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RESULTS OF THE BLUE WHITING OTOLITH EXCHANGE

by

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ABSTRACT

At the Blue Whiting Assessment Working Group, it was agreed to carry out an otolith exchange programme to solve the ageing problems pointed out by ACFM.
A sample of 115 otoliths from Division IXa was exchanged, and seven countries are taking part in the exchange, although it has not yet been completed. One otolith from each fish was sectioned and the other preserved in aqueous solution. In the whole otoliths a tendency to lose one or two early rings was observed, and in the sectioned otoliths the presence of false rings was the cause of misreading. A combination of both methods would probably improve the age determinations, but is unfortunately time consuming.
The agreement between the readers was in general low, from both sliced and whole otoliths.The ANOVA with a significance level of 5% showed that the mean age of the sample is different for various readers, and the Tukey test showed that there are no significant differences between three readers, at the same significance level.
Considering the importance of ageing in the assessment, new investigations are needed to improve the agreement, and it is suggested that further samples are exchanged, or that an otolith workshop should be convened.

INTRODUCTION

The difference in the range of ages in the blue whiting catch, and in the mean weight at age between the northern and southern areas may be due to ageing problems, as pointed out by ACFM. An otolith exchange was carried out to study these problems, and the difficulties of age reading. Seven readers from countries involved in northern and southern fisheries took part in the exchange. This paper evaluates the results so far received.

MATERIAL AND METHODS

A sample of 115 otolith pairs was exchanged, from fish caught in January 1989, covering a length range from 15 to 32 cm. One otolith from each fish was sectioned and embedded in Eukitt, and the other one was preserved in aqueous solution (60% glycerine) to storage them in "wet" condition (Hunt, 1982). Both series were photographed so that readers could mark the identified annual rings.
Regressions between the age readings of the various countries were made, and also between the readings of whole and sectioned otoliths by the same reader. The percentages of agreement were also calculated. The mean length at age and the mean age at length in groups of 2 cm. were calculated for each reader, in whole and sectioned otoliths. The mean age of the sample obtained for each reader was compared using the ANOVA and the Tukey test.

RESULTS

The percentage of agreement between the readers is low as shown in Table 1.
If the otoliths were aged with the same criterion, the slope of the regression must be 1 and the intercept must be 0. The values obtained in some of the regressions are far from these theoretical values (Table 2).
The mean length at age in sectioned otoliths (Table 3, Figure 1), show that three readers use the same criterion. The other two readers are ageing one year less and 1 or 2 years more, respectively. This trend can also be observed in the mean age at length (Table 4, Figure 2). The plot shows a higher variability in the younger fish (due to problems in identification of the first annual ring and the edge), and in the older fish, as expected, with better agreement in the intermediate ages. Only three countries aged the whole otoliths, and two of them read one year less, compared with the sectioned otoliths.

The difference in the mean weight at age between the Northern and Southern Stock, can be partialy explained by the difference in the age readings between Norway and Spain (Figure 3).
In Figures 4,5 and 6 present some examples of the different age readings marked in the photographs.
The ANOVA with a significance level of 5% showed that the mean age of the sample is different for various readers, and the Tukey test showed that there are no significant differences between three readers, at the same significance level. The other two readers differed by -1.3 and +1.5 years respectively.
There seem to be two sources of variation:
- The identification of the first annual ring, which is the cause of differences of 1 or 2 years. To solve this problem, an otolith workshop could be helpful, or it may be useful to continue the exchange and includ otoliths from the northern area.
- The subjective interpretation of the edge, the false rings and the edge rings in old fish. This problem is more difficult to solve, and only the experience of the readers gives the criterion. New investigations are needed, and one could be an analysis ofthe frequency distribution of the rings to identify the true annual rings.

SLICED OTOLITHS:

	GDR	PORTUGAL	FAROE	SPAIN
PORTUGAL	42,9			
FAROE	17,3	12,2		
SPAIN	36,7	51,0	15,3	
NORWAY	11,2	9,2	0,0	23,5

WHOLE OTOLITHS:

	PORTUGAL	SPAIN
SPAIN	47,5	
NORWAY	30,3	57,6

Table 1: Percentage of agreement between the readers, in whole and sliced otoliths.

Whole otoliths	Slope	Intercept
Norway-Spain	1,05	0,03
Norway-Portugal	0,81	1,32
Spain-Portugal	0,80	1,03
Sliced otoliths		
Norway-Spain	1,27	0,28
Norway-Portugal	1,05	1,15
Norway-GDR	0,94	1,65
Norway-Faroe I.	0,78	3,48
Spain-Portugal	0,81	0,99
Spain-GDR	0,71	1,57
Spain-Faroe I.	0,60	3,40
Portugal-GDR	0,81	1,02
Portugal-Faroe I.	0,70	2,83
GDR-Faroe I.	0,76	2,45
Whole-Sliced otoliths		
Norway	0,96	0,06
Spain	0,80	0,14
Portugal	0,70	0,75

Table 2: Regressions between the age readings of the various countries.

BLUE WHITING SOUTHERN STOCK

SLICED OTOLITHS :

AGE	GDR $\bar{L}$ (cm.)	s	PORTUGAL $\bar{L}$ (cm.)	s	FAROE $\bar{L}$ (cm.)	s
1	18,50		18,50	1,41		
2	17,65	1,46	17,86	1,49		
3	18,81	1,77	21,17	2,36	18,00	1,32
4	24,65	4,07	23,86	2,42	18,06	2,17
5	27,73	2,22	26,54	2,61	22,74	3,01
6	26,04	2,34	25,71	2,45	24,79	4,39
7	27,25	2,35	27,79	2,05	26,03	2,78
8	27,10	3,01	29,50		26,38	2,67
9	28,50		26,50		28,88	2,69
10					28,50	

AGE	SPAIN $\bar{L}$ (cm.)	s	NORWAY $\bar{L}$ (cm.)	s
1	17,45	1,13	18,07	1,52
2	19,93	0,90	22,06	1,34
3	20,83	0,94	24,25	2,44
4	23,50	2,32	27,06	2,21
5	26,75	2,09	26,73	2,52
6	26,22	1,97	28,38	2,62
7	27,77	2,22		
8	30,50	1,79		

WHOLE OTOLITHS:

AGE	PORTUGAL $\bar{L}$ (cm.)	S	SPAIN $\bar{L}$ (cm.)	S	NORWAY $\bar{L}$ (cm.)	S
1	18,25	1,30	17,55	1,19	18,16	1,56
2	18,26	1,57	20,25	0,97	21,94	1,26
3	21,10	2,78	22,50	1,85	23,80	2,19
4	26,50	2,47	26,61	2,07	27,06	1,99
5	26,50	2,59	26,66	2,11	26,56	2,11
6	27,41	2,50	27,50	2,72	28,88	2,39
7	26,50	2,16	29,00	0,50		
8	28,50					

Table 3: Mean length at age and standard desviation.

SLICED OTOLITHS : MEAN AGE

Length (cm.)	GDR Age	s	PORTUGAL Age	s	FAROE I. Age	s
15-17	2,38	0,70	2,75	1,09	4,63	0,99
17-19	2,50	0,65	2,33	0,62	4,83	0,90
19-21	3,00	0,82	1,78	0,42	4,00	1,25
21-23	4,30	1,00	4,80	1,60	5,80	1,47
23-25	5,30	1,27	4,70	1,79	6,50	1,91
25-27	5,86	1,39	5,33	1,21	6,29	1,03
27-29	5,81	1,38	5,56	1,12	6,69	1,16
29-31	4,88	0,78	6,38	0,99	7,50	1,32
31-33	6,75	1,09	6,50	1,50	7,75	1,30

Length (cm.)	SPAIN Age	s	NORWAY Age	s
15-17	2,00	1,32	1,50	0,71
17-19	1,58	0,86	1,08	0,28
19-21	1,11	0,31	1,00	0,00
21-23	3,90	1,58	2,80	1,33
23-25	4,90	1,51	3,40	1,56
25-27	5,57	0,95	4,19	0,91
27-29	5,63	0,99	4,25	0,56
29-31	6,63	1,11	4,88	0,78
31-33	7,00	1,00	5,00	1,00

WHOLE OTOLITHS:

Length (cm.)	NORWAY Age	s	SPAIN Age	s	PORTUGAL Age	s
15-17	1,00	0,00	1,00	0,00	2,25	0,43
17-19	1,00	0,00	1,08	0,28	1,83	0,55
19-21	1,30	0,64	1,90	0,70	2,40	1,02
21-23	2,27	0,75	3,00	0,60	3,18	0,57
23-25	3,91	1,08	4,36	1,15	4,82	1,19
25-27	4,29	0,82	4,81	0,91	4,90	0,87
27-29	4,60	0,80	5,00	0,97	4,93	1,12
29-31	4,63	0,70	5,38	1,22	5,38	0,86
31-33	5,33	0,94	5,67	0,47	5,00	0,82

Table 4: Mean age at length group and standard desviation.

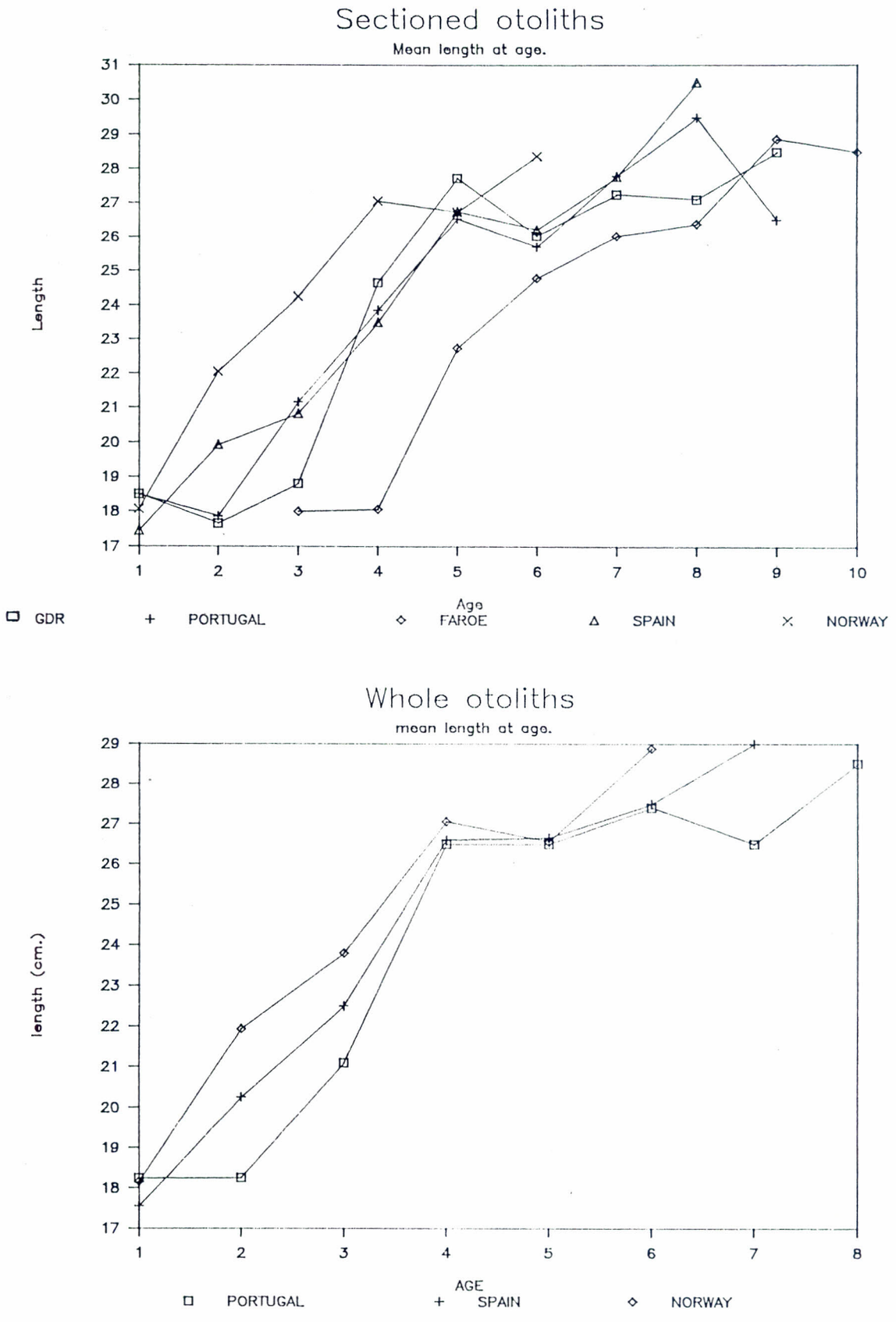
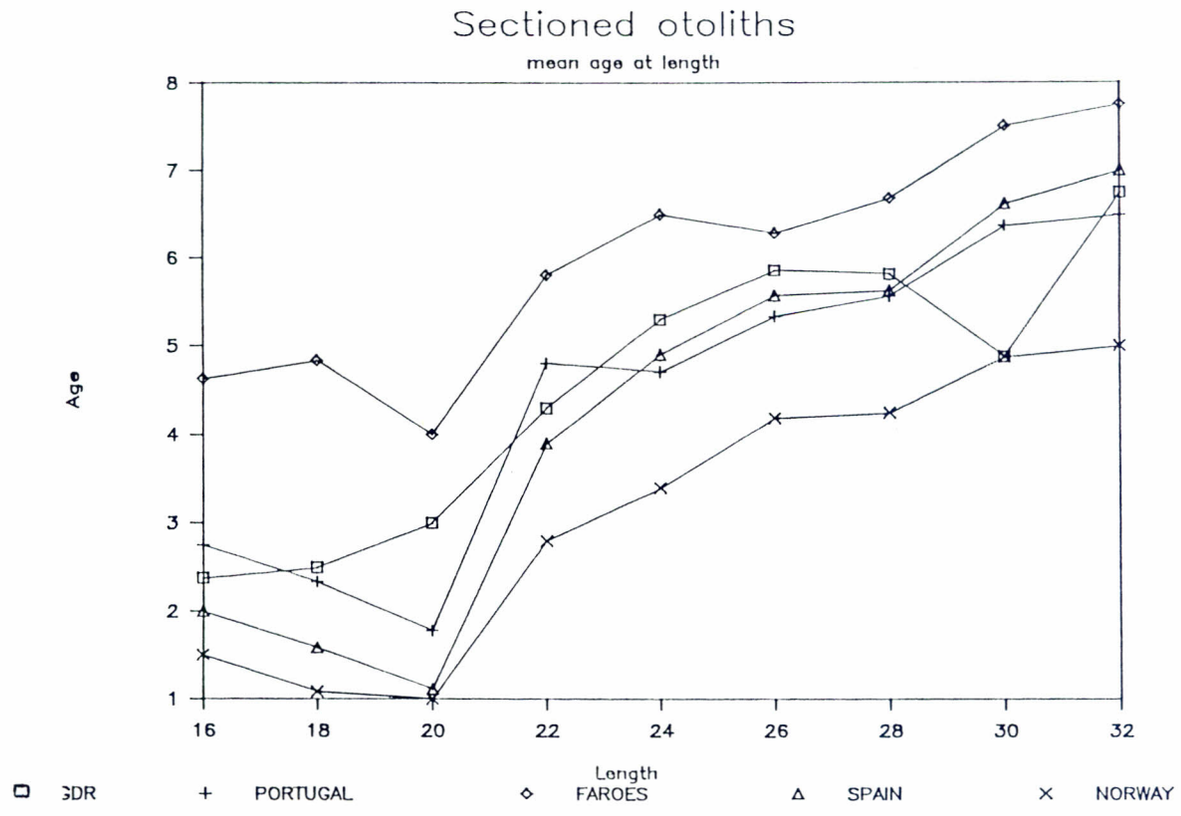


Figure 1: Mean length at age in sectioned and whole otoliths.



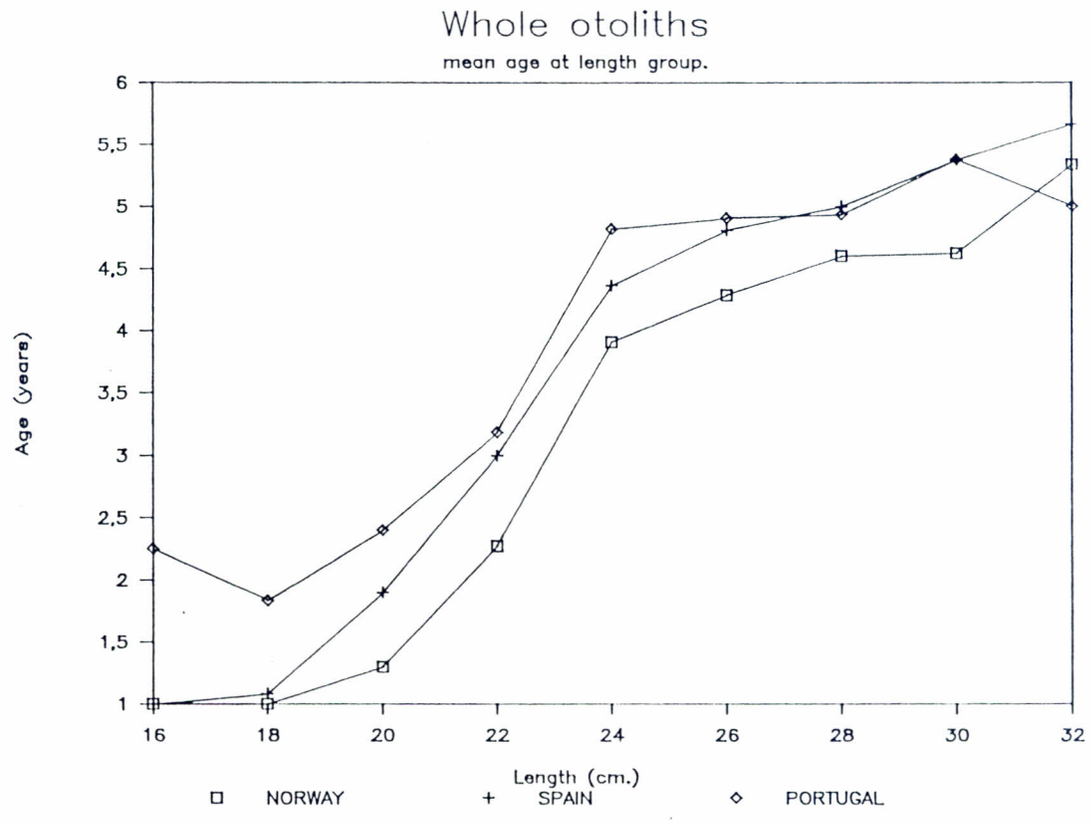
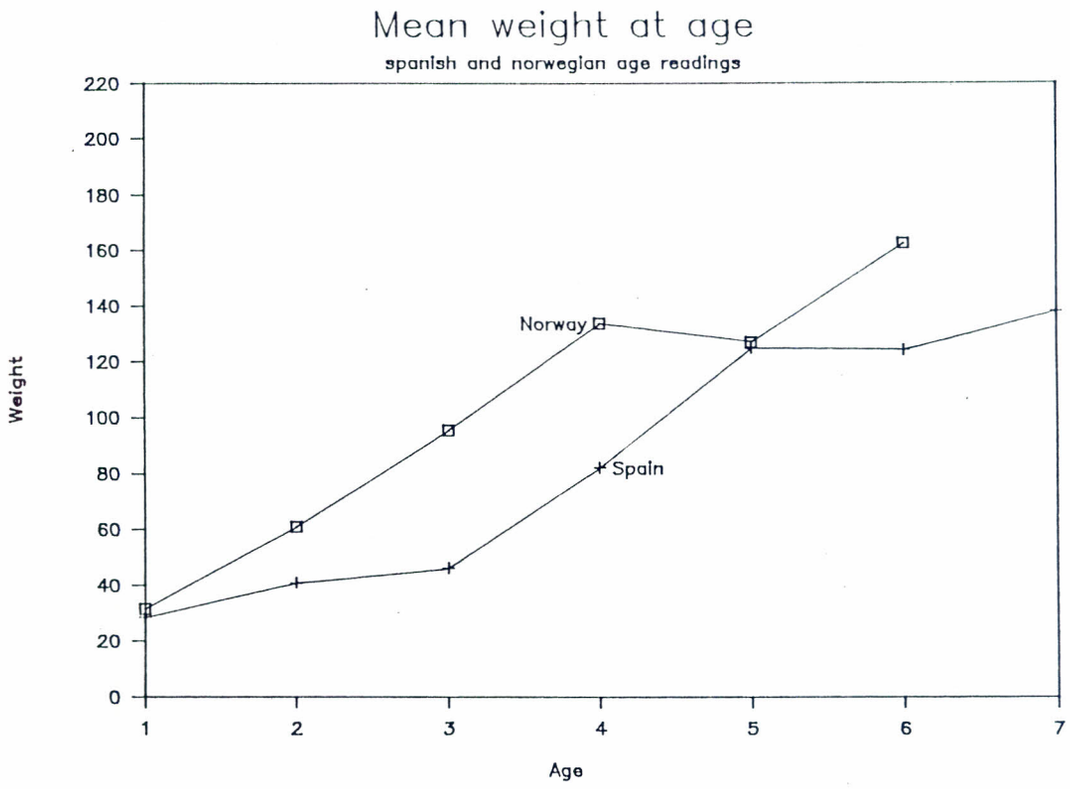


Figure 2: Mean age at length in sectioned and whole otoliths.



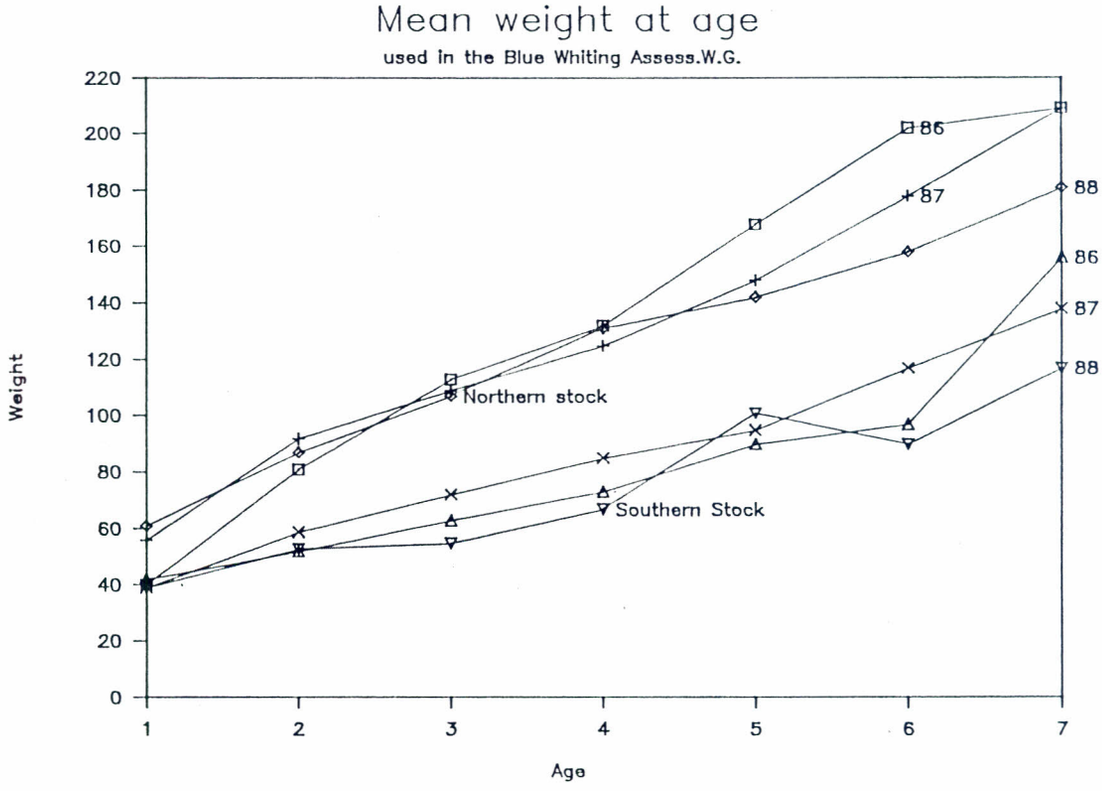
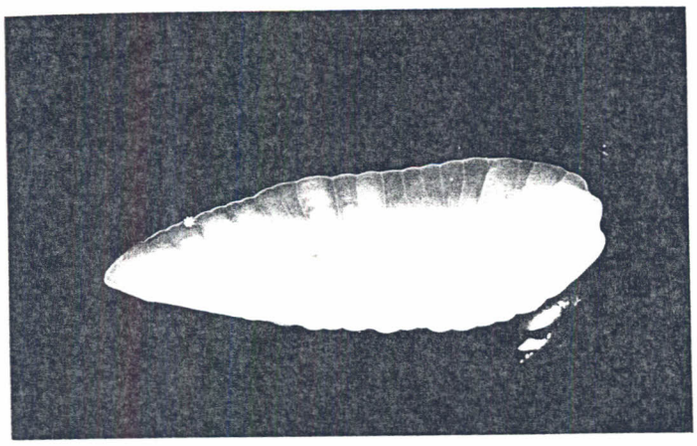
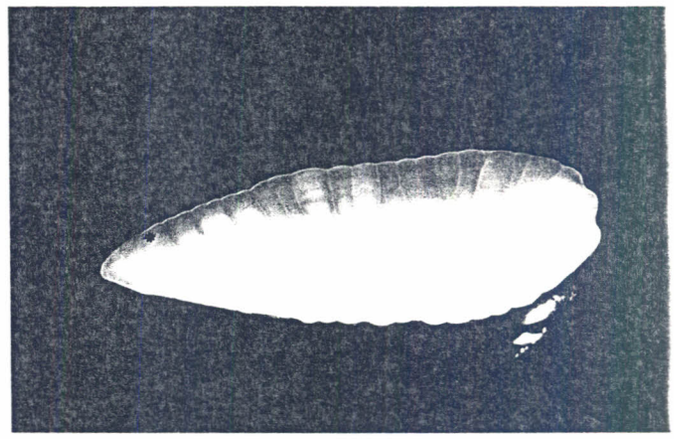


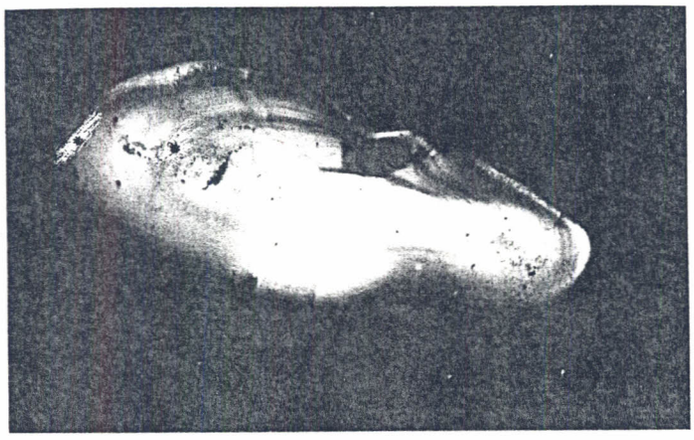
Figure 3: Mean weight at age used in the asssessment of the Northern and Southern Blue Whiting, and mean weight at age in the spanish and norwegian age readings of the sample exchanged.



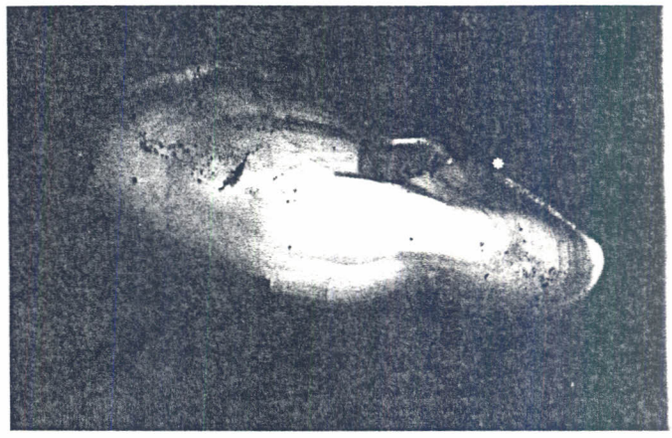
A: Spain. Age 1



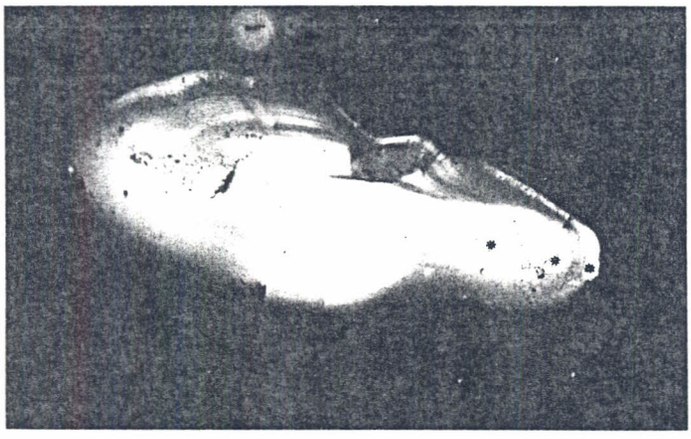
B: Norway. Age 1



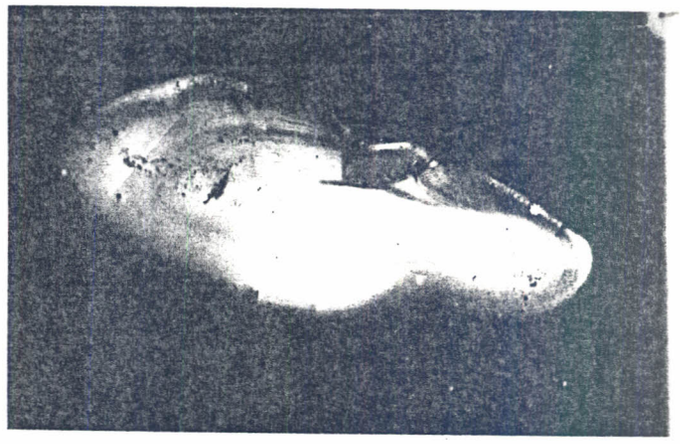
C: G.D.R. Age 2



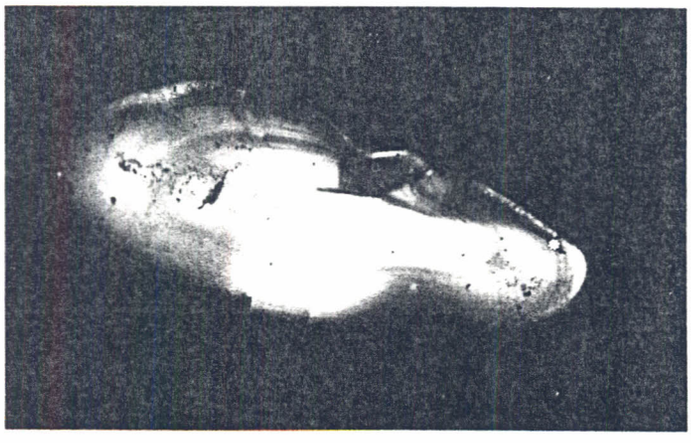
D: Portugal. Age 1



E: Faroe Islands. Age 3

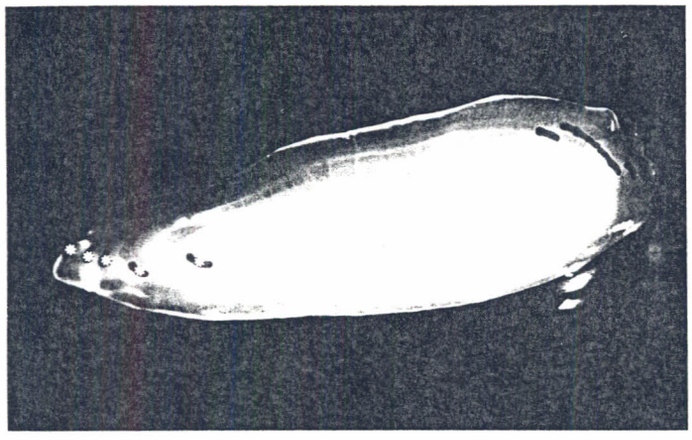


F: Spain. Age 1

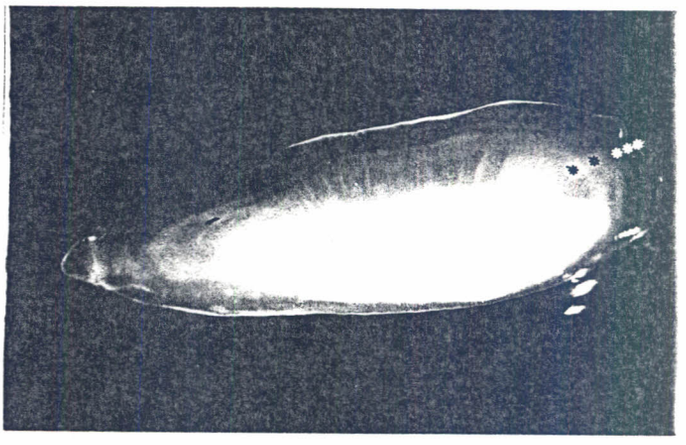


G: Norway. Age 1

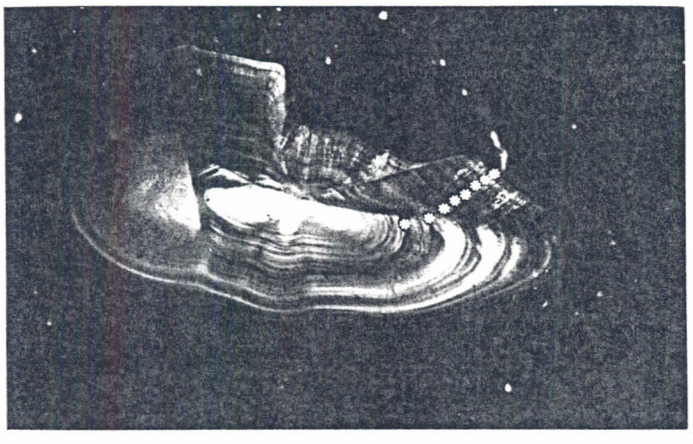
Figure 4: Age readings of a fish of 17 cm. A,B, whole otolith. C to G, sliced otolith.



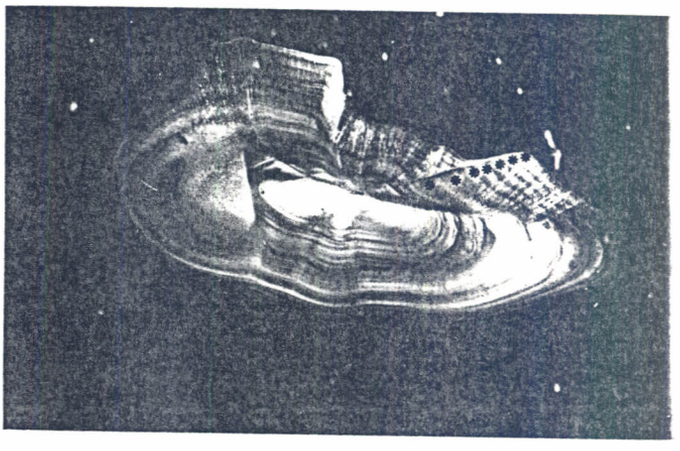
A: Spain. Age 5



B: Norway. Age 5

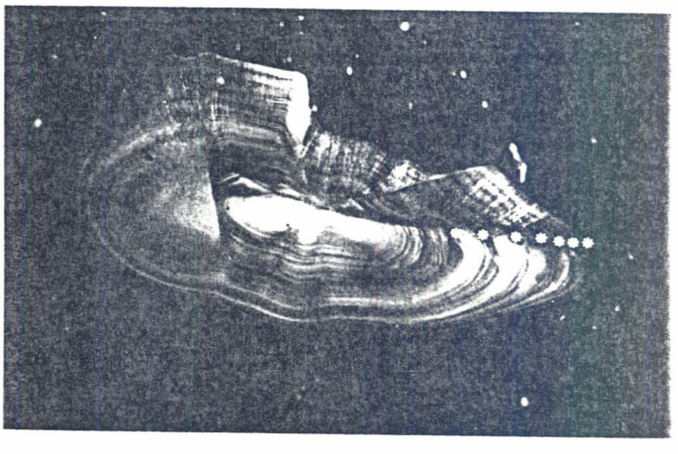


C: G.D.R. Age 8

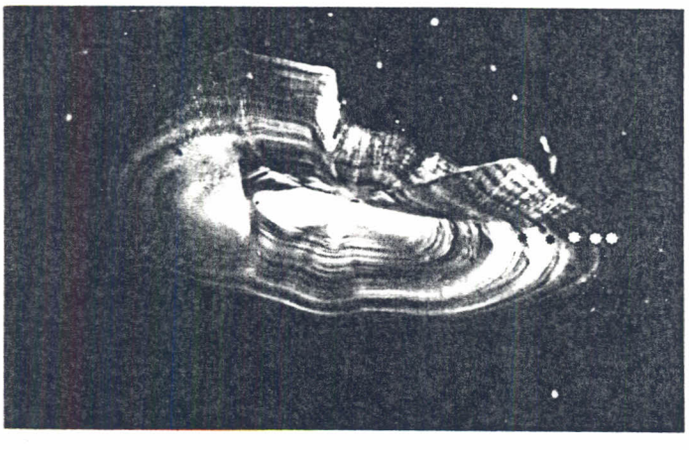


D: Portugal. Age 7

E: Faroe Islands. 9

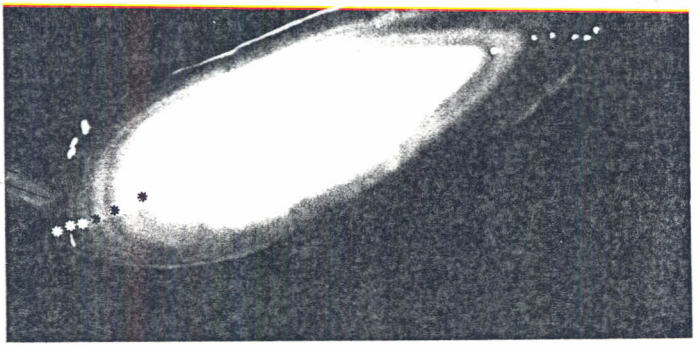


F: Spain. Age 7

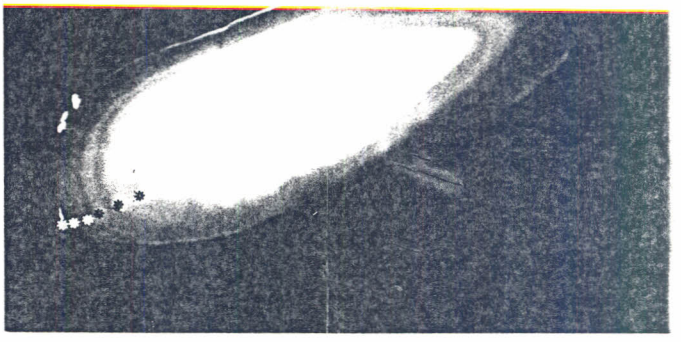


G: Norway. Age 5

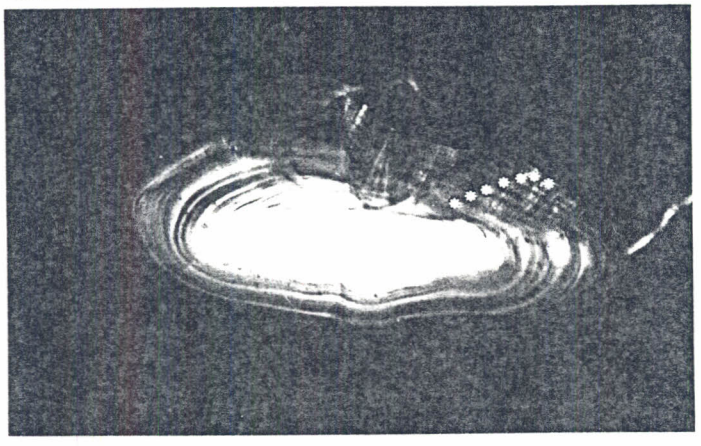
Figure 5: Age readings of a fish of 25 cm. A,B, whole otolith. C to G, sliced otolith.



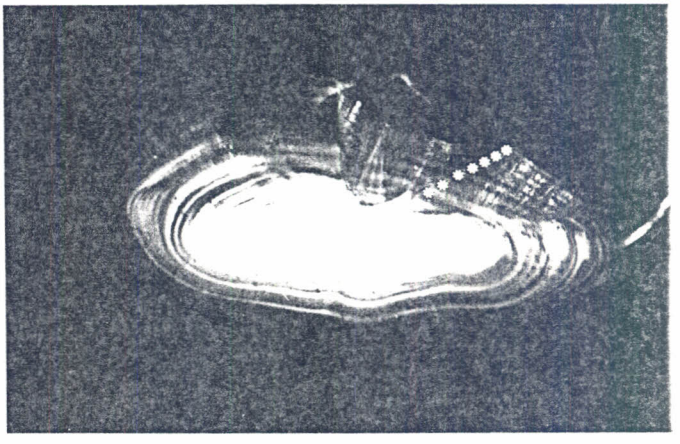
A: Spain. Age 6



B: Norway. Age 6

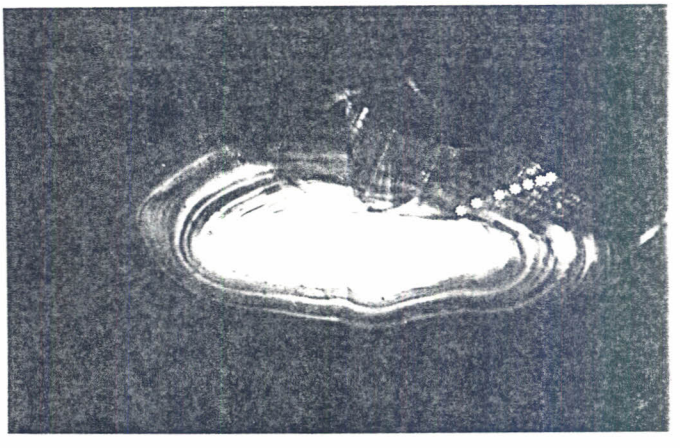


C: G.D.R. Age 7

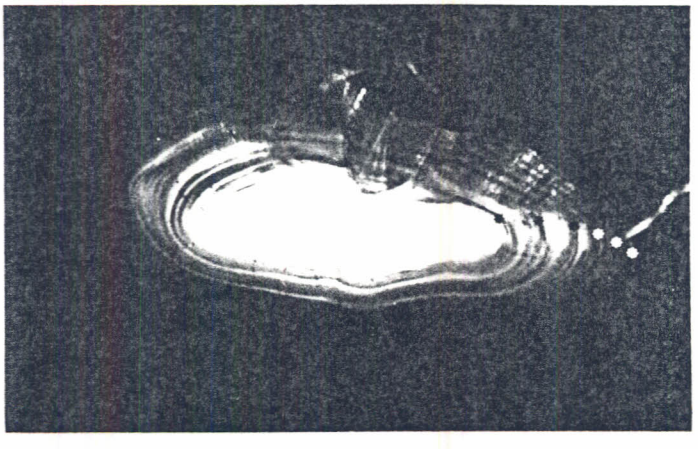


D: Portugal. Age 7

E: Faroe Islands. Age 8



F: Spain. Age 7



Norway: Age 6

Figure 6: Age readings of a fish of 27 cm. A, B, whole otolith. C to G, sliced otolith