EFAN Report 3-99

BLACK SCABBARD FISH (*Aphanopus carbo*) OTOLITH EXCHANGE (1998-1999)

By

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INTRODUCTION

Black scabbard fish (*Aphanopus carbo* Lowe, 1839) is a species inhabiting the continental shelf and slope between 180 and 1600 m depth. It is widely distributed in the northeastern Atlantic along the European continental shelf and also around isolated island groups and seamounts. Black scabbardfish is probably best described as a benthopelagic species, which make excursions into midwater. There is some evidence that these migrations occur mostly at night for feeding. There are often statements on the literature that juveniles are pelagic but evidence is lacking. The smallest specimens known, 10 to 15 cm, were taken from the stomachs of a midwater fish (*Alepisaurus ferox*) off Madeira (Maul, 1948).

Black scabbard fish is already commercial exploited by several countries, namely Portugal, U.K., France and Ireland. In Portugal, black scabbardfish is the target species of the longline fishery off Sesimbra (Portugal mainland) and off Madeira. In Madeira the species was caught until 1982 with the traditional drifting vertical longline (Martins & Ferreira, 1995), but it is now caught (Sena-Carvalho, pers. comm.), as in Portugal mainland, using a near-bottom drifting horizontal longline (Martins *et al.*, 1989). While the long established Madeira's fishery (since the early 19th century) and the more recent fishery off mainland Portugal (since 1983) are longline fisheries targeting for this species, the increasing landings in northern areas result from the bycatch of deep-water trawl fisheries. This fishery, in the west of British Isles is unregulated and part of it made in international waters.

In 1998 started a DG XIV E.U. Biological Study of title: "Environment and biology of deep-water species *Aphanopus carbo* in NE Atlantic: basis for its management (BASBLACK)". Its objective is to provide the basis for the development and implementation of a routine study and management of the black scabbardfish. Owing to the lack of biological and environmental information critical for the assessment and management of the species, a special effort is put into investigations of its biology, being age determination one of the main objectives.

Only a preliminary study on age and growth determination using otoliths was carried out for the species in Madeira. The results showed that black scabbard fish is a relatively fast-growing species living up to 8 years (Morales-Nin & Sena-Carvalho, 1996). Growth parameter estimates based on otolith readings and on length frequency analysis lead to similar results. However, the range of lengths used was quite narrow and adult component over represented.

As a first step on the age determination of the species in the framework of the BASBLACK Project, an Otolith Exchange was carried out with the following objectives:

1. To determine the best otolith preparation method.
2. To investigate the interpretation problems.
3. To uniformice the age determination chriteria.
4. To estimate precision from the age readings of each individual age reader.
5. Finally, to provide a common methodology for all the project participants.

The otolith readers who have participated in this otolith exchange were:

Tom Blasdale, MSS, Aberdeen, UK
Ângela Canha, DOP, Azores, Portugal
Jose Miguel Casas, IEO Vigo, Spain
Ivone Figueiredo, IPIMAR, Lisboa, Portugal
Leonel Gordo, FCUL, Lisboa, Portugal
John Gordon, SAMS, Oban, UK
Elisabete Gouveia, DSIP, Madeira, Portugal
Beatriz Morales-Nin, IMEDEA, Spain, coordinator
Carmen Gloria Piñeiro, IEO Vigo, Spain
Dália Reis, DOP, Azores, Portugal
Sara Reis, DSIP, Madeira, Portugal
Sarah Swan, SAMS, Oban, UK

One of the objectives of EFAN Cell 3 is the precision on age estimation through otolith reading exchange. This preliminary report includes the methodology and protocol established in the exchange as well as some results and conclusions, which were reached in a Workshop, that was held at the IMEDEA on June 1999.

MATERIAL AND METHODS

Following the recommendations of a meeting held in Vigo during the Maturity and Age Workshop from the project CT 95-655, the otoliths were prepared in two ways:

1- Whole otoliths: All the otoliths had a very low contrast between rings, thus they were burned on an electric heater until brown. The whole otoliths were keep dry in vials and read immersed in a mixture 50% glycerol-alcohol. After reading they were cleaned with alcohol and stored dry.

2- Thin sections: The sections were obtained using plastic embedded otoliths (Buheler 2 components epoxy resin) and cut with an Isomet saw equipped with two diamond blades with a separator (acetate disc). The cutting was realised at very low speed to avoid otolith breaking. The sections were mounted in slides with Eukitt and moistened with immersion oil before observation. Some of the sections were carried out using black resin and a modification of the method used in Lowestoft laboratory.

Three sets of material were circulated:

1) 50 otoliths from fish caught in Madeira corresponding to lengths from 56-144 cm caught in June/July 1998.
   a) whole burned otoliths
   b) sectioned in clear resin

2) 11 otoliths from fish caught in the Rockall Trough from 85 to 112 cm TL, from May 1998.
   a) whole otoliths
   b)sectioned in black resin

3) 10 otoliths from fish caught in the Rockall Trough from 82 – 105 cm TL, from 1999.
   a) whole otoliths
   b) sectioned in clear resin

The age determination criteria were that one opaque and one translucent ring were laid down annually. As spawning of black scabbard fish is not well known, the age was considered as the number of annuli and not age class was determined. Each participant was requested to comment their results about the problems encountered, otolith edge and age reliability. Figure 1 shows the schedule and timetable of the exchange activities.

Reading results were analysed for each set separately using a specially designed spreadsheet developed by Guus Eltink (Eltink, 1994) following the recommendations of the Workshop on Sampling Strategies for Age and Maturity (Anon, 1994). For each set of otoliths the modal and the average age are calculated, as well as the highest and lowest ages. In the age bias plots the mean recorded age ±2 standard deviations for each reader and for all the readers combined is plotted against modal age. The percentage agreement with modal age were calculated for each reader as well as for the average of all readers (Eltink, 1997).

Additionally the age-length relationships obtained for the set 1 were plotted to assess if the results followed a von Bertalanffy curve. Moreover, for this set a comparative analysis of the results from whole and sectioned otoliths was carried out by substracting from the age obtained in the section the age from the whole otolith and plotting the results of each otolith.

RESULTS

Exchange

Black scabbard fish otoliths are oblong and show growth zones around a central elongate area (Fig.2). The otoliths had a low contrast; thus they were burned to increase the definition of the translucent increments.

The bias plots for the three sets of otoliths showed clear discrepancies between methods and readers (Tables 1-4). The maximum age determined from whole otoliths was 12 and from sections 24. The main difficulties were to locate the first ring and the interpretation of the marginal growth zones. Thus, giving bigger bias on the younger and older specimens.

Depending of the reader the age-length relationships obtained for the whole otoliths showed different trends (Fig.3). Some readers obtained ages ranging from 1 to 12 years, while others obtained a narrower age-range.

In the sections these difficulties increased and the false rings obscured the interpretation. All the readers considered the sectioned otoliths as unclear (Fig.1c), thus a second small set of otoliths from the Rockall Trough were sectioned. However, the sections remained unclear and the results were bad (Fig.4).

When the data set 1 is compared for ages obtained from whole and sectioned otoliths, it was clear that the sections gave older ages with important differences (Fig.5). The range of variation depended of the reader and could be bigger than 10 years.

Workshop discussion of the results and additional otolith analysis

The results were discussed jointly on the Workshop where most of the readers participated. An additional set of otoliths was interpreted in the workshop to test if unburned otoliths, immersed in water for 24 h, improved otolith clarity. The results were not better and the readers decided that the burned otoliths read in 50% glycerol-alcohol were the best solution. It was agreed that the outer edge is clearer in burnt otoliths but that the centre is probably clearer in untreated otolith.

Based on the discussion of the exchange results a joint second otolith reading was performed with the exchanged otoliths and additional otoliths from Portugal mainland.

The interpretation of the first ring is one of the main problems due to the variability of the nuclear area morphology. Frequently faint 2-3 rings are visible in the central area followed by a more marked one, considered as the first increment. However, there is considerable variability inter areas and in the same sampling locality. The causes of this variability are not clear. Spawning tends to occur over a restricted period of 3 months (October-December) at Madeira. No spawning has been observed in other areas. There appears to be no seasonality in the occurrence of small fish, which are found in small numbers throughout the year. In Madeira about 500 small fish are sampled per year. The possibility of gear selectivity was discussed as well as the absence of larvae and juvenile fish from oceanographic cruises held in the species distribution area.

The general interpretation criteria of following a ring all around the otolith to determine if it is an annuli or a false ring could not be applied to black scabbard fish. The fact is that it was often not possible to follow a ring all the way round. Also, there is considerable variability on the ring number in the different otolith areas.

The question arose as to whether such large fish could have such low ages and whether there were any comparable deep-sea fish. It was considered that it might be more appropriate to think in terms of fish weight rather than fish length. Length at first maturity is around 80 to 90 cm and maximum lengths up to 150 cm. An additional otolith reading of sectioned and whole otoliths from fish between 130-150 cm was recommended to test if very faint rings are laid down in the otolith edge.

To allow for the varying shape and the difficulty of ascertaining the centre of the nucleus, the diameter should be measured.

It was generally agreed that the first five visible rings should be grouped so that a strong translucent band identified the first ring. Thereafter grouping by variable numbers of rings was carried out by subjectively counting the most distinctive.

It was considered important to ensure that rings, which were being counted in small otoliths, should not be rejected in larger otoliths.

There was also a debate about the usefulness of 1 January as birthday. Many deep-water macrourids lay down the opaque zone in autumn. It is not known whether the same occurs in black scabbard fish. A seasonal study of the nature of the otolith edge should be undertaken.

CONCLUSIONS

The group reached the following recommendations for *Aphanopus carbo* age determination:

Methodology

Storage: Cleaned otoliths stored dry. Cleaning can be done with water – no need to use KOH.

Preparation: Slight burning until light brown – otoliths in paper envelops on hotplate at 80°C.

Observation: Read in a mixture of glycerine and alcohol (50/50) [alcohol helps to clarify and dilutes glycerine to aid penetration). After reading the otoliths are wiped in alcohol and stored dry.

The reading should be done at low magnification, only increasing the magnification to read the edge (x12 was used at the workshop)

Otoliths placed in black dish for reading. Glass dish on a black background is not suitable.

Ideally a measuring optical system should be used.

Two independent readers should read otoliths. If the age estimates differ then the otolith should be rejected. If the rejection rate is high then the procedures should be checked.

All fish data on length, weight, sex (maturity) and station/capture data should be recorded.

The nature of the outer edge should be described.

Interpretation chriteria

First ring

In smaller fish the nuclear area is thinner and small rings are visible that are not seen in larger thicker otoliths. In this case measurements may help to differentiate the first ring. The main criterion is the sharpness of the translucent ring and it continuity around the whole otolith. The nuclear area is more opaque than all other areas.

Growth zones

Relative distances to the otolith centre can select growth zones. It is not always possible to follow these zones around the otolith. The growth zones are clearer in the posterior zone than in the rostral area where they are split.

It should be recognised that the outer edge could be a false zone. The thickness of the zone may be important.

Age groups

There is a need to know when the opaque zone is laid down. If spawning is in the autumn/early winter then a birthday of 1 January may be appropriate.

An experiment in measuring all zones on up to 100 otoliths per partner may help to validate zone formation.

Madeira should carry out a seasonal study of the otolith edge. Particular attention should be paid to differences between immature and mature fish.

Validation by daily growth rings will be carried out by BMN on Sesimbra material.

It was considered that length-frequency analysis would not be appropriate aid for indirect validation. This was because of gear selectivity. At Sesimbra there was no change in length/frequency by season. There is also a suggestion that this species may be migratory.

Any information on the larval and juvenile up to 40 cm would be very useful.

ACKNOWLEDGEMENTS

I wish to thank all the otolith readers for their co-operation in this otolith exchange, and specially Dalila Sena-Carvalho DSIP, John Gordon SAMS, and Ivonne Figuereido IPIMAR, for providing the exchanged otoliths and additional material for analysis. Guus Eltink is thanked for providing me with the spreadsheet.

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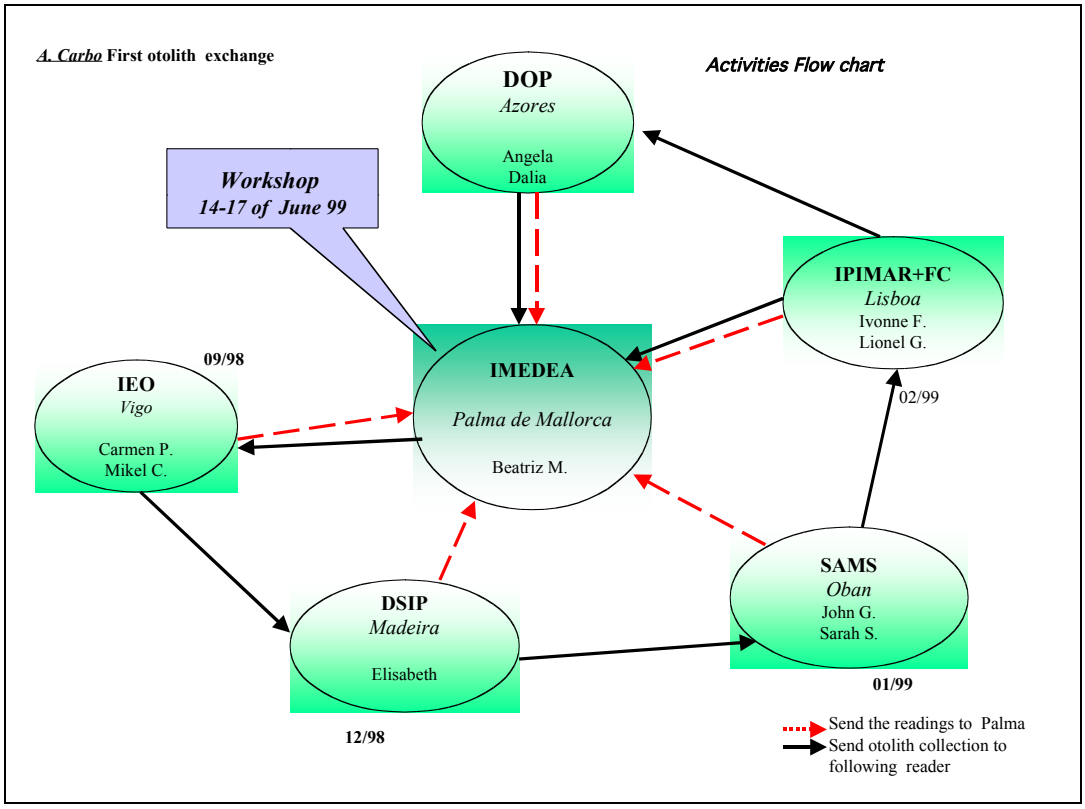

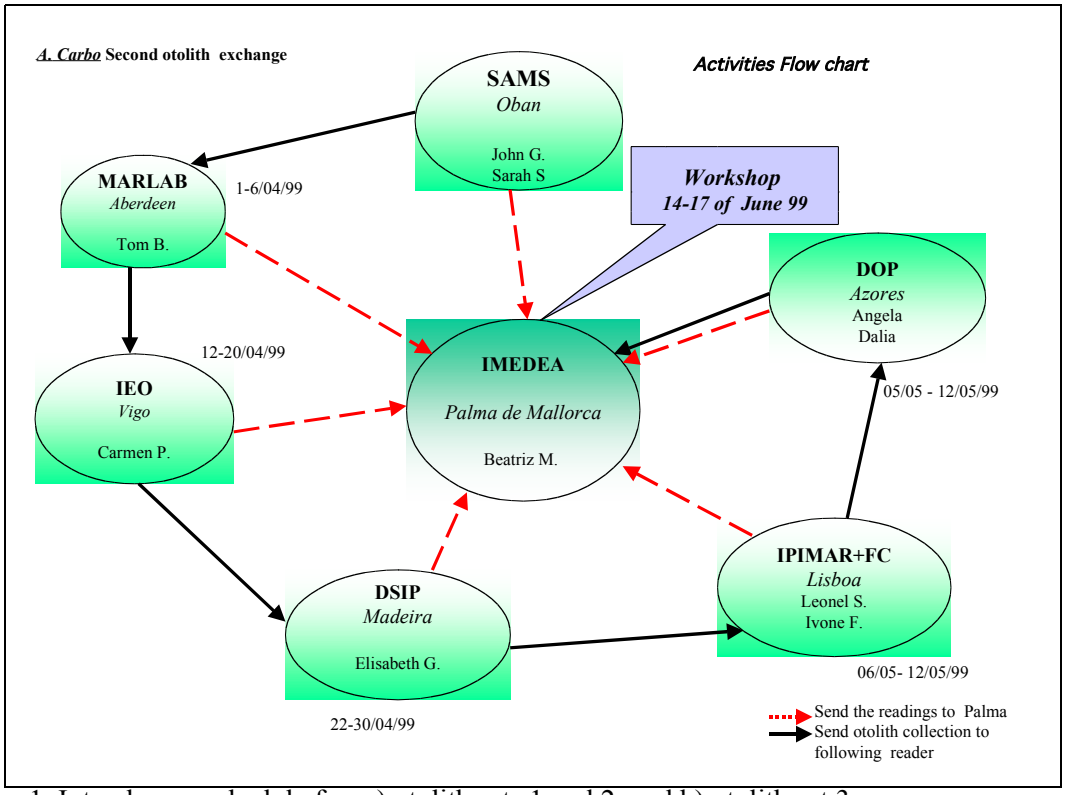

Figure 1. Interchange schedule for: a) otolith sets 1 and 2, and b) otolith set 3.

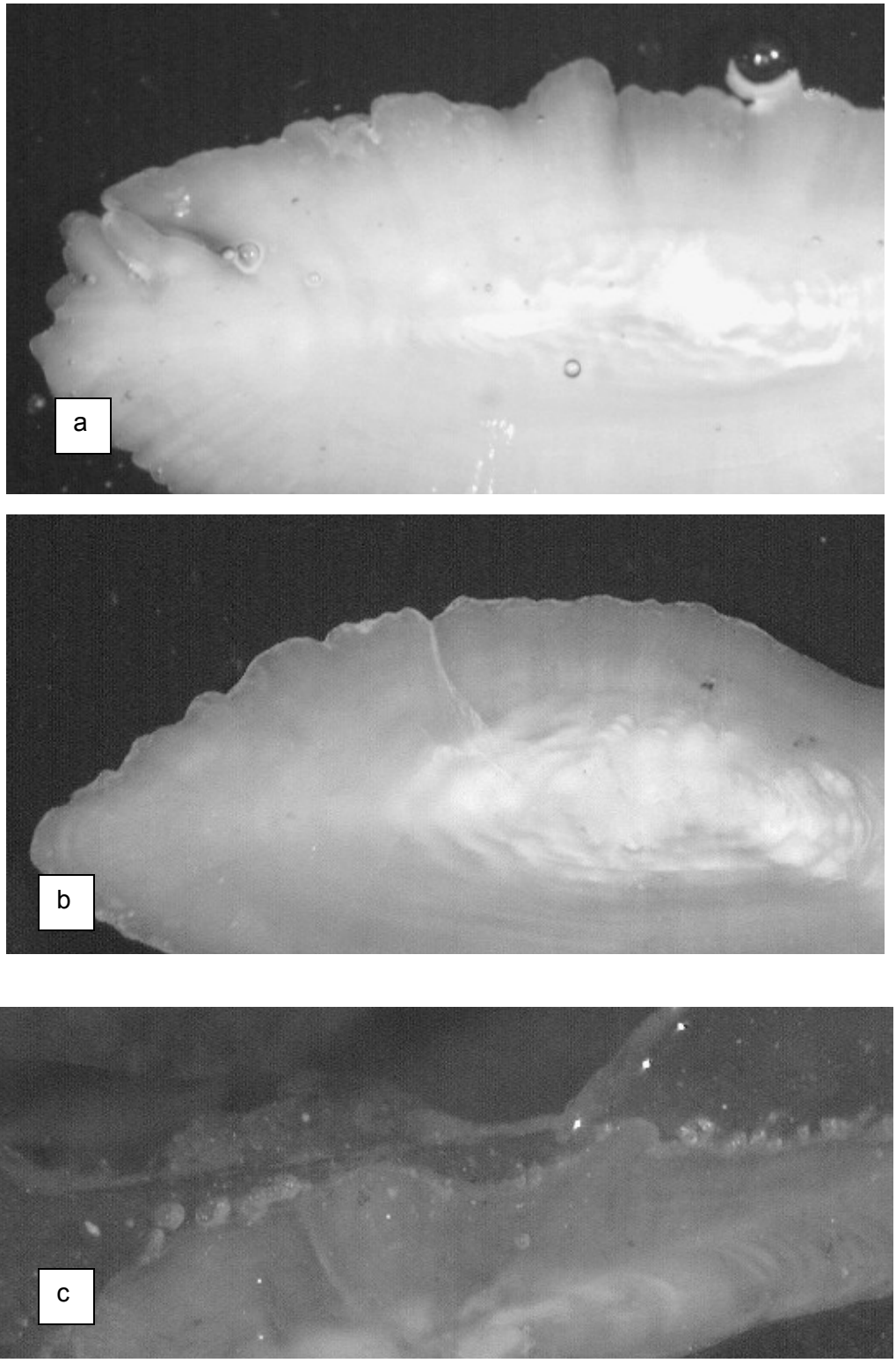

Figure 2. Microphotography of a whole otolith from Madeira(a), from the Rockall Through (b) and a section of a Madeira otolith (c) of black scabbard fish.

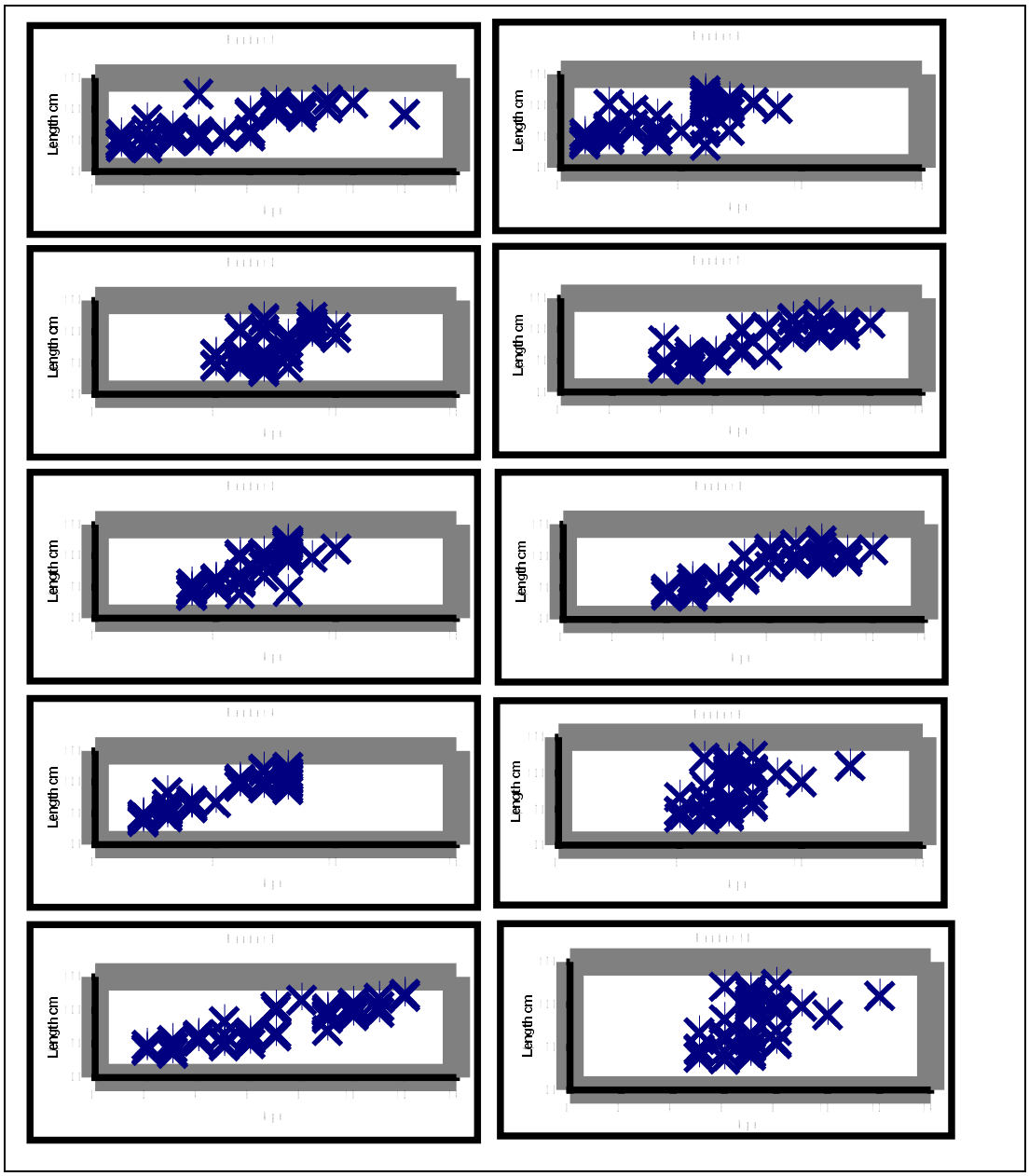

Figure 3. Age-length plot by reader of the Madeira whole otoliths.

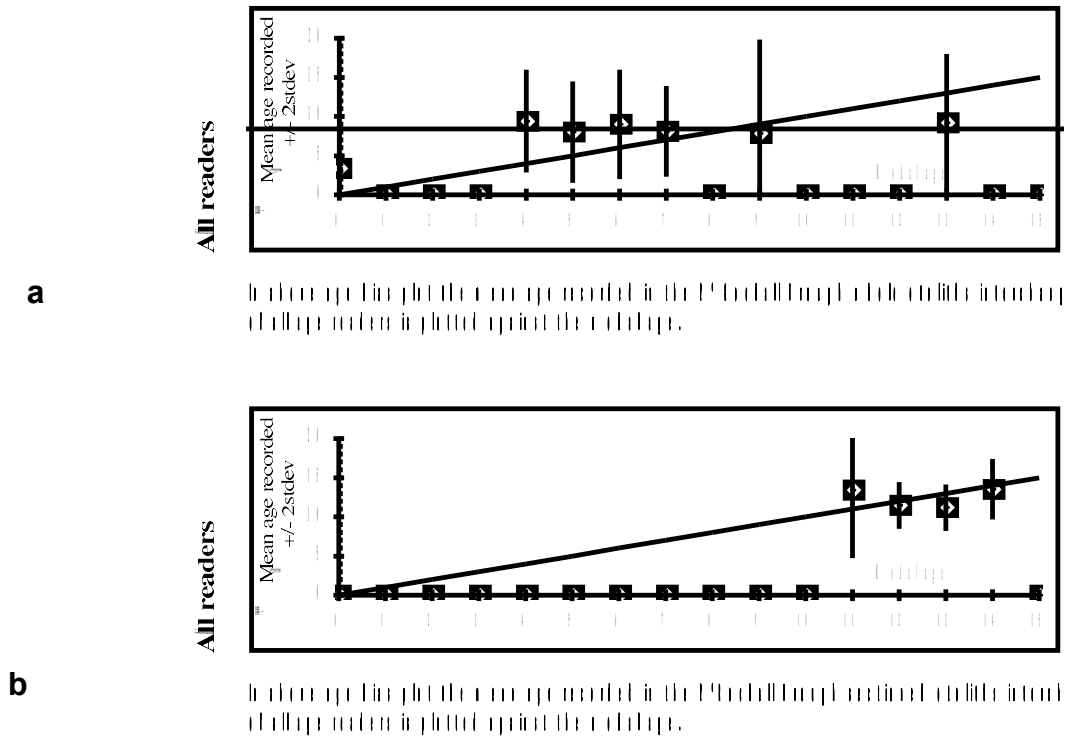

Figure 4. Results of the whole (a) and sectioned (b) 2º Rockall Trhough interchanged otoliths.

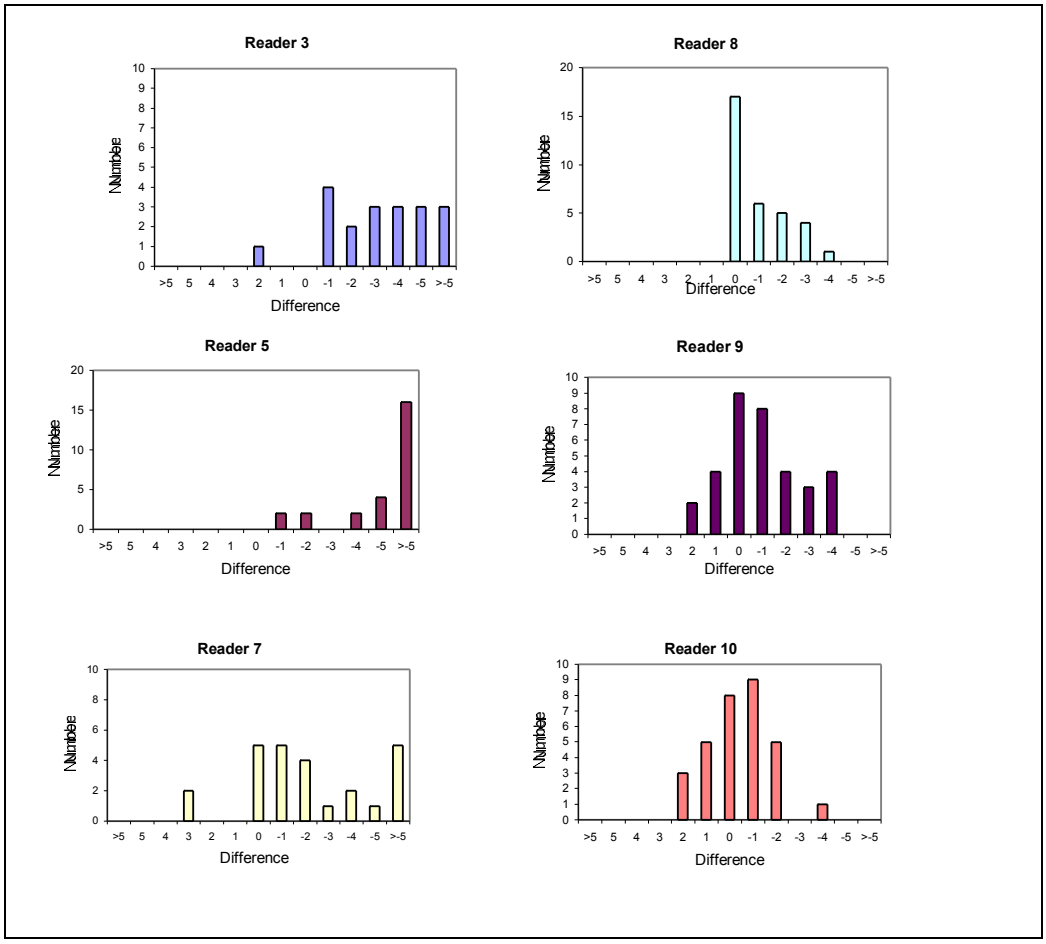

Figure 5. Differences by reader between the readings of whole and sectioned Madeira otoliths.

Table 1. 1998 whole otoliths Madeira.

Year	Sample	Fish no	Fish lenght	Catch month	IMEDA Reader 1	IEO Reader2	IEO-2 Reader 3	DSIP-1 Reader 4	SAMS-1 Reader 5	SAMS-2 Reader 6	IPIMAR Reader 7	FC Reader 8	DOP-1 Reader 9	DOP-2 Reader 10	MODAL AGE	Age difference	Average
98	0	1	125	6	7	6	8	6	7	8	8	8	8	7	8	2	7.30
98	0	2	144	6	4	9	8	8	12	6	10	10	8	8	8	8	8.30
98	0	3	135	6	9	9	8	8	8	6	9	10	8	7	8	4	8.20
98	0	4	130	6	10	9		8	10	6	12	12	12	12	12	6	9.10
98	0	5	77	6	6	7	6	3	6	6	5	5	6	8	6	5	5.80
98	0	6	80	6	4	6	6	4	6	7	6	6	7	7	6	3	5.90
98	0	7	56	6		7	4	2	3	6	5	5	6	6	6	5	4.40
98	0	8	64	6		6	4	3	3	4	4	4	8	7	4	5	4.30
98	0	9	103	6	2	8	7	3	5	4	4	8	7	6	8	6	5.40
98	0	10	79	6	1	7	5	4		5	8	6	7	6	7	7	4.90
98	0	11	84	6	4	5		3	5	6	5	5	6	6	5	3	4.50
98	0	12	76	6	5										0	0	0.50
98	0	13	87	6	6	6	7	5	6	6	7	7	6	5	6	2	6.10
98	0	14	138	6		7	8	7	11	6	9	9	7	7	7	5	7.10
98	0	15	121	6	8	6	8	6	9	6	8	8	8	7	8	3	7.40
98	0	16	123	6	7	7	7	7	10	7	10	10	7	8	7	3	8.00
98	0	17	108	6	8	?		8	9	7	9	9	8	10	8	3	7.56
98	0	18	141	6		7	8	7	12	?			7	6	0	6	5.22
98	0	19	120	6		9		6	7	6	7	7	8	7	7	3	5.70
98	0	20	131	6	7	9	10	8	10	7	11	8	10	7	7	4	8.70
98	0	21	115	6	8	9		7	10	9	11	11	8	8	8	4	8.10
98	0	22	118	6	7	9	6	7	9	6	7	9	7	9	7	3	7.60
98	0	23	124	6	8	7	7	8	7	8	11	11	7	8	8	4	8.20
98	0	24	122	6	9	7	6	6	9	2	10	10	8	7	9	8	7.40
98	0	25	112	6	12	9		8	10	6	11	11	11	8	11	6	8.60
98	0	26	114	6	6	?	8	6	10	6	10	10	8	7	6	4	7.89
98	0	27	126	6	7	10	8	8	11		10	11	11	8	8	4	8.40
98	0	28	117	6	7	7	9	8	11	7	10	10	7	7	7	4	8.30
98	0	29	119	6	8		8	8	9	7	9	9	8	7	8	2	7.30
98	0	30	111	6	6	10	7	7	9	6	10	10	10	7	10	4	8.20
98	0	31	113	7	7	8	8	6	9	3					0	6	4.10
98	0	32	71	7	2	7	5	3	5	4	6	6	6	7	6	5	5.10
98	0	33	79	7	5	8	6	4	4	3	6	6	7	6	6	5	5.50
98	0	34	81	7	3	7	6	4	4	2	6	6	7	7	7	5	5.20
98	0	35	74	7	3	6	5	3	4	2			9	8	3	7	4.00
98	0	36	68	7	1	7	4	2	2	2	4	4	8	5	4	7	3.90
98	0	37	63	7	1	8	8	2	2	1	4	4	8	7	8	7	4.50
98	0	38	75	7	4	6	4	3	3	1					0	5	2.10
98	0	39	83	7	6	5	5	4	4	2	7	7	6	7	7	5	5.30
98	0	40	65	7	2	5	4	2	3	2	4	4	7	6	2	5	3.90
98	0	41	82	7	4	7	5	4	7	4	6	6	6	6	6	3	5.50
98	0	42	67	7	1	5	4	3	5	2	5	5	6	5	5	5	4.10
98	0	43	58	7	2	7	4	2	3	1	4	4	5	5	4	6	3.70
98	0	46	60	7	1	7	6	2	2	1	5	5	7	7	7	6	4.30
98	0	47	86	7	2	7	6	4	7	2	7	7	6	7	7	5	5.50
98	0	48	69	7	3	7	5	3							0	4	1.80
98	0	49	90	7	3	8	6	4	9	3	7	7	10	8	3	7	6.50
98	0	50	70	7	4	6	5	3	6	1	5	5	7	7	5	6	4.90

Table 2.1998 Madeira sectioned otoliths.

Year	Sample	Fish no	Fish lenght	Catch month	IEO-2 Reader 3	DSIP-1 Reader 4	SAMS-1 Reader 5	IPIMAR Reader 7	FC Reader 8	DOP-1 Reader 9	DOP-2 Reader 10	MODAL AGE	Age difference	Average
98	0	1	125	6			12	8	8	12	8	8	4	6.86
98	0	2	144	6			14		11	12	10	0	4	6.71
98	0	3	135	6								0	0	0.00
98	0	4	130	6								0	0	0.00
98	0	5	77	6								0	0	0.00
98	0	6	80	6			11	6	6	7	8	0	5	5.33
98	0	7	56	6					5	6	4	0	2	2.14
98	0	8	64	6			9	4	4	7	6	0	5	4.33
98	0	9	103	6	8	11	14	8	8	9	7	8	7	9.50
98	0	10	79	6			9	5	8	9	7	0	2	5.50
98	0	11	84	6	10		6	6	7	9	7	7	4	6.50
98	0	12	76	6	9		14	5	6	9	6	9	8	7.33
98	0	13	87	6		8	13		7	7	5	0	8	5.71
98	0	14	138	6					9			0	0	1.29
98	0	15	121	6			18	11	8	8	7	0	11	6.83
98	0	16	123	6	15		20	16	13	11	10	-	10	11.50
98	0	17	108	6	19			13	12	11	10	0	9	8.67
98	0	18	141	6								0	0	0.00
98	0	19	120	6				13	8	9	7	0	2	4.00
98	0	20	131	6	20		24	17	12	8	9	-	16	12.17
98	0	21	115	6								0	0	0.00
98	0	22	118	6	13		20	16	12	9	7	-	13	10.17
98	0	23	124	6				17	13	10	10	0	3	5.50
98	0	24	122	6								0	0	0.00
98	0	25	112	6								0	0	0.00
98	0	26	114	6					10	8	8	0	2	3.71
98	0	27	126	6	13				13	11	10	0	3	6.71
98	0	28	117	6	13		19		12	10	11	0	9	9.29
98	0	29	119	6								0	0	0.00
98	0	30	111	6			10			11		0	1	3.00
98	0	31	113	7	10		22	11	11	8	8	8	14	9.83
98	0	32	71	7					7	8	7	0	1	3.14
98	0	33	79	7	7		12	7	6	7	7	7	6	6.50
98	0	34	81	7	7		12		6	8	6	0	6	5.57
98	0	35	74	7	9	8	13	7	5	8	8	8	8	8.50
98	0	36	68	7	9	7	9	6	5	6	5	9	4	6.83
98	0	37	63	7	6		8	5	4	7	7	7	4	5.33
98	0	38	75	7		7	14	7	7	7	7	7	7	7.00
98	0	39	83	7				4	7	10	6	0	4	3.83
98	0	40	65	7	7	9	8	5	5	6	5	5	4	6.67
98	0	41	82	7	6	8	14	7	6	7	7	6	8	8.00
98	0	42	67	7			7	5	5	6	6	0	2	4.00
98	0	43	58	7	6	8	7	6	4	6	5	6	4	6.00
98	0	46	60	7	6							0	0	0.86
98	0	47	86	7	9							0	0	1.29
98	0	48	69	7	9	11	11	6	5	7	5	11	6	8.00
98	0	49	90	7	9	9	14	7	7	10	6	9	8	9.17
98	0	50	70	7	10	8	10	7	6	7	6	10	4	7.83

Table 3.1998 whole otoliths Rockall.

Year	Sample	Fish no	Fish lenght	Catch month	IMEDEA Reader 1	IEO Reader 2	IEO-2 Reader 3	DSIP-1 Reader 4	SAMS-1 Reader 5	SAMS-2 Reader 6	IPIMAR Reader 7	FC Reader 8	DOP-1 Reader 9	DOP-2 Reader 10	MODAL AGE	Age difference	Average
98	0	1	92	6	6	7	10	6+	6	4	7	7	9+	-	7	6	6.71
98	0	2	100.2	6	7	7	9	7	?	3	7	7	10	-	7	7	7.13
98	0	3	93.3	6	7?	8?	9	8	6	5	7	7	9/10	-	7	4	7.00
98	0	4	97.6	6	8	7?	10	7	7	6	7	7	8+	-	7	4	7.43
98	0	5	87.8	6	?	6?	7-8	6	6	4	8	7	8	-	6	4	6.50
98	0	6	95	6	6	6	8	7	6	5	8	8	8	-	8	3	6.89
98	0	7	107.2	6	9	7	7?	7+	11	?	10	10	7/8	-	10	4	9.40
98	0	8	97.9	6	7 edge opaque	7	7	7+	7	5	9	8	7/8?	-	7	4	7.17
98	0	9	104	6	11	10?	9?	9?	11	6	9	9	8/9	-	11	5	9.20
98	0	10	112	6	10		8?	6+	9	4	9	9	8	-	9	6	7.00
98	0	11	85.3	6	6 edge opaque	6	5?	6?	5	3	7	7	6	-	6	4	5.67

Table 4. 1998 selectioned otoliths Rockall.

Year	Sample	Fish no	Fish lenght	Catch month	IPIMAR Reader 7	FC Reader 8	DOP-1 Reader 9	DOP-2 Reader 10	MODAL AGE	Age difference	Average
98	0	1	92.00	6	11.00	7.00	9	9+	9.00	4.00	2.25
98	0	2	100.20	6	11.00	10.00	6/7?	10.00	10.00	1.00	3.44
98	0	3	93.30	6	9.00	8.00	7/9	9/10	9.00	1.00	2.13
98	0	4	97.60	6	9.00	7.00	7/8	8+	7.00	2.00	2.00
98	0	5	87.80	6	9.00	8.00	9	8.00	8.00	1.00	2.78
98	0	6	95.00	6	8.00	8.00	8	8.00	8.00	0.00	2.67
98	0	7	107.20	6	12.00	10.00	8/9	7/8	8.00	2.00	2.75
98	0	8	97.90	6	10.00	8.00	7	7/8?	7.00	2.00	2.25
98	0	9	104.00	6	10.00	9.00	8	8/9	8.00	1.00	2.38
98	0	10	112.00	6	11.00	9.00	7/8	8.00	8.00	3.00	3.11
98	0	11	85.30	6	6.00	7.00	4/5	6.00	6.00	1.00	2.11

Table 3.1998 whole otoliths Rockall.

Year	Sample	Fish no	Fish lenght	Catch month	IMEDEA Reader 1	IEO Reader 2	IEO-2 Reader 3	DSIP-1 Reader 4	SAMS-1 Reader 5	SAMS-2 Reader 6	IPIMAR Reader 7	FC Reader 8	DOP-1 Reader 9	DOP-2 Reader 10	MODAL AGE	Age difference	Average
98	0	1	92	6	6	7	10	6+	6	4	7	7	9+	-	7	6	6.71
98	0	2	100.2	6	7	7	9	7	?	3	7	7	10	-	7	7	7.13
98	0	3	93.3	6	7?	8?	9	8	6	5	7	7	9/10	-	7	4	7.00
98	0	4	97.6	6	8	7?	10	7	7	6	7	7	8+	-	7	4	7.43
98	0	5	87.8	6	?	6?	7-8	6	6	4	8	7	8	-	6	4	6.50
98	0	6	95	6	6	6	8	7	6	5	8	8	8	-	8	3	6.89
98	0	7	107.2	6	9	7	7?	7+	11	?	10	10	7/8	-	10	4	9.40
98	0	8	97.9	6	7 edge opaque	7	7	7+	7	5	9	8	7/8?	-	7	4	7.17
98	0	9	104	6	11	10?	9?	9?	11	6	9	9	8/9	-	11	5	9.20
98	0	10	112	6	10		8?	6+	9	4	9	9	8	-	9	6	7.00
98	0	11	85.3	6	6 edge opaque	6	5?	6?	5	3	7	7	6	-	6	4	5.67

Table 4. 1998 selectioned otoliths Rockall.

Year	Sample	Fish no	Fish lenght	Catch month	IPIMAR Reader 7	FC Reader 8	DOP-1 Reader 9	DOP-2 Reader 10	MODAL AGE	Age difference	Average
98	0	1	92.00	6	11.00	7.00	9	9+	9.00	4.00	2.25
98	0	2	100.20	6	11.00	10.00	6/7?	10.00	10.00	1.00	3.44
98	0	3	93.30	6	9.00	8.00	7/9	9/10	9.00	1.00	2.13
98	0	4	97.60	6	9.00	7.00	7/8	8+	7.00	2.00	2.00
98	0	5	87.80	6	9.00	8.00	9	8.00	8.00	1.00	2.78
98	0	6	95.00	6	8.00	8.00	8	8.00	8.00	0.00	2.67
98	0	7	107.20	6	12.00	10.00	8/9	7/8	8.00	2.00	2.75
98	0	8	97.90	6	10.00	8.00	7	7/8?	7.00	2.00	2.25
98	0	9	104.00	6	10.00	9.00	8	8/9	8.00	1.00	2.38
98	0	10	112.00	6	11.00	9.00	7/8	8.00	8.00	3.00	3.11
98	0	11	85.30	6	6.00	7.00	4/5	6.00	6.00	1.00	2.11