement and the RELATIVE bias are presented by MODAL age for each age reader and for all readers combined. A weighted mean CV and a weighted mean percent agreement are given by reader and all readers combined. The CV's by MODAL age for each individual age reader and all readers combined indicate the precision in age reading by MODAL age. The weighted mean CV's over all MODAL age groups combined indicate the precision in age reading by reader and for all age readers combined.

NUMBER OF AGE READINGS

	MODAL age	England Reader 1	England Reader 2	England Reader 3	England Reader 4	England Reader 5	Irland Reader 6	France Reader 7	TOTAL
	0	-	-	-	-	-	-	-	-
	1	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-
	3	-	-	-	-	-	-	-	-
	4	6	6	6	6	6	6	6	42
	5	6	6	6	6	6	6	6	42
	6	22	22	22	22	22	22	22	154
	7	8	8	8	8	8	8	8	56
	8	6	6	6	6	6	6	6	42
	9	3	3	3	3	3	3	3	21
	10	1	1	1	1	1	1	1	7
	11	1	1	1	1	1	1	1	7
	12	1	1	1	1	1	1	1	7
	13	1	1	1	1	1	1	1	7
	14	-	-	-	-	-	-	-	-
	15	-	-	-	-	-	-	-	-
Total	0-15	55	55	55	55	55	55	55	385

COEFFICIENT OF VARIATION (CV)

	MODAL age	England Reader 1	England Reader 2	England Reader 3	England Reader 4	England Reader 5	Irland Reader 6	France Reader 7	ALL Readers
	0	-	-	-	-	-	-	-	-
	1	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-
	3	-	-	-	-	-	-	-	-
	4	0%	0%	0%	0%	16%	10%	0%	3.5%
	5	0%	8%	8%	0%	8%	11%	13%	4.8%
	6	4%	4%	5%	0%	11%	10%	7%	4.5%
	7	10%	14%	0%	10%	12%	12%	6%	5.4%
	8	0%	19%	0%	6%	8%	6%	5%	7.2%
	9	0%	12%	0%	12%	7%	0%	6%	7.3%
	10	-	-	-	-	-	-	-	-
	11	-	-	-	-	-	-	-	-
	12	-	-	-	-	-	-	-	-
	13	-	-	-	-	-	-	-	-
	14	-	-	-	-	-	-	-	-
	15	-	-	-	-	-	-	-	-
Weighted mean	0-15	2.9%	7.1%	3.0%	2.8%	10.1%	8.5%	6.2%	5.2%
	RANKING	2	5	3	1	7	6	4	

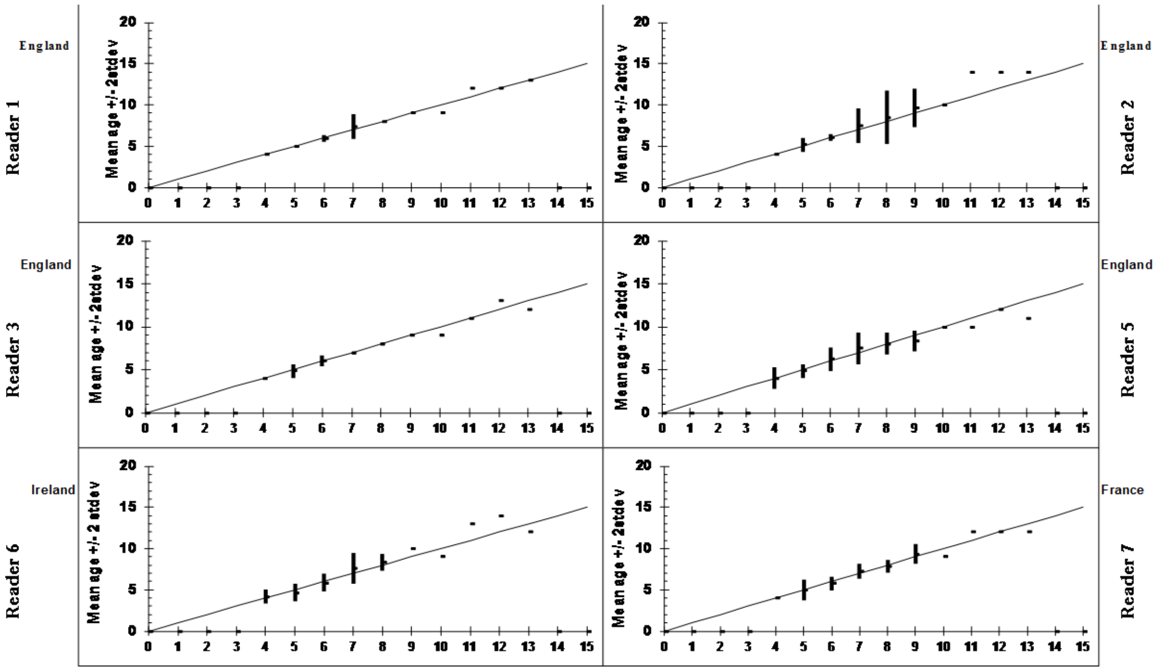
PERCENTAGE AGREEMENT

	MODAL age	England Reader 1	England Reader 2	England Reader 3	England Reader 4	England Reader 5	Irland Reader 6	France Reader 7	ALL
	0	-	-	-	-	-	-	-	-
	1	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-
	3	-	-	-	-	-	-	-	-
	4	100%	100%	100%	100%	67%	83%	100%	93%
	5	100%	83%	83%	100%	83%	67%	67%	83%
	6	95%	95%	91%	100%	64%	68%	77%	84%
	7	75%	75%	100%	75%	75%	63%	75%	77%
	8	100%	33%	100%	67%	67%	67%	83%	74%
	9	100%	67%	100%	67%	33%	0%	67%	62%
	10	0%	100%	0%	100%	100%	0%	0%	43%
	11	0%	0%	100%	100%	0%	0%	0%	29%
	12	100%	0%	0%	0%	100%	0%	100%	43%
	13	100%	0%	0%	100%	0%	0%	0%	29%
	14	-	-	-	-	-	-	-	-
	15	-	-	-	-	-	-	-	-
Weighted mean	0-15	90.9%	78.2%	89.1%	89.1%	65.5%	60.0%	74.5%	78.2%
	RANKING	1	4	2	2	6	7	5	

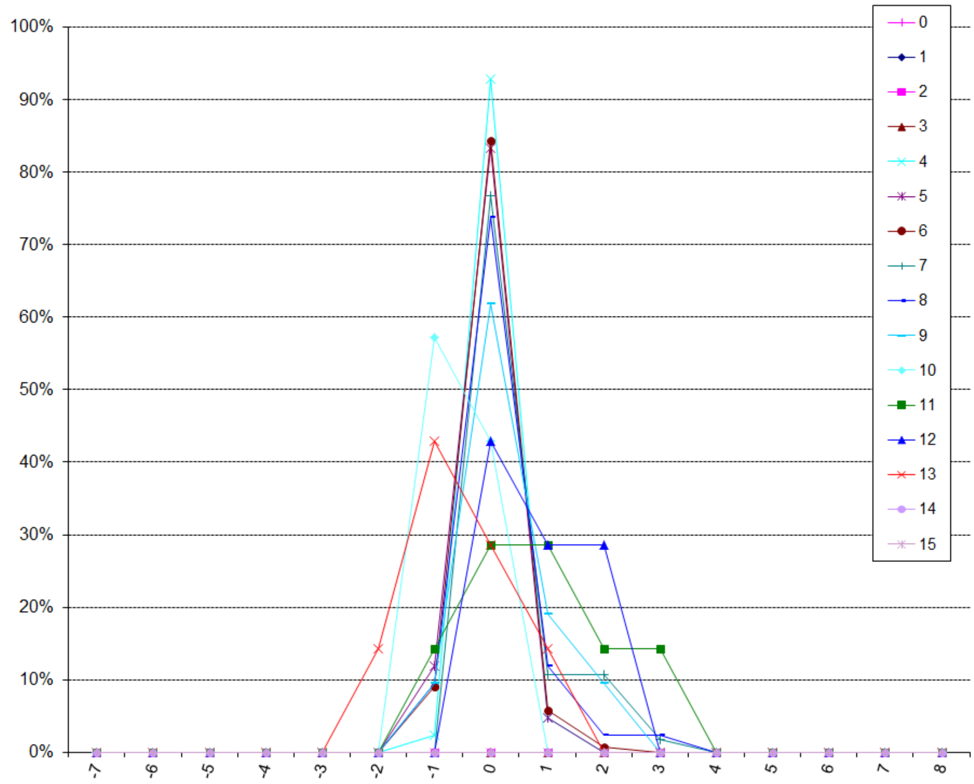
RELATIVE BIAS

	MODAL age	England Reader 1	England Reader 2	England Reader 3	England Reader 4	England Reader 5	Irland Reader 6	France Reader 7	ALL
	0	-	-	-	-	-	-	-	-
	1	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-
	3	-	-	-	-	-	-	-	-
	4	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.02
	5	0.00	0.17	-0.17	0.00	-0.17	-0.33	0.00	-0.07
	6	-0.05	0.05	0.00	0.00	0.23	-0.14	-0.23	-0.02
	7	0.38	0.50	0.00	0.38	0.50	0.63	0.25	0.38
	8	0.00	0.50	0.00	0.33	0.00	0.33	-0.17	0.14
	9	0.00	0.67	0.00	0.67	-0.67	1.00	0.33	0.29
	10	-1.00	0.00	-1.00	0.00	0.00	-1.00	-1.00	-0.57
	11	1.00	3.00	0.00	0.00	-1.00	2.00	1.00	0.86
	12	0.00	2.00	1.00	1.00	0.00	2.00	0.00	0.86
	13	0.00	1.00	-1.00	0.00	-2.00	-1.00	-1.00	-0.57
	14	-	-	-	-	-	-	-	-
	15	-	-	-	-	-	-	-	-
Weighted mean	0-15	0.04	0.31	-0.04	0.15	0.05	0.15	-0.07	0.08
	RANKING	1	7	2	6	3	5	4	

In the age bias plots below the mean age recorded +/- 2stdev of each age reader and all readers combined are plotted against the MODAL age. The estimated mean age corresponds to MODAL age, if 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 coefficient of variation (CV%), percentage of agreement and the standard deviation (STDEV) are plotted against MODAL age. CV is much less age dependent than the standard deviation (STDEV) and the percentage of agreement. CV is therefore a better index for the precision in age reading. Problems in age reading are indicated by relatively high CV's at-age.



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.

Annex 2: WKARDL2 terms of reference for the next meeting

The Workshop on Age reading of Sea bass (*Dicentrarchus labrax*) 2 (WKARDL2) will meet in xx, XX 2021 in xx, XX to:

a) Clarify the interpretation of annual growth rings using stained otolith sections and scales on the same fish;

b) Continue the guidelines and common ageing criteria;

c) Develop existing reference collections of calcified structures and improve the existing database of scales images;

d) Address the generic ToRs adopted for workshops on age calibration (see 'PGCCDBS Guidelines for Workshops on Age Calibration').

Supporting Information

Priority:	Essential. Age determination is an essential feature in fish stock assessment to estimate the rates of mortalities and growth. Age data are provided by different countries and are estimated using international ageing criteria. It is necessary to continue to clarify this guideline of age interpretation. Therefore, an appropriate otolith and scale exchange programme will be carried out in 2019 for the purpose of inter-calibration between ageing labs. Results of this otolith exchange will be discussed during WKARDL2.
Scientific justification:	The aim of the workshop is to identify the current ageing problems between readers and standardize the age-reading procedures in order to improve the accuracy and precision in the age reading of this species.
Resource requirements:	No specific resource requirement beyond the need for members to prepare for and participate in the meeting.
Participants:	In view of its relevance to the DCF, and ICES WG, the Workshop will try to join international experts on growth, age estimation and scientists involved in assessment in order to progress towards a solution. Participants should announce their intention to participate in the WK no later than two months before the meeting.
Secretariat facilities:	
Financial:	
Linkages to advisory committees:	ACOM, SCICOM
Linkages to other committees or groups:	WGBIOP, WGCSE, WGBIE
Linkages to other organizations:	There is a direct link with the EU DCF.

Annex3: Recommendations

Recommendations	Adressed to
1. WKARDL2 Workshop in 2021	WGBIOP, WGCSE, WGBIE, ACOM
2. Otolith and Scale Exchange of *D. labrax* in 2019	WGBIOP, WGCSE, WGBIE, ACOM
3. Clarify the ageing criteria guideline	WGBIOP, WGCSE, WGBIE, ACOM
4. Develop the WebGR tool	WGBIOP, ACOM