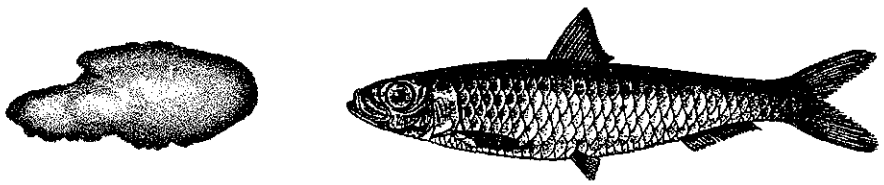
Pelagic Fish Committee ICES CM 1997/H:7

REPORT OF THE WORKSHOP ON SARDINE OTOLITH AGE READING

Vigo (Spain)
17-21 February 1997



Workshop sponsored by the European Commission

Programme FAIR

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

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1. INTRODUCTION

1.1 Terms of Reference

At the ICES Annual Science Conference in Reykjavik (Iceland) from October 26 to November 4, 1996 it was decided (C.Res. 1996/2:39) that a Workshop on Sardine Otolith Age Reading (Chairman: E.Soares) will be held at the Instituto Español de Oceanografia (IEO) in Vigo, Spain from 4-8 March 1997 to:

a) analyse the otolith structure and define the yearly growth pattern of otolith from different areas;
b) report on the main problems resulting from the applied ageing criteria, and on agreement between readers;
c) establish a protocol for age determination using diagrams and photographs to illustrate age reading criteria.

As some of the participants would be in a Spanish-Portuguese joint sardine acoustic survey in March 1997, it was agreed between both countries that it would be more convenient to anticipate this Workshop to 17-21 February.

This Workshop was sponsored by the European Commission (DG-XIV) within the framework of programme FAIR.

1.2 Participants

The Workshop was held in Vigo from 17-21 February 1997 with the following participants:

Otolith readers

Eduardo Soares	(Chairman), Portugal
Pablo Carrera	Spain
Ivone Figueiredo	Portugal
Federico Alvarez	Spain
Nelson Teixeira	Portugal
Afonso Jorge	Portugal
Eugenia Peleteiro	Spain
Manuel Garci	Spain

Observers

Millagros Millán	Spain
Michael Kerstan	South Africa
Luis Quintanilla	Spain
Maria Sainza	Spain

2. CONTRIBUTIONS TO THE WORKSHOP

Two cases of investigation within fish ageing based on otolith analysis were presented as a contribution to this Workshop. Michael Kerstan from the Sea Fisheries Research Institute of South Africa presented the investigation on *Sardinops sagax* and Federico Alvarez from the Instituto Español de Oceanografia (Spain) presented the investigation on Atlantic Iberian Sardine (*Sardina pilchardus*).

2.1 South African Sardine (*Sardinops sagax*)

The South African sardine (*Sardinops sagax*) has been aged for some 20 years. In recent years, knowledge has increased considerably regarding annulus deposition times (Kerstan, 1995) and otolith growth patterns (Kerstan, 1996). Age validation employing daily ring counts between the suspected annuli indicated that annuli are deposited in irregular intervals corresponding to 8-14 months. *Sardinops sagax* also seems to deposit annuli in intervals which become increasingly shorter than one year with increasing age. High proportions of otoliths of the strong 1994 year-class showed very narrow 2nd year's annuli. Simultaneously, the length at 50% sexual maturity has increased to 18 cm SL in 1996. Reduced growth ratios and increased lengths and/or year-class at sexual maturity coincide with the highest stock biomass estimates in the last 20 years. All factors point at the effect of stock density on the biological parameters of the species. The period of annulus completion in recruits does not coincide with minimal somatic growth (Kerstan, 1995) but falls into the period September/October which marks the onset of the fish spawning peak. In South African waters, spawning occurs almost all year round. The minimum spawning period being observed in May.

Age determination in *Sardinops sagax* otoliths is complicated by the frequent occurrence of double rings in each annual growth zone. False rings are discriminated against mainly by growth zone measurements and the results from daily ageing. In South Africa, the management reference year lasts from 1 July to 30 June of the following year. The present age determination technique aims to correctly assess year-class strength from monthly otolith samples collected from commercial catches.

Age-groups are used for calculating growth parameters whereas year-class assignments of aged otoliths serve to determine year-class strength for stock assessment purposes. Valuable input was expected from the South Africa readings regarding the identification of false rings and the correct assignment of year-classes. This was hoped to provide answers to the questions arising from the discrepancies between Spanish and Portuguese readings in the previous otolith exchange programme (Carrera, 1996).

2.2 Atlantic Iberian Sardine (*Sardina pilchardus*)

Counts of daily growth rings in otoliths of juvenile sardines (*Sardina pilchardus*) was applied in order to study the birthday distribution of the Atlanto-Iberian stock in 1992 (Álvarez and Alemany, 1997). The aim of the study was to relate the bithday distribution to the biotic and abiotic data taken during a series of oceanographic cruises carried out during several months in spring and covering the supposed area of origin for the recruits. This area is located in the Cantabrian sea and Galician coast. However, such a relationship was not documented because the results of the study showed that most of the surviving juveniles were spawned before the period considered during the oceanographic cruises. Therefore, the observed birthday of the recruits, together with hydrographic data, does suggest that a larval drift from the northern Portuguese coast to the Galician coast. Thus, at least in 1992, there is evidence which suggests that the winter-spawning zone, located along the coast of northern Portugal, may have been the area of origin for recruits off Galicia, in contrast to the previous assumption that these fish were spawned in the Cantabrian Sea (Porteiro *et al.*, 1986). The influence of this mechanism on year-class abundance remains to be investigated.

On the other hand, the data from the 217 individuals aged have shown that the precision of ageing within each sample and within each 1-cm length range was good, with values of cv<10% and cv<17% respectively. These results suggest that the intrinsic variability that may exist between otoliths of different fish of the same length range is low and that the precision of the age estimates is not affected by age.

3. REVIEW OF SARDINE BIOLOGY

3.1 Distribution

Sardine (*Sardina pilchardus*, Walbaum 1792) is a neritic species which is distributed along the coastal areas of the northern Atlantic, between the North Sea and the Mauritanean coast including the archipelagos of Azores, Madeira and the Canarian islands. This species also occurs in the Mediterranean and adjacent seas, except in the Lebanese coast, in the Gulf of Gabés and in the northern Black Sea (Larrañeta, 1960).

The northern and southern boundaries of this area are well defined and coincide respectively with the 10ºC and 20ºC isotherms (Furnestin, 1952). This area is limited in the north (France and British Isles) by the distribution area of *Clupea harengus*, and in the south (Western Africa and Eastern Mediterranean Sea) by *Sardinella aurita* (Wyatt, 1985 *in* Robles *et al.,* 1992).

This species is the target of the most important fishery in the Atlantic Iberian coast (ICES Divisions VIIIc and IXa) yielding high catches and representing an important social-economic factor. During the last years more than 50% of the catches from the whole area were undertaken off the Portuguese coast (ICES Sub-Divisions IXa Central-North and Central-South) (Anon, 1997). The annual landings during 1940-1995 (Fig.1) show three periods of decreasing trends: 1944-1949, 1961-1977 and 1981-1995 (Anon, 1995). The highest landings occurred in 1961 (250,000 tonnes) and the lowest in 1949 (67,000 tonnes). The trend in the catches of both Iberian countries are quite similar. Nevertheless, after a period of high catches from 1980 to 1985, the Spanish catches show a decreasing trend since 1987, whereas the Portuguese catches remained quite stable around 100,000 tonnes per year (Anon, 1995). More than 50% of the annual catches are landed in the second half of the year. In the last years it has been observed that a decreasing trend in the abundance of this stock is related to successive years of poor recruitment. The 1995 catches of age group 0 fish were notably lower than those in 1994, decreasing from 120.8 million to 30.5 million fish (75% less) and the estimated recruitments at age 0 show a decreasing trend since 1983, being the recruitment of 1994 the lowest in the time series.

The Atlantic Iberian coast is located at the northern limit of the East Central Atlantic coastal upwelling system (Wooster *et al.*, 1976). In terms of oceanographic conditions two well differentiated regions can be distinguished in this area: the Cantabrian and the Atlantic. Both are separated by a convergence zone between capes Ortegal and Finisterre.

The west Atlantic Iberian coast is influenced by seasonal coastal upwelling that generally occurs from the beginnings of spring till the end of summer and also by surface currents parallel to the coast in the direction of the dominant winds, with a marked northern component (Fiúza, 1984 and Cabanas *et al.*, 1988 *in* Porteiro *et al.*, 1996).

Sardine is located in the lowest levels of the trophic chain, thus strongly depending on the physical environment.

The reproductive strategy of fish adapted to the coastal upwelling ecosystems, such as the Atlantic Iberian Sardine, seems to be settled in order to minimise the Ekman offshore transport effects and to assure the most favourable larval feeding conditions. Actually the spawning season of the Atlantic Iberian Sardine occurs from October to March when generally occur the best conditions of Ekman inshore transport (larval retention) and when periods of 4 to 6 days of weak winds (Lasker windows) take place which are favourable to eggs and larval survival (Dias *et al.*, 1996). On the other hand, during Summer (June-September), when more intense and extensive coastal upwelling conditions prevail and consequently there is a

phyto and a zooplanktonic high level production, most favourable feeding conditions are met not only for adult fish but also for juveniles before and after recruitment.

The problem of recruitment variability of pelagic fish can sometimes cause some important effects in the fisheries. In the last decades, although world-wide marine fish catches have remained stable, a decrease in the clupeoid catches has been perceived: their contribution for the total world catch decreased from 1/2 to 1/3 (Smith, 1985 *in* Dias *et al.*, 1996). Fishing mortality added to natural depletion of fishing resources may cause the temporary disappearance of pelagic fish resources and unbalance the ecosystems (Beverton, 1990 *in* Dias *et al.*, 1996).

As most clupeoids, sardine is a short lived species. In the Portuguese coast it attains 6 years of age, in average, and in the Spanish waters, it reaches older ages (11-12 years), mainly in the Cantabrian Sea. The sexual maturity is usually reached at the end of the first year at total lengths between 14 and 15 cm (Figueiredo, 1984; Figueiredo and Santos, 1988; Pérez *et al.*, 1985).

From the available acoustic information undertaken in the whole Atlantic Iberian coast it was observed that sardine is distributed along all the coast within the continental shelf (0-200m). The available acoustic information also points at a differentiation between the distribution areas of adults and juveniles. Generally juveniles distribute in shallow waters ($\leq$50 m), near to the coast, while adults also extend their distribution to deeper zones of the continental shelf.

The north western Portuguese coast (from Caminha to Nazaré) was identified as a preferential distribution area of juveniles (recruits) (Dias *et. al.*, 1989). In the southern west coast (from Nazaré to Sagres) the juveniles mainly occur between the northern limit of the area and cape Espichel, particularly in the area in front of the Tagus estuary, between capes Raso and Espichel. The Gulf of Cadiz seems to be also a distribution area of juvenile sardines (Marques *et al.*, 1996).

Sardines, as most clupeoids, show variation in diel vertical distribution and aggregation habits off the Atlantic Iberian waters (Dias *et al.*, 1989; Anon, 1989: Soares, 1995). The adults aggregate in dense and well defined schools in midwater during daytime. At dusk schools disperse and sardines migrate downwards, generally forming dense and extensive aggregations over the bottom. There they remain until dawn when they migrate upward to the upper water layers and form dense and well defined schools. The diel behaviour of juveniles does not show any vertical migration.

3.2 Spawning

Sardine is a serial spawner and like most clupeoids with pelagic eggs presents a crepuscular or nocturnal spawning (Gamulin and Hure, 1955; Blaxter and Hunter, 1982; Ré, 1984). There are two main spawning areas in the Atlantic Iberian area: the Portuguese coast (Cunha and Figueiredo, 1988) and the Cantabrian Sea (García *et al.*, 1988).

The spawning off the Portuguese coast occurs in shallow waters of the continental shelf mainly during the first hours of the dusk (Ré, 1984; Ré *et al.*, 1988). According to Cunha and Figueiredo (1988) and Pestana (1989) the spawning season in the Portuguese coast is long, occurring from November until April of the next year. Spawning shows two peaks: one in November-January and other in April-May (Ré *et al.*, 1990). On the northern coast spawning is more intense during autumn-winter. In the southern coast it is more intense during spring (Ré, 1984; Anon, 1982, 1987; Ré *et al.*, 1990; Pestana, 1989). In the Cantabrian Sea spawning occurs between October and July with the highest intensity in April-May and a less marked peak in November-December (Chesney and Alonso,1988 *in* Robles *et al.*, 1992; Solá *et al.*, 1990).

According to Cunha and Figueiredo (1988) and Figueiredo and Santos (1989), on the Portuguese coast sardine females spawn during different periods within the same spawning season. The bigger sardines, thus the older ones, that have already spawn at least once in their lifetime, begin to spawn at the beginning of the spawning season, remaining active throughout the entire period (from October to March), while the smaller, i.e. the younger ones, are sexually active during a later and shorter period (from January till March).

3.3 Recruitment

Annual recruitment of the 0 group fish to the fishing grounds, occurs during a period which ranges from the beginning of the third quarter of each year until the end of first quarter of the next year, showing a marked peak from August till November/December and a smaller secondary one from February until March/April (Anon, 1980, 1982).

According to Pestana (1989), who based her analysis on the status of the sardine stock during the period 1976-1989, the fishery short term yield depends on year class strength, which is a characteristic of the pelagic species with a short life span.

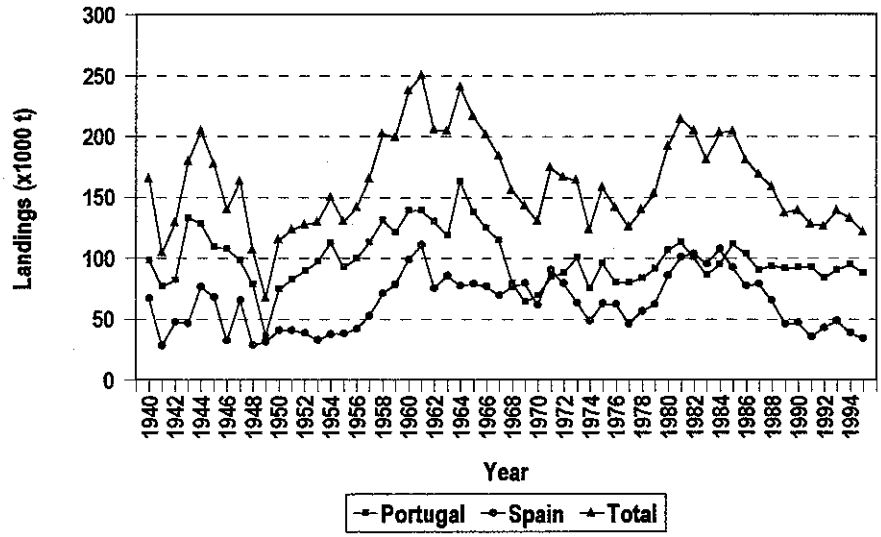


Figure 1 - 1940-1995 (ICES Div. VIIIc+IXa): Sardine annual catches in Portugal and Spain (*in* Reports of the ICES "Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy").

4. RESULTS OF THE LAST OTOLITH AGE READING EXCHANGE BETWEEN SPAIN AND PORTUGAL

Following a recommendation of the ICES Working Group on the Assessment of Mackerel, Horse Mackerel and Anchovy (WGMHSA) in 1995 an otolith exchange programme between Portugal and Spain was initiated this year in order to improve otolith age readings among different readers of both countries.

Prior to this exchange, a Workshop was held in June 1994. The main conclusions and recommendations of this Workshop were (Anon, 1994a, 1994b; Carrera, 1996):

1. the ageing criteria established in FAO (1979) were still valid and should continue to be used by both countries;
2. in order to reduce the discrepancies in age group determinations, the number of otoliths sampled should be increased, mainly for sardines of higher lengths.
3. otoliths should be exchanged regularly between both countries;
4. efforts should be focused on the characterisation of the otolith margin in order to perceive its pattern deposition and thus getting information about the validation of the annual growth pattern and, consequently, on the age group assignment;

The results of the 1996 otolith program concluded that the agreement between readers was, in general, low and the problems found during the 1994 Workshop were still present (Carrera, 1996). Nevertheless, the level of agreement of readings improved between the Portuguese readers and the Spanish reader responsible for the elaboration of the age-length keys used on the stock assessment. A good agreement between the two Spanish readers involved was also noticed.

The results of this exchange programme led to a proposal for a Workshop in 1997 to the ICES WGMHSA with the terms of reference already mentioned.

5. AGE DETERMINATION CRITERIA

The criteria for the sardine age determination followed by both countries are those which were established for the Northeast Atlantic sardine (FAO, 1978, 1979; Anon 1981) which can be summarised as follows:

1. A set of an opaque and a hyaline zone corresponds to an annual growth zone (annulus);

2. The date of birth of sardine is conventionally assumed to be the 1st of January and the fish is assigned to a year class on this basis, i.e. if an otolith is collected from a fish captured during the first semester the age group assigned will correspond to the number of hyaline zones present. If the otolith is extracted from a fish caught during the second semester the age group assigned will correspond to the hyaline zones completely formed, i.e. if the otolith edge is hyaline it will be not considered.

6. MATERIAL AND METHODS

In Portugal, 6 otoliths are extracted from fish of each length class (0.5 cm) in each sample. In Spain all the otoliths are collected from fish of each length class. For length class higher than 20 cm all the otoliths are extracted as it was agreed in the 1994 Workshop. After extraction otoliths are washed thoroughly, dried, mounted and preserved in xylol resistant plastic plaques in a synthetic resin ("Eukitt" in Spain and "Entellan" in Portugal). Observations of entire otoliths under reflected light against a black background are made using magnifying dissection microscopes with 20X magnification.

As an improvement of the mounting technique and in order to avoid the formation of air bubbles in the resin and better preserve the otoliths it was recommended to use a glass cover slip in each plaque.

During the Workshop a sample of otoliths collected in the different areas and seasons off the Atlantic-Iberian coasts were analysed by the readers of both countries and a comparative analysis of age readings was made. Previous to this

analysis some photo projecting slides of otoliths of sardines caught in different Spanish areas and seasons were analysed and discussed in order to contribute to the identification of the main age reading problems.

7. RESULTS OF COMPARATIVE AGE READINGS AT THE WORKSHOP

Nine readers have participated in these exercises. Readers one to six are involved in the annual production of ALK (Age-Length Keys) for assessment purposes, being readers 2, 3 and 4 the most experienced ones, whose readings are used to perform ALK's. Readers 1, 5 and 6 are beginners and readers 7 and 8 are experienced readers who have read otoliths from this stock until 1990. Reader 9 is an experienced reader who is involved on growth studies of different fish species (mainly South African sardine and horse mackerel).

Two different samples have been read at the workshop. The first one consisted in a sample of 259 otoliths coming from the Spanish Spring acoustic surveys (ICES Subareas IXa North, VIIIc East and West) carried out from 1988 to 1993, (samples from 1989 were not available). In order to check consistencies and discrepancies among and within readers, each reader has made three readings of this sample. Once the results of this sample were analysed, a new set was read. This consisted of a sample of 131 pairs of otoliths taken all around the main fishery area (ICES Subareas VIIIc West, IXa North, Central North and Central South) in June. Due to the annual growth pattern of sardine, otoliths taken during this particular period, are considered as the most difficult to interpretate and, thus, to allocate into age groups. Besides, samples coming from the first quarter are regarded as the easiest to interpretate.

7.1 Methods

In order to check consistencies within readers, two indices of precision (average percent error - APE, Hoenig *et al.,* 1994) were calculated for each reader and sample as follows,

$$APE_{BF} = 100x\frac{1}{N}\sum_{j=1}^{N}\left(\frac{1}{R}\sum_{i=1}^{R}\frac{\left|X_{ij}-X_j\right|}{X_j}\right)$$, Beamish and Fournier (1981)

where: N is the number of fish aged

R is the number of times each fish is aged (three times for the first sample)

X_{ij} is the i_{th} age determination for the j_{th} fish

X_j is the average age calculated for the j_{th} fish

and:

$$APEc = 100 \times \frac{1}{N} \sum_{j=1}^{N} \frac{\sqrt{\sum_{i=1}^{R} \frac{(X_{ij} - X_j)^2}{R-1}}}{X_j}, \text{ Chang (1982)}$$

these tests were used only in order to check the consistence for each reader.

Trends in both within and among readers were tested using a test of symmetry (Bowker, 1948):

$$\chi^2 = \sum_{i=1}^{m-1} \sum_{j=i+1}^{m} \frac{(n_{ij} - n_{ji})^2}{n_{ij} + n_{ji}}$$

where: n_{ij} is the observed frequency in the i_{th} row and j_{th} column, and
n_{ji} is the observed frequency in the j_{th} row and i_{th} column

As well as these tests, an analysis of the percentage of agreement and plots of the average age of each age reader against modal age were also made. Finally, the Non Parametric Wilcoxon Matched-pair Signed-Rank test was also performed (Zar, 1984).

7.2 Results on the first sample

As it was pointed out, this sample was read three times. Results of the last reading are shown in table 7.1. Besides, this reading was used as the best one and hence, the subsequent analyses have been performed on this reading.

Consistence within readers was, in general, good. Average percentage errors calculated on the three readings ranged between 4 to 10 % for all readers except for reader one which had 15.87% and 21.02% in both indices (table 7.2). An analysis of trends was also performed between the first and the third reading for each reader. The test of symmetry was significant for almost all the readers ($p<=.01$, table 7.3). Reader one has clearly changed the ageing criteria for younger fish from the first to the third reading, whereas reader two gave older age to the bigger ones during the third reading. Reader three did not have clear trends ($p=0.04$), and only presented problems in ageing older fish, specially between age groups 4 and 5. Reader four, despite his general good agreement, had a slight trend to assign higher age during the third reading to the older fish. The same problem arose for reader five, but in this case there was a trend during the third reading and for fish older than 2. Readers six and seven have no trends, but reader six, had problems in ageing the youngers and the olders. Reader eight changed the ageing criteria for both youngers and olders, and reader nine had the same problem described for reader four.

Cumulative age composition by age reader in percentage as well as age and length composition by age reader are presented in tables 7.4, 7.5 and 7.6. General agreement among readers for the third reading is shown in table 7.7a. This agreement was not high (55%). Nevertheless, the agreement among the best readers reached 70% (table 7.7b). This agreement, for the best readers, was especially higher when age 7 and olders were excluded (80%). There are disagreements of one year among readers ranging from 16% to 50% with a 33% as a mean (table 7.8). Also, disagreements of two or more years were, in general, low (between 3-20%), with a 12% as a mean (table 7.9). For fish older than 7, the agreement was low, around 25% with no great differences among the best readers results and the other readers.

Among readers, results of the symmetry test as well as the Wilcoxon Matched-Pair Signed-Rank are described in tables 7.10 and 7.11. General trends for each reader can be also shown by plotting the average age recorded for each reader against the modal age (figure 7.1). Main disagreements seem to be related to the younger and older ages. Readers 5, 8 and 9 allocated less age 1 than the others, whereas readers 3 and 8 have recorded age 7 as the oldest one.

Reader 1 gave, in general, less age than the other readers and the modal age. Besides, only readers 3 and 8 allocated into younger age groups those otoliths older than ages 5-6. Readers 2 and 4 had a good agreement, which was close to the modal age, and their trends against the other readers were similar. Readers 6 and 7 had also a reasonable good agreement, but they allocated into older age groups the oldest otoliths. Differences in ageing younger fish arose between reader 3 and 8, but both readers seem to have the same criteria for the olders, which was different to that used for the other readers, as it was already mentioned. Reader 9 had a criteria which was also close to the modal age, but in ageing young fish, the criteria was different. The ageing criteria for reader 5 related to the modal one, varies for the youngers, whose average age is higher than the modal one, and for the olders, with an average age less than the modal one.

Bowker's symmetry test seems to be more restrictive than the Wilcoxon one. In fact, only one single pair had no significant differences, whereas by performing the Wilcoxon's test, 6 pairs had no significant differences.

In spite of the differences among readers are in general significant, the percentage of agreement is high, especially among the experienced readers and it may be concluded that there are no differences, at least for this exercise, in the ageing criteria and ALK's performed in both countries are rather similar.

7.3 Results on the second sample

From the last otolith exchange results, it was pointed out that sardines caught at the middle of the year can create problems in the interpretation of the border. Besides it was observed that the otolith structure of sardines caught in the southern areas present a different and more complicated structure, than those caught in the northern areas, especially in the Cantabrian Sea (ICES Division VIIIc). This different pattern also contributes to the misinterpretation of the general structure of the otolith (i.e. number of true rings) and, thus, to allocate it into a wrong age group

In order to check these problems, a second sample was analysed. This corresponded to a subset of otoliths used in the previous exchange, coming from the main fishery area and caught at the middle of the year. Only seven readers have read the whole sample. In addition, readers 1, 3, 4, 5 and 6 have participated in the exchange and both readings have been analysed by means of Average Percentage Error techniques and the symmetry test was also performed.

Table 7.12 shows the individual readings for each otolith and reader as well as its average age, mode, range and standard deviation. Average Percentage Errors were higher than those estimated for the first sample (table 7.13). Only reader 4 had in both indices values lower than 10%. Compared these results to those obtained for the first sample, only reader 1 has lower values in this sample. This may be due to the elapsed time between readings; whereas in the first sample, the elapsed time was one day, in the second the elapsed time was 8 months. The Bowker's test of symmetry arose similar results, with significant differences between readings (table 7.14). Readers 1 and 3, varied the ageing criteria and they allocated the otoliths into older age groups during the second reading. On the contrary, reader 6 assigned less age during the second reading. reader 5 had similar trend for fish older than 4. Reader 4 has no clear trends and only shows problems in age groups 3 and 4.

Among readers, cumulative age composition, number of otoliths and mean length are summarised in tables 7.15, 7.16 and 7.17. General agreement for this sample was lower than in the first sample (47%, table 7.18a) and contrary to that, there was no significant improvement by comparing the results of the best readers and the general mean. Besides, the agreement is independent of fish age, except for those fish older than 7. Nevertheless, if the agreement is analysed by geographical area (see table 7.18b) the percentage of agreement varies, being higher in ICES Subdivision VIIIc and the lowest is reached in ICES Subdivision IXa-CS. For pair of readers, in ICES Subdivision VIIIc-W the agreement reached 90%, whereas in Subdivision IXa-N the highest agreement was 76%, 68% in Subdivision IXa-CN and 60% in Subdivision IXa-CS. The lowest values were 38% in ICES Subdivision VIIIc-W, 14% in Subdivision IXa-N and around 12% in Subdivisions IXa-CN and IXa-CS. These results agree with the problems described above about the different morphology and/or structure of the otoliths of fish caught in the southern areas.

It is worth to point out, that in spite this low agreement, disagreement of two or more years were around 10%, meaning that most of the problems were a misinterpretation of the hyaline/opaque edge of the otoliths (tables 7.19 and 7.20). From that, the Bowker's symmetry analysis did not show trends among readers (table 7.21) and only disagreements of one year can be seen. General trends against the modal age for each reader and all age reader are shown in figure 7.2. For the younger fish (ages 1 to 3) there was a general trend to allocate those fish into older age groups, whereas the trend was inverse for fish older than 3.

As in the previous sample, both Bowker's symmetry test and Wilcoxon Matched-Pair signed-rank tests gave, in general significant differences ($p<0.01$) among readers (table 7.22).

7.4 Main conclusions

Differences between tests could be related with the fact that the Bowker test only use those cells out of the diagonal (i.e. all those cells with disagreements). It compares the cells above the diagonal which are paired with the corresponding cells below the diagonal. Besides, it is independent of the total number of cases (i.e. number of otoliths read). In such conditions, for a fixed number of otoliths with disagreement, the test would be always significative, but, by increasing the number of otolith with agreement, the percentage of agreement could improve and therefore, the APE's indices fall down into lower values, meaning that there is a good consistence between readings. Nevertheless, it seems to be a good tool to look for trends and to check outliers.

From the analysis of both samples, it may be concluded that Reader 4 who performs the ALK's in the Spanish area, has the most consistent criteria independent of time and area and his readings have a reasonable good agreement with those performed by the Portuguese experienced readers, especially with those made by reader 2 (higher than 70% for fish younger than 7).

It was also concluded that the otoliths coming from the southern area (ICES Subdivision IXa-CS) present an overall structure which is different from those observed in otoliths from northern areas, especially in Subdivision VIIIc. These otoliths present, in general, several false rings and the hyaline rings are narrower compared to those found in otoliths caught in the northern areas. Besides, they present a higher calcification. Despite these otoliths come from an area where the sardine fishery is not as important as in the northern areas (i.e. ICES Subdivisions IXa CN, and N and Division VIIIc), it was suggested that an especial effort should be paid in order to clarify the growth pattern and the structure of these otoliths and then to allocate these into age groups.

8. PROBLEMS IN THE INTERPRETATION OF OTOLITH READINGS

Prolonged spawning period results in variable sizes of the first growth zones. Consequently a wide variation in distance between the nucleus and the first hyaline ring can be expected. Although this should be borne in mind when interpreting the first opaque and hyaline zones, it must be printed out that it is a rule not to consider as an annulus the first hyaline ring when its distance to the nucleus is proportionally shorter than the distance between this ring and the following one. Nevertheless, this question must be clarified in a further investigation.

Unexpected large opaque edges were observed in some otoliths collected during the first quarter of the year in the center of the Western Portuguese coast. Also a clear hyaline edge was observed in the third quarter of the year. These patterns can create confusion in the interpretation of otoliths. Thus, it is agreed to follow with the criterium adopted until now, i.e. in the first case the year class assigned corresponds to the number of hyaline annuli and in the second case it corresponds to the number of hyaline annuli minus one.

It is worth to mention that the occurrence of these cases is very low and consequently, they do not constitute a serious problem for the stock assessment model adjustment.

9. PROTOCOL

The Workshop adopted a protocol with the criteria for the standardisation of sardine age determination (Annex 1). It is planned that this protocol will be complemented with a future guide which will assist the otolith readers.

10. RECOMMENDATIONS

The workshop participants agreed on the fact that this co-operation between both Iberian countries should be continued in order to arrive at an unified and precise ageing methodology. Apart from the ageing methodology itself, it was felt by all participants that the co-operation between the countries concerned needs to be intensified to solve the ageing problems encountered. It is therefore recommended to:

1. regularly exchange otolith samples for the purpose of checking and improving the precision of all the readers involved in sardine age determination in Spain and Portugal;

2. monitor annulus deposition patterns along the entire Portuguese and Spanish coasts throughout each year. There are three ways to achieve this task:

   - Research surveys should be carried out simultaneously in the shelf areas of Spain and Portugal to collect otolith material without the obscuring effect of sardine migration, i.e. when surveys cover the different areas at different times;

   - Monthly samples of all age groups should be collected in both countries and in different areas along both coasts to monitor the monthly progression of the marginal increments of the otoliths. The exercise aims at determining the exact times of annulus completion in the entire distributional range of the stock;

   - The investigation of the ring deposition patterns should be paralleled by a simultaneous investigation of the reproductive biology of the species which quantifies the monthly changes in the spawning activity.

3. It is recommended that an age determination guide is developed which assists individual readers with the correct interpretation of the ring deposition structures and to determine ages precisely. The guide should have photographs which explicitly give the various otolith types and the suspected time of ring completion in the various shelf regions.

4. In order to determine the origin of the different growth patterns of this species in the adjacent areas of France and Morocco it is recommended to study samples from these countries.

5. It is strongly recommended that the daily ring counting technique is employed to validate the annuli of at least the first few age groups. The study will also help to discriminate between false rings and true annuli. This study is essential for an accurate age determination which will aid accurate stock assessment methods. It also should be a useful tool to quantify individual growth rate variation in juveniles and to estimate the time of annulus deposition accurately, following the South African example (Kerstan, 1995).

The proposed recommendations necessitate continuous sampling and monitoring which requires a dedicated project.

11. REFERENCES

Álvarez, F. and Alemany, F., 1997. Birthdate analysis and its application to the study of recruitment of the Atlanto-Iberian sardine *Sardina pilchardus*. Fish. Bull. 95(2):187-194.

Anon, 1980. Rapport du Groupe de Travail pour l'Evaluation des Stocks de Sardines dans les Divisions VIIIc et IXa. *ICES, C.M.1980/H:53*, 39p.

Anon., 1981. Rapport du Group de Travail pour l'Evaluation des Stocks de Sardine dans les Divisions VIIIc and IXa . *ICES, CM 1981/H:72. 59p.*

Anon, 1982. Report of the Working Group for the Appraisal of Sardine Stocks in Divisions VIIIc and IXa. *ICES, C.M. 1982/Assess.:10*, 49p.

Anon., 1987. Informação da Cruzeiro nº.02131286 do N/I "Noruega" de 4 a 22 de Dezembro. *Inf. Camp. Nav. INIP.* nº. 3, 1987. 21p.

Anon, 1989. Report of the Planning Group for Acoustic Surveys in ICES Sub-Areas VIII and IX. Vigo, 5-7 April 1989. *ICES, C.M. 1989/H:6*, 12p.

Anon, 1994a. Report of the Spanish Portuguese Workshop on Otolith Age Readings of Sardine in ICES Divisions VIIIc and IXa, Lisbon, 6-8 June 1994. Working Document presented to the ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. Copenhagen, 20 June - 1 July 1996. 20p.

Anon, 1994b. Taller de Lectura de Otolitos de Sardina - 6-8 de junio de 1994. Informe de Assistencia. Internal report of the Instituto Español de Oceanografia, Vigo (Spain), 10p.

Anon, 1995. Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. Copenhagen, 13-22 August 1996. *ICES CM 1995/Assess:2.*

Anon, 1997. Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. Copenhagen, 13-22 August 1996. *ICES CM 1997/Assess:3.*

Beamish, R. J. and D. A. Fournier. 1981. A method for comparing the precision of a set of age determinations. Can. J. Fish. Aquat. Sci. 38:982-983

Blaxter, J.H.S. and Hunter, J.R., 1982. The Biology of Clupeoid Fishes. *Adv. Mar. biol.,* **20**: 1-194, Eds. Blaxter, Russel and Yonge, Academic Press.

Bowker, A. H. 1948. A test for symmetry in contingency tables. J. Am. Stat. Assoc. 43:572-574.

Carrera, P., 1996. The Sardine Otolith Exchange Programme in 1996: Preliminary Results. Working Document presented to the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. Copenhagen, 13-22 August 1996.

Chang, W. Y. B. 1982. A statistical method for evaluating the reproducibility of age determination. Can. J. Fish. Aquat. Sci. 39:1208-1210.

Cunha, M.E. and Figueiredo, I., 1988. Reproductive cycle of *Sardina pilchardus* in the central region off the Portuguese coast (1971/1987). *ICES, C.M. 1988/H:61*, 53p.

Dias, C.A., Pestana, G., Soares, E. and Marques, V., 1996. Present state of sardine stock in ICES Divisions VIIIc and IXa. WD ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. Copenhagen, 1996. 45p.

Dias, C.A., Soares, E. and Marques, V., 1989. Acoustic abundance and estimation of Sardine (*Sardina pilchardus*, Walb.) off the Portuguese Coast, July-August 1988. *ICES, C.M. 1989/H:52*, 24p.

FAO, 1978. Report of the Working Group on the Standardazation of Age Determination of the Sardine (*Sardina pilchardus*, Walb.). *CECAF Tech. Rep. 78/8.*

FAO, 1979.Report of the Workshop on the Standardazation of Age Reading Techniques for *Sardina pilchardus* (Walb.). *CECAF Tech. Rep. 79/18.*

Figueiredo, I and Santos, M.A.,1988. On sexual maturation, condition factor and gonosomatic index of *Sardina pilchardus* Walb., off Portugal (1986-1987). *ICES CM 1988/H:70*, 26p.

Figueiredo, I. and Santos, M.A., 1989. Reproductive biology of *Sardina pilchardus* (Walb.): seasonal maturity evolution (1986 to 1988). *ICES, CM 1989/H:40*, 4p.

Figueiredo, I.,1984. Alguns aspectos da biologia de sardinha *Sardina pilchardus* (Walbaum, 1792) (Pisces, Clupeidae). Relatório de Estágio de Licenciatura em Ciências Biológicas 1982/1984. INIP/FCL, 310 p.

Furnestin, J., 1952. Biologie des clupéidés méditerraéens. Oceanographie méditérranéene. *Vie et Milieu*, suppl. 2:96-116.

Gamulin, T. and Hure, J., 1955. Contribution à la connaissance de l'écologie de la ponte da la sardine (*Sardina pilchardus* Walb.) dans l'Adriatique. *Acta Adriatica*, **8**: 1-22.

García, A., Franco, C., Solá, A. and Alonso, M., 1988. Distribution of sardine (*Sardina pilchardus* Walb.) egg and larval abundance off the Spanish North Atlantic coast (Galician and Cantabrian areas) in April 1987. *ICES, C.M. 1988/H:27.*

Hoenig, J. M., Morgan, M. J. and Brown, C. A. 1994. Testing the Equivalence of Two Age Determination Methods (or Two Age Readers). ICES CM 1994/D:11.

Kerstan, M., 1995. Seasonal uncoupling of otolith and somatic growth in South African pilchard (*Sardinops sagax*) and its applications. *ICES CM 1995/P:6*, 17p.

Kerstan, M., 1996. Quantification of growth compensation and depensation in the South African sardine (*Sardinops sagax*) populartion. *ICES CM 1996/H:10*, 15p.

Larrañeta, M.G.,1960. Synopsis of biological data on Sardina pilchardus of the Mediterranean and adjacent seas.*FAO Fish. Biolog. Synop.*, **9**: 137-173.

Marques, V., Soares, E. and Dias, C.A., 1996. Results of the Portuguese sardine acoustic survey "SAR96JUL", June-July 1996. WD ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy. Copenhagen, 1996. 24p.

Pérez, N., Porteiro, C. and Alvarez, F., 1985. Contribución al conocimiento de la biologia de la sardina de Galicia. *Bul. Inst. Esp. Oceanog.* 2 (3): 27-37.

Pestana, G., 1989. Manancial Ibero-Atlântico de Sardinha (*Sardina pilchardus*, Walb.) sua Avaliação e Medidas de Gestão. Dissertação original apresentada para provas de acesso à categoria de Investigador Auxiliar. Área Científica de Dinâmica de Populações. INIP, 192p., 1 Anexo.

Porteiro, C., Alvarez, F. and Pérez, N., 1986. Variaciones en el stock de sardina (*Sardina pilchardus* Walb.) de las costas atlánticas de la Peninsula Ibérica (1976-1985). *Int. Symp. Long Term Changes Mar. Fish Pop.*, Vigo. 529-541.

Porteiro, C., Carrera, P. and Miquel, J., 1996. Analysis of Spanish Acoustic Surveys for Sardine, 1991-1993: Abundance Estimates and Inter-Annual Variability. *ICES J. Mar. Sci.*, **53**:429-433.

Ré, P., 1984. Ictioplâncton da região central da costa portuguesa e do estuário do Tejo. Ecologia da postura e da fase planctónica de *Sardina pilchardus* (Walbaum, 1792) e de *Engraulis encrasicolus* (Linné, 1758). Ph. D., Univ. Lisbon, Portugal, 425p.

Ré, P., Cabral e Silva, R., Cunha, E., Farinha, A., Meneses, I. and Moita, T., 1990. Sardine Spawning off Portugal. *Bol. Inst. Nac. Invest. Pescas*, Lisboa **15**: 31-44.

Ré, P., Farinha, A. and Menezes, I., 1988. Diel spawning time of sardine, *Sardina pilchardus* (Walbaum, 1792) Teleostei, Clupeidae), off Portugal. *Inv. Pesq.* **52**(2): 207-213.

Robles, R., Porteiro, C. and Cabanas, J.M., 1992. The stock of Atlanto-Iberian sardine: possible causes of variability. *ICES mar. Sci. Symp.*, 195: 418-423.

Soares, E., 1995. Contribuição para o estudo da distribuição e do comportamento da sardinha na costa continental portuguesa. Trabalho de síntese apresentado para as provas de acesso à categoria de Assistente de Investigação. Área Científica de Recursos Haliêuticos. IPIMAR, Lisboa, 1995. 100p.

Solá, A., Motos, L., Franco, C. and Lago, A., 1990. Seasonal occurrence of pelagic fish eggs and larvae in the Cantabrian sea (VIIIc) and Galicia (IXa) from 1987 to 1989. *ICES, C.M. 1990/H:25.*

Wooster, W.S., Bakun, S.A. and McLain, D.R., 1976. The seasonal upwelling cycle along the eastern boundary of the North Atlantic. *Journal of Marine Research*, **36**(2): 131-141.

Zar, J. H. Paired-Sample Hypothesis (1984) *In* Biostatistical Analysis, 2nd edition, Prentice-Hall, Inc.:150-160.

ANNEX 1

PROTOCOL FOR SARDINE AGE DETERMINATION

In order to standardise the sardine age assignments and to improve the age estimates the Workshop adopted the following protocol:

1. The first of January is adopted as the birthdate reference for age assignment purposes. Consequently, if an otolith is collected from a fish caught in the first semester of the year the age group assignment will correspond to the number of hyaline zones present. If the otolith is extracted from a fish caught in the second semester of the year the age group assigned will correspond to the hyaline zones completely formed, i.e. if the edge of the otolith is hyaline it will be not considered.

2. After extraction otoliths are washed thoroughly, dried, mounted and preserved in xylol resistant plastic plaques in a synthetic resin ("Eukitt" or "Entellan"). The observations of entire otoliths are made under reflected light against a black background using magnifying dissection microscopes with 20X magnification.

3. It is always advisable to have pairs of whole otoliths available from individual sardine specimens when trying to interpret the ring structure.

4. A set of an opaque and a hyaline zone corresponds to one annual growth zone (*annulus*).

5. Despite the fact that sardine otoliths vary in appearance, it is recommended to use the *anti-rostrum* as the most adequate zone to count hyaline rings for age assignment.

6. Sometimes it may happen that other areas of the otolith, i.e. the dorsal part, are easier to read. In this case the age reading based on the analysis of these areas can be considered appropriate if the readings prove to be consistent.

7. In order to adopt a ring as an annulus it is recommended that the ring can be followed throughout the whole otolith contour. This rule must be applied specially for the first three annuli, since in the older specimens growth often slows down to such an extent that hyaline rings are very close together. In that case opaque and hyaline zones become more difficult to be identified.

8. If several regions of each otolith are examined it may happen that conflicting ages may be determined, particularly in older fish. When this happens, the oldest age is probably the correct one. Therefore it must be adopted as a general rule to assign the highest age to the otolith.

Table 7.1 - Sardine from ICES Divisions VIIIc and IXa and from Spanish spring acoustic surveys (March - April), all readers, third reading.

Fish no	Fish length	Catch month	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(Sp) Reader 7	Ext(Por) Reader 8	Ext(SA) Reader 9	Average age	Mode	Range	s.d.
1	15	3	2	1	1	1	1	1	1	1	1	1	1	1	0,31
2	14,5	3	1	1	1	1	1	2	1	1	2	1	1	1	0,42
3	15	3	2	1	1	1	1	1	1	1	2	1	1	1	0,42
4	15	3	1	1	1	1	1	1	1	1	1	1	1	0	0,00
5	15,5	3	1	1	1	1	1	1	1	1	1	1	1	0	0,00
6	16	3	1	1	1	1	1	1	1	1	1	1	1	0	0,00
7	19,7	3	1	1	1	1	1	2	1	1	1	1	1	1	0,31
8	15,4	3	2	1	1	1	1	1	1	1	1	1	1	1	0,31
9	15,7	3	2	1	1	1	1	1	1	1	1	1	1	1	0,31
10	17,4	3	2	1	2	2	2	2	1	2	2	2	2	1	0,42
11	17,7	3	2	3	3	3	4	3	3	3	3	3	3	2	0,47
12	16,5	3	2	1	1	1	1	1	1	2	1	1	1	1	0,42
13	17,6	3	2	2	2	2	2	2	2	2	2	2	2	0	0,00
14	17,7	3	2	2	3	2	2	2	2	2	2	2	2	1	0,31
15	15,5	3	1	1	1	2	1	2	1	2	2	1	1	1	0,50
16	19,3	3	2	3	3	3	3	2	3	2	3	3	3	1	0,47
17	15	3	2	1	1	1	2	1	1	1	2	1	1	1	0,47
18	19,2	3	2	4	4	5	4	4	3	3	4	4	4	3	0,82
19	16	3	1	1	1	1	1	3	1	1	1	1	1	2	0,63
20	16,1	3	3	6	5	5	4	6	5	3	5	5	5	3	1,05
21	19,7	3	2	4	4	4	4	4	4	3	3	4	4	2	0,68
22	19,1	3	3	7	5	6	5	7	7	4	6	6	7	4	1,34
23	20,6	3	2	2	2	2	2	4	2	2	2	2	2	2	0,63
24	18	3	2	2	2	2	2	4	2	2	2	2	2	2	0,63
25	18	3	2	2	2	2	2	2	2	2	2	2	2	0	0,00
26	17,1	3	1	1	1	1	1	1	-	-	2	1	1	1	0,35
27	15,2	3	1	1	1	1	1	1	1	1	2	1	1	1	0,31
28	16,5	3	1	1	1	1	1	3	1	1	2	1	1	2	0,67
29	16,4	3	1	2	2	2	2	2	2	2	2	2	2	1	0,31
30	17,6	3	6	7	5	5	5	9	7	5	8	6	5	4	1,41
31	23,5	3	5	5	5	5	4	7	6	6	6	5	5	3	0,83
32	24	3	4	5	4	5	4	5	5	5	5	5	5	1	0,47
33	24	3	3	4	4	5	4	5	4	4	5	4	4	2	0,63
34	24,5	3	4	5	4	4	4	4	5	4	5	4	4	1	0,47
35	25	3	4	5	5	5	5	5	5	5	5	5	5	1	0,31
36	24,5	3	5	7	5	6	5	6	6	5	5	6	5	2	0,68
37	23,5	3	5	6	5	5	6	6	6	5	6	6	6	1	0,50
38	24,5	3	7	7	5	5	6	10	-	-	8	7	7	5	1,64
39	25,5	3	4	5	4	5	5	5	5	4	4	5	5	1	0,50
40	22,5	3	4	5	5	5	5	5	5	5	5	5	5	1	0,31
41	23,5	3	6	7	5	7	6	7	7	5	5	6	7	2	0,87
42	22	3	4	4	4	4	4	5	5	3	4	4	4	2	0,57
43	23	3	4	4	4	4	5	5	5	4	5	4	4	1	0,50
44	24	3	5	6	6	5	6	7	6	6	6	6	6	2	0,57
45	21,5	3	4	5	4	5	4	5	5	4	4	4	4	1	0,50
46	23	3	4	4	4	5	4	5	5	4	5	4	4	1	0,50
47	24	3	1	1	1	1	2	1	1	2	2	1	1	1	0,47
48	22,5	3	2	1	1	1	3	1	1	2	2	2	1	2	0,68
49	14	3	2	1	1	1	3	1	1	2	2	2	1	2	0,68
50	14	3	1	1	1	1	2	1	1	2	2	1	1	1	0,47
51	14	3	1	1	1	1	2	1	1	2	2	1	1	1	0,47
52	14	3	1	1	1	1	2	1	1	2	2	1	1	1	0,47
53	14,5	3	2	1	1	1	3	1	1	2	2	2	1	2	0,68
54	14,5	3	2	1	1	1	2	1	1	2	2	1	1	1	0,50
55	14,5	3	1	1	1	1	2	1	1	2	2	1	1	1	0,47
56	14,5	3	1	1	1	1	2	1	1	2	2	1	1	1	0,47
57	14,5	3	1	1	1	1	2	1	1	2	2	1	1	1	0,47
58	14,5	3	1	1	1	1	2	1	1	2	2	1	1	1	0,47
59	15	3	1	1	1	1	2	1	1	2	2	1	1	1	0,47
60	15	3	2	1	1	1	3	1	1	2	2	2	1	2	0,68
61	15	3	1	1	1	1	2	1	1	2	2	1	1	1	0,47
62	15	3	1	1	1	1	2	1	1	2	2	1	1	1	0,47
63	15	3	1	1	1	1	2	1	1	1	2	1	1	1	0,42

Table 7.1 - (Continued)

Fish no	Fish length	Catch month	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(Sp) Reader 7	Ext(Por) Reader 8	Ext(SA) Reader 9	Average age	Mode	Range	s.d.
64	15	3	2	1	1	1	2	1	1	2	2	1	1	1	0,50
65	15,5	3	2	1	1	1	3	1	1	1	2	1	1	2	0,68
66	15,5	3	1	1	1	1	2	1	1	2	2	1	1	1	0,47
67	15,5	3	2	1	1	1	3	1	1	2	2	2	1	2	0,68
68	15,5	3	1	1	1	1	2	1	1	2	2	1	1	1	0,47
69	15,5	3	1	1	1	1	2	1	1	1	2	1	1	1	0,42
70	15,5	3	1	1	1	1	2	1	1	1	2	1	1	1	0,42
71	16	3	1	1	1	1	2	1	1	1	2	1	1	1	0,42
72	16	3	2	1	1	1	2	1	1	2	2	1	1	1	0,50
73	16	3	2	1	1	1	3	1	1	2	2	2	1	2	0,68
74	16	3	2	2	1	1	3	1	1	2	2	2	2	2	0,67
75	16	3	2	2	1	1	3	2	1	2	2	2	2	2	0,63
76	16	3	2	2	1	1	3	2	-	2	3	2	2	2	0,71
77	16,5	3	2	3	3	3	3	3	3	3	3	3	3	1	0,31
78	16,5	3	7	7	5	7	7	8	8	6	9	7	7	4	1,10
79	20,5	3	8	9	5	8	8	9	9	6	9	8	9	4	1,37
80	26,5	3	11	8	6	9	7	11	10	6	11	9	11	5	1,99
81	25	3	9	9	6	8	8	10	10	6	11	9	9	5	1,64
82	23,5	3	8	7	3	7	6	11	8	6	7	7	7	8	2,00
83	24	3	-	6	5	7	5	9	8	5	9	7	5	4	1,64
84	24	3	6	6	5	6	6	7	7	5	7	6	6	2	0,74
85	24	3	7	8	5	7	7	9	9	7	9	8	7	4	1,26
86	23,5	3	9	5	3	7	5	8	-	6	6	6	5	6	1,76
87	23	3	6	6	5	6	6	6	6	6	6	6	6	1	0,31
88	24	3	3	3	3	3	3	3	3	3	3	3	3	0	0,00
89	23,5	3	5	6	4	6	6	6	6	6	6	6	6	2	0,67
90	21,5	3	8	9	6	7	6	9	9	6	6	7	6	3	1,33
91	24	3	5	6	5	7	6	7	7	5	7	6	7	2	0,87
92	23	3	3	3	3	3	3	3	3	3	3	3	3	0	0,00
93	21,5	3	2	3	3	3	3	3	3	3	3	3	3	1	0,31
94	21,5	3	6	5	5	5	5	5	6	5	5	5	5	1	0,42
95	21,5	3	5	4	4	4	5	5	5	4	5	5	5	1	0,50
96	24	3	8	8	6	7	6	12	-	7	7	8	7	6	1,80
97	23	3	6	6	5	6	5	6	6	5	6	6	6	1	0,47
98	24	3	3	3	3	4	3	4	3	3	4	3	3	1	0,47
99	23	3	6	7	5	8	5	9	7	5	6	6	5	4	1,34
100	22	3	3	5	4	4	3	5	5	3	5	4	5	2	0,87
101	23,5	3	3	3	3	4	3	3	3	3	4	3	3	1	0,42
102	20	3	9	10	6	10	9	12	12	8	8	9	9	6	1,83
103	20,5	3	-	2	2	2	2	2	-	-	2	2	2	0	0,00
104	22,5	3	2	2	2	2	2	2	2	2	2	2	2	0	0,00
105	17	3	3	4	4	4	3	4	4	4	4	4	4	1	0,42
106	17	3	3	4	4	4	3	4	4	3	4	4	4	1	0,47
107	20,5	3	7	7	6	7	5	7	7	7	8	7	7	3	0,79
108	22	3	2	2	2	2	2	2	2	3	2	2	2	1	0,31
109	19	3	3	4	3	4	3	4	4	3	4	4	4	1	0,50
110	20,5	3	2	2	2	2	2	2	2	2	2	2	2	0	0,00
111	18,5	3	5	6	4	6	4	6	6	5	6	5	6	2	0,82
112	19	3	1	2	2	2	2	2	2	2	2	2	2	1	0,31
113	21,5	3	2	2	2	2	2	2	2	2	2	2	2	0	0,00
114	17,5	3	2	2	2	2	2	2	2	2	2	2	2	0	0,00
115	18	3	1	1	1	1	1	1	1	1	1	1	1	0	0,00
116	18	3	2	3	3	3	3	3	3	3	3	3	3	1	0,31
117	16	3	3	3	3	4	3	3	4	3	4	3	3	1	0,47
118	22,5	3	2	2	2	2	2	2	2	2	3	2	2	1	0,31
119	22,5	3	2	2	2	2	2	2	2	2	2	2	2	0	0,00
120	18,5	3	2	1	1	1	2	1	1	2	2	1	1	1	0,50
121	18	3	2	2	2	2	2	2	2	2	2	2	2	0	0,00
122	16,5	3	2	2	2	2	2	2	2	2	3	2	2	1	0,31
123	18	3	2	2	2	2	2	2	2	2	2	2	2	0	0,00
124	17,5	3	2	3	2	3	3	2	2	3	3	3	3	1	0,50
125	17	3	2	2	2	2	2	2	2	2	2	2	2	0	0,00
126	19	3	2	2	1	2	2	2	2	2	2	2	2	1	0,31
127	16,5	3	1	2	2	2	2	2	2	2	2	2	2	1	0,31
128	20	3	1	2	2	2	2	2	2	2	2	2	2	1	0,31
129	19,5	3	1	2	3	2	2	2	2	2	2	2	2	2	0,47
130	19,5	3	1	2	2	2	2	2	2	2	2	2	2	1	0,31

Table 7.1 - (Continued)

Fish no	Fish length	Catch month	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(Sp) Reader 7	Ext(Por) Reader 8	Ext(SA) Reader 9	Average age	Mode	Range	s.d.
131	19,5	3	1	2	2	2	2	2	2	2	2	2	2	1	0,31
132	19,5	3	1	2	2	2	2	2	2	3	2	2	2	2	0,47
133	19,5	3	1	2	2	2	2	2	2	2	2	2	2	1	0,31
134	19,5	3	1	2	2	2	2	2	2	3	2	2	2	2	0,47
135	19,5	3	1	2	2	2	2	2	2	2	2	2	2	1	0,31
136	19,5	3	1	2	2	2	2	2	2	2	2	2	2	1	0,31
137	20	3	-	-	-	-	-	-	-	-	-				
138	20	3	5	7	4	8	5	8	7	5	6	6	5	4	1,37
139	20	3	6	7	4	8	5	8	7	5	6	6	6	4	1,31
140	20	3	5	6	4	-	4	8	7	6	7	6	6	4	1,36
141	20	3	5	7	7	6	6	9	9	6	7	7	7	4	1,29
142	20	3	4	7	4	4	5	7	6	5	6	5	4	3	1,15
143	20	3	7	7	4	6	6	9	8	4	6	6	6	5	1,56
144	20,5	3	4	5	5	7	5	6	5	4	6	5	5	3	0,92
145	20,5	3	7	6	5	5	5	8	7	5	7	6	5	3	1,10
146	20,5	3	5	6	5	8	5	9	6	5	6	6	5	4	1,37
147	20,5	3	-	5	4	5	4	9	5	5	5	5	5	5	1,48
148	20,5	3	6	7	7	8	7	8	7	7	8	7	7	2	0,63
149	20,5	3	7	8	5	8	7	8	8	5	8	7	8	3	1,20
150	20,5	3	6	6	4	5	6	7	8	5	6	6	6	4	1,10
151	20,5	3	6	8	5	7	5	9	9	6	8	7	6	4	1,49
152	20,5	3	4	5	4	5	4	5	6	4	5	5	4	2	0,67
153	20,5	3	5	5	4	5	5	7	7	5	5	5	5	3	0,94
154	21	3	6	7	5	8	6	8	8	7	8	7	8	3	1,05
155	21	3	4	5	4	5	4	5	5	4	5	5	5	1	0,50
156	21	3	5	7	6	7	6	7	7	4	7	6	7	3	1,03
157	21	3	3	1	1	1	1	3	1	1	2	2	1	2	0,83
158	21	3	1	1	1	1	1	1	1	1	2	1	1	1	0,31
159	16	3	1	1	1	1	1	1	1	1	2	1	1	1	0,31
160	16,5	3	1	1	1	1	2	1	1	1	2	1	1	1	0,42
161	16,5	3	-	-	-	-	-	-	-	1	-	1	1	0	0,00
162	16,5	3	1	1	1	1	2	1	1	1	2	1	1	1	0,42
163	16,5	3	1	1	1	1	2	1	1	1	2	1	1	1	0,42
164	16,5	3	1	1	1	1	2	1	1	1	2	1	1	1	0,42
165	16,5	3	1	1	1	1	1	1	1	1	1	1	1	0	0,00
166	16,5	3	1	1	1	1	2	1	1	1	2	1	1	1	0,42
167	16,5	3	1	1	1	1	1	1	1	1	1	1	1	0	0,00
168	17	3	1	1	1	1	2	1	1	1	2	1	1	1	0,42
169	17	3	1	1	1	1	1	1	1	1	2	1	1	1	0,31
170	17	3	1	1	1	1	1	1	1	1	2	1	1	1	0,31
171	17	3	1	1	1	1	1	1	1	1	2	1	1	1	0,31
172	17	3	1	1	1	1	1	1	1	1	2	1	1	1	0,31
173	17	3	1	1	1	1	1	1	1	1	1	1	1	0	0,00
174	17	3	1	1	1	1	1	1	1	1	2	1	1	1	0,31
175	17	3	1	1	1	1	2	1	1	1	2	1	1	1	0,42
176	17	3	1	1	1	1	2	1	1	1	2	1	1	1	0,42
177	17	3	1	1	1	1	1	1	1	1	2	1	1	1	0,31
178	17	3	1	1	1	1	2	1	1	1	2	1	1	1	0,42
179	17	3	1	1	1	1	1	1	1	1	2	1	1	1	0,31
180	17,5	3	1	1	1	1	1	1	1	1	2	1	1	1	0,31
181	17,5	3	1	1	1	1	1	1	1	1	2	1	1	1	0,31
182	17,5	3	1	1	1	1	2	1	1	1	2	1	1	1	0,42
183	17,5	3	1	1	1	-	1	1	1	1	3	1	1	2	0,66
184	17,5	3	1	1	1	-	1	1	1	1	2	1	1	1	0,33
185	18	3	1	1	1	1	1	1	1	1	2	1	1	1	0,31
186	18	3	1	1	1	1	2	1	1	1	2	1	1	1	0,42
187	18	3	2	3	3	3	3	3	3	2	3	3	3	1	0,42
188	18	3	1	2	2	2	2	2	1	2	2	2	2	1	0,42
189	21	3	2	3	3	3	3	3	3	3	3	3	3	1	0,31
190	20,5	3	2	3	3	3	4	3	3	2	3	3	3	2	0,57
191	20,5	3	2	4	4	4	4	4	4	3	3	4	4	2	0,68
192	21	3	1	2	2	2	2	2	2	2	2	2	2	1	0,31
193	21,5	3	4	5	5	5	5	7	6	4	7	5	5	3	1,05
194	20,5	3	6	7	6	9	6	9	7	6	6	7	6	3	1,20
195	23	3	6	6	5	7	4	11	-	6	5	6	6	7	1,98
196	24	3	4	4	3	4	3	5	3	4	3	4	4	2	0,67
197	24,5	3	3	3	3	3	3	3	3	3	3	3	3	0	0,00

Table 7.1 - (Continued)

Fish no	Fish length	Catch month	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(Sp) Reader 7	Ext(Por) Reader 8	Ext(SA) Reader 9	Average age	Mode	Range	s.d.
198	22	3	5	7	5	7	6	6	8	6	7	6	7	3	0,94
199	21	3	3	4	4	4	3	4	3	3	3	3	3	1	0,50
200	24	3	7	7	5	7	5	8	7	6	8	7	7	3	1,05
201	22,5	3	7	7	6	6	6	8	8	7	8	7	7	2	0,82
202	24	3	5	5	5	4	4	5	5	5	5	5	5	1	0,42
203	24,5	3	7	8	4	9	5	11	-	5	7	7	7	7	2,18
204	22,5	3	2	3	3	3	2	3	2	2	3	3	3	1	0,50
205	24,5	3	3	4	3	3	3	3	2	2	3	3	3	2	0,57
206	20,5	3	3	3	3	3	3	3	3	3	4	3	3	1	0,31
207	23,5	3	4	5	5	5	5	5	5	5	5	5	5	1	0,31
208	25	3	4	4	4	5	4	4	4	4	4	4	4	1	0,31
209	23	3	4	5	4	4	5	5	5	4	4	4	4	1	0,50
210	23,5	3	5	3	3	3	3	3	3	3	3	3	3	2	0,63
211	24,5	3	4	5	4	5	5	5	5	4	4	5	5	1	0,50
212	22	3	8	7	6	7	6	9	7	7	8	7	7	3	0,92
213	22	3	4	4	4	4	4	4	4	4	4	4	4	0	0,00
214	25	3	3	4	4	4	4	4	4	4	4	4	4	1	0,31
215	23	3	4	5	5	5	5	5	5	5	6	5	5	2	0,47
216	23,5	3	4	4	4	4	4	4	4	4	4	4	4	0	0,00
217	24	3	7	9	7	8	9	10	8	6	10	8	7	4	1,31
218	24	3	-	-	4	-	2	4	-	-	5	4	4	3	1,09
219	25	3	3	5	5	4	4	5	4	4	5	4	5	2	0,67
220	23	3	4	5	4	5	4	5	5	4	5	5	5	1	0,50
221	23	3	4	4	4	4	4	3	3	4	3	4	4	1	0,47
222	22,5	3	4	5	5	5	5	5	5	5	5	5	5	1	0,31
223	22	3	6	6	5	7	7	6	6	5	7	6	6	2	0,74
224	23,5	3	3	4	4	4	4	4	3	4	4	4	4	1	0,42
225	25	3	3	4	3	4	4	4	3	3	3	3	3	1	0,50
226	23	3	2	3	3	3	3	3	3	2	3	3	3	1	0,42
227	23,5	3	5	5	4	5	5	6	-	4	5	5	5	2	0,60
228	21	3	2	3	3	3	3	3	2	3	3	3	3	1	0,42
229	23,5	3	2	3	3	3	3	3	3	3	3	3	3	1	0,31
230	21	3	2	3	3	3	3	3	3	3	3	3	3	1	0,31
231	21,5	3	-	4	4	3	3	-	-	-	4	4	4	1	0,49
232	20,5	3	6	6	5	7	5	6	7	5	7	6	6	2	0,82
233	21,5	3	-	-	-	-	-	-	-	-	-				
234	23,5	3	1	2	3	2	2	2	2	2	2	2	2	2	0,47
235	20	3	6	8	5	7	7	11	12	7	8	8	7	7	2,13
236	20,5	3	6	6	4	5	6	6	6	6	7	6	6	3	0,79
237	24	3	3	3	3	3	3	3	-	3	3	3	3	0	0,00
238	23	3	5	4	5	5	5	5	5	4	5	5	5	1	0,42
239	21	3	-	2	2	2	2	-	-	2	2	2	2	0	0,00
240	23,5	3	2	3	3	3	3	3	2	2	3	3	3	1	0,47
241	20	3	4	4	4	5	4	4	5	2	3	4	4	3	0,87
242	19	3	4	5	4	5	4	4	5	4	5	4	4	1	0,50
243	21,5	3	1	2	2	2	2	2	2	2	2	2	2	1	0,31
244	22,5	3	5	6	6	6	6	6	6	6	6	6	6	1	0,31
245	19,5	3	-	3	3	3	3	-	-	-	3	3	3	0	0,00
246	23,5	3	-	-	4	-	3	-	-	-	-	4	3	1	0,50
247	21,5	3	5	6	6	6	6	5	6	4	6	6	6	2	0,68
248	23,5	3	5	2	3	2	2	2	-	2	2	3	3	3	1,00
249	24	3	1	2	2	2	2	2	2	2	2	2	2	1	0,31
250	20	3	5	6	5	6	5	5	6	4	5	5	5	2	0,63
251	20,5	3	5	6	4	7	6	8	-	5	7	6	5	4	1,22
252	22	3	2	3	3	3	3	2	3	2	3	3	3	1	0,47
253	22	3	2	3	3	3	3	3	3	3	3	3	3	1	0,31
254	20,5	3	2	3	3	3	3	3	3	3	2	3	3	1	0,42
255	19	3	1	2	2	2	2	2	2	2	2	2	2	1	0,31
256	20	3	3	3	3	3	3	3	3	3	3	3	3	0	0,00
257	20	3	3	3	3	3	4	3	3	3	3	3	3	1	0,31
258	21	3	3	3	3	3	3	3	3	3	3	3	3	0	0,00
259	20,5	3	3	3	3	3	4	3	3	3	3	3	3	1	0,31
	Total read		248	254	256	251	256	252	239	250	255				
	Total NOT read		8	2	0	5	0	4	17	6	1				
	Empty rows		3	3	3	3	3	3	3	3	3				
	Agreement above average?		N	Y	Y	Y	N	Y	Y	N	N				

Table 7.2 - Results on Average Percent Error for each reader. (No - number of otoliths read; APE(bf) - Beamish and Fournier index; APE(c) - Chang index).

	No	APE(bf)	APE(c)
Reader 1	246	15,87	21,02
Reader 2	253	4,63	6,09
Reader 3	253	3,84	5,07
Reader 4	249	4,22	5,62
Reader 5	254	7,36	9,80
Reader 6	249	7,77	10,33
Reader 7	233	7,45	10,44
Reader 8	253	3,94	5,18
Reader 9	248	7,16	9,50

Table 7.3 - Results of the test of symmetry for each reader.

READER 1

first read. \ *3rd reading*	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
I	20	3										23
II	51	31	1	1	2							86
III	3	19	16	6	4	1						49
IV		4	6	13	5	4	1					33
V			1	7	6	3						17
VI					6	5	4	1				16
VII					1	4	2	1				8
VIII						1	2	3				6
IX									2			2
X									1		1	2
XI												0
Tot	74	57	24	27	24	18	9	5	3	0	1	242

READER 2

first read. \ *3rd reading*	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
I	73	2										75
II	2	38	2									42
III			28	7		1						36
IV				16	13	4	1					34
V				1	13	9	10	2				35
VI						8	9	1	3			21
VII							2	4				6
VIII									1	1		2
IX												0
X												0
XI												0
Tot	75	40	30	24	26	22	22	7	4	1	0	251

READER 3

first read. \ *3rd reading*	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
I	74											74
II	4	28	1									33
III		6	33	4		1						44
IV			5	29	6	1						41
V				13	28	1						42
VI					5	4	2					11
VII					1	6	1					8
VIII												0
IX												0
X												0
XI												0
Tot	78	34	39	46	40	13	3	0	0	0	0	253

READER 4

first read. \ *3rd reading*	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
I	67											67
II	4	40	1									45
III	2		28	5								35
IV				18	6	1	1	3				29
V				2	24	5	5	1	1			38
VI						7	2	2				11
VII					2		12	2	1			17
VIII					1			1	1			3
IX								1				1
X										1		1
XI												0
Tot	73	40	29	25	33	13	20	10	3	1	0	247

READER 5

first read. \ *3rd reading*	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
I	27	3										30
II	7	67	5									79
III		4	37	14	5							60
IV			3	16	15	7						41
V				1	11	11	2					25
VI					3	3	2					8
VII				1		3	3	2	2			11
VIII											0	
IX												0
X												0
XI												0
Tot	34	74	45	32	34	24	7	2	2	0	0	254

READER 6

first read. \ *3rd reading*	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
I	57	3	1									61
II	5	32	1	1								39
III	1	5	26									32
IV	2	2	2	13	3							22
V	1	1		6	20	1						29
VI					3	10	6	1	1			21
VII						3	6	4	3	1	1	18
VIII								4	1	1	1	7
IX								2	7	1		10
X								1			2	3
XI									1		1	2
Tot	66	43	30	20	26	14	12	12	13	3	5	244

Table 7.3 - (Continued)

READER 7

		2nd reading											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
first read.	I	72	2										74
	II	1	32	1									34
	III		5	21									26
	IV			7	8								15
	V				4	23	2						29
	VI					1	14	2					17
	VII						2	6	2				10
	VIII							6	6				12
	IX					1		1	1	4			7
	X							1	1		2		4
	XI									1			1
	Tot	73	39	29	12	25	18	16	10	5	2	0	229

READER 8

		3rd reading											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
first read.	I	5	4										9
	II	2	3	2		1	1						9
	III			16	15	6	1						38
	IV			6	13	4							23
	V			3	7	3			1				14
	VI			2	7	3	2						14
	VII			2	5	2		1		2			12
	VIII				1	2	2						5
	IX					1							1
	X						1	2		1			4
	XI											1	1
	Tot	7	7	31	48	22	7	3	1	3	0	1	130

READER 9

		3rd reading											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
first read.	I	9	4										13
	II	4	95	4									103
	III		1	33	6								40
	IV				13	7	2	1	1				24
	V					20	8	3	3				34
	VI					1	12	5	1	1	1		21
	VII							6	5				11
	VIII								2				2
	IX									3			3
	X												0
	XI											1	1
	Tot	13	100	37	19	28	22	15	12	4	1	1	252

	Test	d.f	Prob
Reader 1	78,1	18	1.8E-09
Reader 2	65,3	16	6.6E-08
Reader 3	17,9	9	0.0360
Reader 4	33,3	17	0.0104
Reader 5	44,9	12	0.0000
Reader 6	28,8	23	*0.1859*
Reader 7	22,3	13	*0.0504*
Reader 8	40	21	0.0074
Reader 9	43,2	15	0.0001

Table 7.4 - Cumulative age composition by age reader in percentage. Cumulative age composition of all and best readers obtained from the modes.

	All Readers										
AGE	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(Sp) Reader 7	Ext(Por) Reader 8	Ext(SA) Reader 9	All readers	Best readers
0	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	30%	30%	30%	29%	13%	27%	32%	20%	5%	29%	30%
2	54%	46%	44%	45%	42%	45%	49%	48%	44%	45%	46%
3	64%	58%	60%	58%	60%	58%	62%	63%	60%	60%	58%
4	75%	68%	78%	68%	73%	65%	67%	76%	67%	70%	68%
5	85%	78%	94%	81%	86%	76%	77%	88%	78%	83%	79%
6	92%	87%	99%	86%	96%	81%	85%	96%	87%	91%	87%
7	96%	95%	100%	94%	98%	86%	92%	100%	93%	98%	95%
8	98%	98%	100%	98%	99%	91%	96%	100%	97%	99%	97%
9	100%	100%	100%	100%	100%	96%	98%	100%	99%	100%	99%
10	100%	100%	100%	100%	100%	97%	99%	100%	99%	100%	100%
11	100%	100%	100%	100%	100%	99%	99%	100%	100%	100%	100%
12	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 7.5 - Age composition by age reader (in numbers of otoliths read). Age composition of all and best readers obtained from the modes.

	All Readers										
AGE	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(Sp) Reader 7	Ext(Por) Reader 8	Ext(SA) Reader 9	All readers	Best readers
0	-	-	-	-	-	-	-	-	-	-	-
1	74	75	78	74	34	69	77	49	13	75	76
2	59	41	35	40	74	44	39	72	100	41	41
3	26	32	41	31	46	32	31	37	39	37	32
4	27	24	46	25	33	20	12	31	19	26	24
5	24	26	40	33	34	26	25	31	28	33	29
6	18	22	13	13	24	14	18	21	22	20	20
7	11	22	3	21	7	12	18	8	15	19	20
8	5	7	-	10	2	12	10	1	12	2	7
9	3	4	-	3	2	13	5	-	4	3	5
10	-	1	-	1	-	3	2	-	1	-	2
11	1	-	-	-	-	5	-	-	2	1	-
12	-	-	-	-	-	2	2	-	-	-	-
	248	254	256	251	256	252	239	250	255	257	256

Table 7.6 - Mean length at age by otolith reader (without correction for measured below). Age modes of all and best readers used for the calculation of mean length.

	All Readers										
AGE	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(Sp) Reader 7	Ext(Por) Reader 8	Ext(SA) Reader 9	All readers	Best readers
0	-	-	-	-	-	-	-	-		-	-
1	17,2	16,4	16,4	16,3	16,8		16,4	16,7	16,4	16,4	16,4
2	18,5	19,4	19,5	19,6	18,1	19,3	19,9	18,3	17,6	19,3	19,5
3	21,5	21,0	21,4	21,1	20,1	21,0	21,4	20,7	21,0	21,4	21,3
4	22,6	22,0	21,7	21,9	21,8	21,4	21,1	22,3	21,7	21,7	22,0
5	22,0	22,7	22,0	22,1	22,1	22,8	22,3	22,0	22,4	22,2	22,3
6	21,4	21,6	22,4	21,7	22,2	21,7	21,9	22,3	21,6	21,6	21,9
7	22,0	21,2	21,5	22,0	21,4	21,8	21,2	21,8	21,9	22,1	21,0
8	22,3	22,9	-	21,5	22,8	20,8	21,5		21,1	20,8	22,6
9	22,8	22,8	-	23,8	22,0	21,1	21,3		21,3	21,8	22,6
10	-	20,0	-	20,0	-	24,5	25,8		24,0	-	22,5
11	26,5	-	-	-	-	23,5	-		25,8	26,5	-
12	-	-	-	-	-	22,0	20,0		-	-	-

Table 7.7a - Agreement (%) of otolith readings. All cases and split by year classes and differences (%) between all readers and the best ones for each case.

All readers, all otoliths

	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(Sp) Reader 7	Ext(Por) Reader 8	Ext(SA) Reader 9	Mean per reader
Reader 1	-	47,18%	47,58%	42,45%	41,13%	41,53%	44,30%	53,66%	31,05%	43,10%
Reader 2		-	68,11%	76,10%	55,51%	72,11%	78,66%	57,83%	48,82%	63,04%
Reader 3			-	68,13%	58,98%	61,51%	64,85%	61,45%	41,96%	59,07%
Reader 4				-	54,18%	70,56%	73,73%	55,69%	50,60%	61,43%
Reader 5					-	46,83%	49,79%	62,65%	54,90%	53,00%
Reader 6						-	74,90%	50,00%	48,41%	58,23%
Reader 7							-	53,97%	48,95%	61,15%
Reader 8								-	50,20%	55,68%
Reader 9									-	46,86%
										55,79%

Dif. in % between best readers and all: 15,08%

Excluding older than 7 years

	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(Sp) Reader 7	Ext(Por) Reader 8	Ext(SA) Reader 9	Mean per reader
Reader 1	-	50,71%	52,61%	46,92%	42,65%	45,97%	48,29%	57,42%	33,65%	46,79%
Reader 2		-	78,24%	83,80%	61,11%	80,28%	82,52%	64,45%	53,70%	69,35%
Reader 3			-	79,17%	62,50%	71,36%	73,30%	65,40%	47,69%	66,28%
Reader 4				-	60,19%	77,46%	79,61%	62,56%	53,70%	67,93%
Reader 5					-	53,99%	55,83%	66,35%	63,43%	58,26%
Reader 6						-	79,13%	57,14%	51,64%	64,62%
Reader 7							-	60,19%	52,43%	66,41%
Reader 8								-	56,40%	61,24%
Reader 9									-	51,58%
										61,44%

Dif. in % between best readers and all: 17,05%

Only year classes 1 and 2. (#116)

	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(Sp) Reader 7	Ext(Por) Reader 8	Ext(SA) Reader 9	Mean per reader
Reader 1	-	64,91%	62,28%	62,28%	42,98%	61,40%	64,86%	62,83%	35,09%	55,96%
Reader 2		-	91,38%	95,69%	62,07%	89,57%	96,40%	73,68%	45,69%	77,42%
Reader 3			-	93,97%	57,76%	86,09%	94,59%	66,67%	39,66%	74,05%
Reader 4				-	62,07%	90,43%	96,40%	72,81%	45,69%	77,42%
Reader 5					-	53,91%	59,46%	71,93%	74,14%	60,54%
Reader 6						-	89,19%	68,14%	41,74%	72,56%
Reader 7							-	69,37%	41,44%	76,46%
Reader 8								-	63,16%	68,57%
Reader 9									-	48,32%
										68,05%

Dif. in % between best readers and all: 24,32%

Table 7.7a - (Continued)

3-6 year classes (#100)

	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(Sp) Reader 7	Ext(Por) Reader 8	Ext(SA) Reader 9	Mean per reader
Reader 1	-	33,67%	40,82%	28,57%	41,84%	28,57%	28,42%	51,55%	31,63%	35,91%
Reader 2		-	63,37%	70,30%	60,40%	68,69%	66,67%	53,06%	63,37%	59,94%
Reader 3			-	62,38%	68,32%	53,54%	48,96%		57,43%	57,26%
Reader 4				-	58,42%	61,62%	60,42%		63,37%	56,88%
Reader 5					-	53,54%	52,08%		51,49%	55,66%
Reader 6						-	66,67%		62,63%	55,02%
Reader 7							-		65,63%	54,72%
Reader 8									47,96%	52,36%
Reader 9									-	55,44%
										53,66%

Dif. in % between best readers and all: 8,60%

7 and older year classes (#38)

	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(Sp) Reader 7	Ext(Por) Reader 8	Ext(SA) Reader 9	Mean per reader
Reader 1	-	27,03%	18,92%	14,71%	32,43%	16,22%	18,75%	32,43%	16,22%	21,38%
Reader 2		-	10,53%	28,57%	23,68%	26,32%	54,55%	21,05%	21,05%	26,60%
Reader 3			-	0,00%	40,00%	7,69%	12,12%	39,47%	10,26%	17,37%
Reader 4				-	17,14%	28,57%	33,33%	14,29%	31,43%	21,00%
Reader 5					-	7,69%	12,12%	42,11%	7,69%	22,86%
Reader 6						-	48,48%	10,53%	30,77%	22,03%
Reader 7							-	15,15%	27,27%	27,72%
Reader 8								-	15,79%	23,85%
Reader 9									-	20,06%
										22,62%

Dif. in % between best readers and all: 2,40%

Table 7.7b - Agreement (%) of otolith readings for the best reader. All cases and split by year classes and differences (%) between all readers and the best ones for each case.

Best readers, all otoliths

	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 6	Ext(Sp) Reader 7	Mean per reader
Reader 2	-	68,11%	76,10%	72,11%	78,66%	73,74%
Reader 3		-	68,13%	61,51%	64,85%	65,65%
Reader 4			-	70,56%	73,73%	72,13%
Reader 6				-	74,90%	69,77%
Reader 7					-	73,03%
						70,87%

Excluding older than 7 years

	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 6	Ext(Sp) Reader 7	Mean per reader
Reader 2	-	78,24%	83,80%	80,28%	82,52%	81,21%
Reader 3		-	79,17%	71,36%	73,30%	75,52%
Reader 4			-	77,46%	79,61%	80,01%
Reader 6				-	79,13%	77,06%
Reader 7					-	78,64%
						78,49%

Only year classes 1 and 2.

	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 6	Ext(Sp) Reader 7	Mean per reader
Reader 2	-	91,38%	95,69%	89,57%	96,40%	93,26%
Reader 3		-	93,97%	86,09%	94,59%	91,51%
Reader 4			-	90,43%	96,40%	94,12%
Reader 6				-	89,19%	88,82%
Reader 7					-	94,14%
						92,37%

3-6 year classes

	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 6	Ext(Sp) Reader 7	Mean per reader
Reader 2	-	63,37%	70,30%	68,69%	66,67%	67,25%
Reader 3		-	62,38%	53,54%	48,96%	57,06%
Reader 4			-	61,62%	60,42%	63,68%
Reader 6				-	66,67%	62,63%
Reader 7					-	60,68%
						62,26%

7 and older year classes

	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 6	Ext(Sp) Reader 7	Mean per reader
Reader 2	-	10,53%	28,57%	26,32%	54,55%	29,99%
Reader 3		-	0,00%	7,69%	12,12%	7,58%
Reader 4			-	28,57%	33,33%	22,62%
Reader 6				-	48,48%	27,77%
Reader 7					-	37,12%
						25,02%

Table 7.8 - Disagreement of one year (%) between otolith readings. (This could be due to misinterpretation of the hyaline/opaque edge of the otolith).

	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(Sp) Reader 7	Ext(Por) Reader 8	Ext(SA) Reader 9	Mean per reader
Reader 1	-	44,35%	39,52%	46,37%	50,40%	40,73%	45,61%	39,52%	56,85%	45,42%
Reader 2		-	18,50%	20,72%	34,65%	16,27%	17,99%	32,00%	47,24%	28,97%
Reader 3			-	19,52%	30,47%	17,46%	20,08%	33,20%	42,35%	27,64%
Reader 4				-	35,06%	16,33%	18,41%	32,80%	39,84%	28,63%
Reader 5					-	31,75%	33,89%	31,20%	36,08%	35,44%
Reader 6						-	18,83%	29,20%	42,06%	26,58%
Reader 7							-	30,54%	46,44%	28,97%
Reader 8								-	38,80%	33,41%
Reader 9									-	43,71%
										33,20%

Table 7.9 - Disagreement of two or more years (%) between otolith readings.

	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(Sp) Reader 7	Ext(Por) Reader 8	Ext(SA) Reader 9	Mean per reader
Reader 1	-	8,47%	12,90%	11,18%	8,47%	17,74%	10,09%	6,83%	12,10%	10,97%
Reader 2		-	13,39%	3,19%	9,84%	11,62%	3,35%	10,17%	3,94%	7,99%
Reader 3			-	12,35%	10,55%	21,03%	15,06%	5,35%	15,69%	13,29%
Reader 4				-	10,76%	13,10%	7,86%	11,51%	9,56%	9,94%
Reader 5					-	21,43%	16,32%	6,15%	9,02%	11,57%
Reader 6						-	6,28%	20,80%	9,52%	15,19%
Reader 7							-	15,48%	4,60%	9,88%
Reader 8								-	11,00%	10,91%
Reader 9									-	9,43%
										11,02%

Table 7.10 - Results of the test of symmetry among readers.

		Reader 2											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 1	I	**56**	18										74
	II	18	**20**	18	3								59
	III	1		**10**	9	2	1	1					24
	IV				**9**	17		1					27
	V		1	1	2	**4**	11	5					24
	VI					1	**8**	7	2				18
	VII						1	**6**	3	1			11
	VIII							2	**1**	2			5
	IX					1				**1**	1		3
	X												0
	XI								1				1
	Tot	75	39	29	23	25	21	22	7	4	1	0	246

		Reader 3											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 1	I	**56**	16	2									74
	II	21	**17**	18	3								59
	III	1		**13**	7	3							24
	IV			1	**19**	7							27
	V			2	8	**9**	4	1					24
	VI				3	13	**1**	1					18
	VII				2	6	2	**1**					11
	VIII			1		1	3						5
	IX			1			2						3
	X												0
	XI						1						1
	Tot	78	33	38	42	39	13	3	0	0	0	0	246

		Reader 4											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 1	I	**53**	19										72
	II	20	**18**	18	2	1							59
	III	1		**8**	12	2	1						24
	IV				**9**	17		1					27
	V		1	1	2	**6**	7	4	2				23
	VI					4	**3**	6	4	1			18
	VII					2	2	**4**	2	1			11
	VIII							4	**1**				5
	IX							1	1		1		3
	X												0
	XI									1			1
	Tot	74	38	27	25	32	13	20	10	3	1	0	243

		Reader 5											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 1	I	**28**	46										74
	II	5	**24**	25	5								59
	III	1		**15**	7	1							24
	IV			1	**14**	12							27
	V		1	1	4	**8**	10						24
	VI				1	7	**7**	3					18
	VII					4	3	**3**		1			11
	VIII						4		**1**				5
	IX					1		1	**1**				3
	X												0
	XI							1					1
	Tot	34	71	42	31	33	24	7	2	2	0	0	246

		Reader 6											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 1	I	**51**	21	2									74
	II	18	**21**	15	5								59
	III			**11**	8	3	1	1					24
	IV			1	**6**	17	1	2					27
	V		1	1		**5**	7	5	3	2			24
	VI					1	**5**	3	3	4		2	18
	VII							**1**	5	2	2	1	11
	VIII									3		2	5
	IX								1		1	1	3
	X												0
	XI											**1**	1
	Tot	69	43	30	19	26	14	12	12	11	3	7	246

		Reader 7											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 1	I	**56**	17										73
	II	20	**21**	15	2								58
	III	1	1	**11**	7	2		1					23
	IV			2	**3**	19	3						27
	V			1		**3**	10	5	1	1			21
	VI						**5**	8	2	1		1	17
	VII							**3**	5	1			9
	VIII							1	**1**	2			4
	IX										1	1	2
	X												0
	XI										1		1
	Tot	77	39	29	12	24	18	18	9	5	2	2	235

		Reader 8											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 1	I	**41**	30	2									73
	II	6	**38**	15									59
	III	1	1	**16**	6								24
	IV		1	1	**18**	7							27
	V		1	1	6	**9**	7						24
	VI					10	**5**	3					18
	VII				1	3	3	**3**					10
	VIII						3	2					5
	IX						2		1				3
	X												0
	XI						1						1
	Tot	48	71	35	31	29	21	8	1	0	0	0	244

		Reader 9											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 1	I	**9**	64	1									74
	II	4	**32**	22	1								59
	III		1	**9**	9	4	1						24
	IV			3	**8**	12	3	1					27
	V		1	1		**7**	9	6					24
	VI					3	**6**	4	5				18
	VII						1	**2**	5	2	1		11
	VIII						1	2	**1**	1			5
	IX						1		1			1	3
	X												0
	XI											**1**	1
	Tot	13	98	36	18	26	22	15	12	3	1	2	246

		Reader 3											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 2	I	**74**	1										75
	II	4	**33**	4									41
	III		1	**29**									30
	IV			4	**19**	1							24
	V			1	14	**11**							26
	VI				6	13	**3**						22
	VII			1	4	10	5	**2**					22
	VIII				1	4	2						7
	IX					1	2	1					4
	X						1						1
	XI												0
	Tot	78	35	39	44	40	13	3	0	0	0	0	252

		Reader 3											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 2	I	**71**	2										73
	II	3	**38**										41
	III			**27**	3								30
	IV			2	**16**	6							24
	V				5	**19**		2					26
	VI					6	**8**	6	1				21
	VII				1	2	5	**8**	5	1			22
	VIII							4	**1**	2			7
	IX							1	3				4
	X										**1**		1
	XI												0
	Tot	74	40	29	25	33	13	21	10	3	1	0	249

Table 7.10 - (Continued)

		Reader 5											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 2	I	**34**	34	7									75
	II		**38**	3									41
	III		1	**26**	3								30
	IV			7	**14**	3							24
	V			1	11	**14**							26
	VI				4	6	**11**	1					22
	VII					9	11	**2**					22
	VIII					2	1	4					7
	IX						1		2	**1**			4
	X									1			1
	XI												0
	Tot	34	73	44	32	34	24	7	2	2	0	0	252

		Reader 6											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 2	I	**68**	4	3									75
	II	1	**37**		2								40
	III		3	**25**	1								29
	IV			2	**14**	7							23
	V				2	**17**	2	3	1	1			26
	VI					2	**10**	4	3	2		1	22
	VII						2	**5**	7	6	1	1	22
	VIII								**1**	2		4	7
	IX									**2**	2		4
	X											1	1
	XI												0
	Tot	69	44	30	19	26	14	12	12	13	3	7	249

		Reader 7											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 2	I	**74**											74
	II	3	**34**										37
	III		4	**23**	1								28
	IV		1	6	**10**	6							23
	V				1	**18**	4	1					24
	VI					1	**12**	5	2				20
	VII						2	**12**	6	1			21
	VIII								**1**	2	1	1	5
	IX								1	**2**	1		4
	X											1	1
	XI												0
	Tot	77	39	29	12	25	18	18	10	5	2	2	237

		Reader 8											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 2	I	**48**	26										74
	II		**37**	3									40
	III		7	**22**									29
	IV		2	8	**13**								23
	V			1	13	**10**	2						26
	VI			1	2	12	**7**						22
	VII				3	7	6	**5**					21
	VIII					2	2	3					7
	IX						4						4
	X								1				1
	XI												0
	Tot	48	72	35	31	31	21	8	1	0	0	0	247

		Reader 9											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 2	I	**13**	61	1									75
	II		**38**	3									41
	III		1	**25**	4								30
	IV			8	**11**	5							24
	V				4	**17**	4	1					26
	VI					3	**10**	8		1			22
	VII					2	7	**4**	8	1			22
	VIII							2	**3**	1		1	7
	IX						1			**1**	1	1	4
	X								1				1
	XI												0
	Tot	13	100	37	19	27	22	15	12	4	1	2	252

		Reader 4											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 3	I	**74**	2										76
	II		**34**	1									35
	III		4	**27**	6			2					39
	IV			1	**17**	18	3	1	2	1			43
	V				2	**14**	6	13	5				40
	VI					1	**3**	5	1	2	1		13
	VII						1		2				3
	VIII												0
	IX												0
	X												0
	XI												0
	Tot	74	40	29	25	33	13	21	10	3	1	0	249

		Reader 5											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 3	I	**34**	34	10									78
	II		**34**	1									35
	III		5	**28**	4	1	1						39
	IV		1	6	**23**	11	5						46
	V				5	**21**	8	5	1				40
	VI					1	**9**	1	1	1			13
	VII						1	**1**		1			3
	VIII												0
	IX												0
	X												0
	XI												0
	Tot	34	74	45	32	34	24	7	2	2	0	0	254

		Reader 6											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 3	I	**69**	6	3									78
	II		**32**		2								34
	III		6	**26**	3	1			1				37
	IV			1	**15**	14	4	3	4	2			43
	V					**10**	9	6	5	7	1	2	40
	VI					1	**1**	3	1	3	1	3	13
	VII								1	1	1		3
	VIII												0
	IX												0
	X												0
	XI												0
	Tot	69	44	30	20	26	14	12	12	13	3	5	248

		Reader 7											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 3	I	**75**	1										76
	II	2	**31**										33
	III		7	**25**	2				1				35
	IV			4	**9**	16	5	4	2				40
	V				1	**9**	10	9	5	3		1	38
	VI						**3**	4	1	1	2	1	12
	VII							**1**	1	1			3
	VIII												0
	IX												0
	X												0
	XI												0
	Tot	77	39	29	12	25	18	18	10	5	2	2	237

		Reader 8											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 3	I	**48**	29										77
	II		**30**	4									34
	III		12	**23**	1		2						38
	IV		1	7	**22**	10	3						43
	V			1	6	**21**	8	3					39
	VI				2		**6**	4	1				13
	VII						2	**1**					3
	VIII												0
	IX												0
	X												0
	XI												0
	Tot	48	72	35	31	31	21	8	1	0	0	0	247

Table 7.10 - (Continued)

		Reader 9											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 3	I	**13**	63	2									78
	II		**32**	3									35
	III		5	**27**	5		1	1					39
	IV			5	**14**	15	7	4					45
	V					**13**	9	7	7	4			40
	VI						**5**	2	4			2	13
	VII							**1**	1			1	3
	VIII												0
	IX												0
	X												0
	XI												0
	Tot	13	100	37	19	28	22	15	12	4	0	3	253

		Reader 5											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 4	I	**31**	33	10									74
	II	1	**39**										40
	III		1	**25**	3								29
	IV			9	**12**	4							25
	V				14	**14**	5						33
	VI				1	4	**8**						13
	VII				1	7	9	**4**					21
	VIII					4	1	2	**2**	1			10
	IX					1	1	1					3
	X									1			1
	XI												0
	Tot	32	73	44	31	34	24	7	2	2	0	0	249

		Reader 6											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 4	I	**67**	4	3									74
	II		**37**		2								39
	III		3	**24**									27
	IV			3	**13**	8		1					25
	V				4	**16**	4	5	1	2	1		33
	VI					2	**6**	2	1	2			13
	VII						4	**4**	4	5		4	21
	VIII								**5**	3	2		10
	IX									**1**		2	3
	X											1	1
	XI												0
	Tot	67	44	30	19	26	14	12	11	13	3	7	246

		Reader 7											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 4	I	**72**											72
	II	3	**34**										37
	III		5	**21**									26
	IV			7	**10**	7	1						25
	V			1	2	**17**	7	3	1				31
	VI						**8**	2	2	1			13
	VII					1	1	**7**	4	3		1	17
	VIII						1	4	**3**	1	1		10
	IX							1			1		2
	X											1	1
	XI												0
	Tot	75	39	29	12	25	18	17	10	5	2	2	234

		Reader 8											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 4	I	**46**	27										73
	II		**36**	3									39
	III		8	**19**									27
	IV			11	**12**	2							25
	V		1	2	13	**13**	3						32
	VI				4	4	**4**	1					13
	VII				2	6	8	**5**					21
	VIII				5	3	2						10
	IX					1	2						3
	X								1				1
	XI												0
	Tot	46	72	35	36	29	19	6	1	0	0	0	244

		Reader 9											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 4	I	**13**	60	1									74
	II		**38**	2									40
	III		1	**26**	2								29
	IV			6	**12**	6	1						25
	V			1	5	**17**	5	3	2				33
	VI					2	**8**	2	1				13
	VII					2	3	**8**	5	3			21
	VIII						4		**3**	1	1	1	10
	IX						1	1			1		3
	X								1				1
	XI												0
	Tot	13	99	36	19	27	22	14	12	4	2	1	249

		Reader 6											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 5	I	**28**	3	3									34
	II	33	**36**	1	3								73
	III	8	5	**22**	5	2							42
	IV			4	**12**	10	2	1	1	1			31
	V					**13**	5	5	5	5		1	34
	VI					1	**6**	6	3	5	1	2	24
	VII						1		3	1		2	7
	VIII									1	1		2
	IX										1	1	2
	X												0
	XI												0
	Tot	69	44	30	20	26	14	12	12	13	3	6	249

		Reader7											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 5	I	**33**											33
	II	35	**35**										70
	III	9	4	**22**	4	1							40
	IV			7	**8**	12	3	1					31
	V					**12**	7	10	1	1			31
	VI						**7**	6	6	2			21
	VII						1	**1**	2	1	1	1	7
	VIII									1	1		2
	IX								1			1	2
	X												0
	XI												0
	Tot	77	39	29	12	25	18	18	10	5	2	2	237

		Reader 8											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 5	I	**31**	2										33
	II	16	**53**	3									72
	III	1	15	**24**	2								42
	IV		2	8	**15**	4	3						32
	V				11	**19**	3	1					34
	VI				3	6	**10**	4					23
	VII					2	2	**3**					7
	VIII						2						2
	IX						1		1				2
	X												0
	XI												0
	Tot	48	72	35	31	31	21	8	1	0	0	0	247

		Reader 9											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 5	I	**13**	20	1									34
	II		**70**	3		1							74
	III		10	**25**	8	1							44
	IV			8	**8**	13	2	1					32
	V				3	**12**	10	4	4	1			34
	VI					1	**10**	9	4				24
	VII							**1**	3	2		1	7
	VIII								1			1	2
	IX									1	1		2
	X												0
	XI												0
	Tot	13	100	37	19	28	22	15	12	4	1	2	253

Table 7.10 - (Continued)

		Reader 7											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 6	I	**68**											68
	II	6	**33**	2									41
	III	3	4	**21**	1								29
	IV		2	5	**9**	3							19
	V			1	2	**19**	4						26
	VI					2	**9**	1	1				13
	VII						4	**7**	1				12
	VIII							6	**4**				10
	IX					1	1	4	2	**5**			13
	X								1		**1**		2
	XI								1		1		2
	Tot	77	39	29	12	25	18	18	10	5	2	0	235

		Reader 8											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 6	I	**43**	25										68
	II	2	**37**	4									43
	III	3	6	**20**	1								30
	IV		3	8	**8**								19
	V			2	16	**8**							26
	VI			1	2	6	**5**						14
	VII				3	6	2	**1**					12
	VIII					5	4	3					12
	IX				1	5	5	2					13
	X						2						2
	XI					1	3	1					5
	Tot	48	71	35	31	31	21	7	0	0	0	0	244

		Reader 9											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 6	I	**11**	57	1									69
	II	1	**37**	6									44
	III	1	3	**23**	3								30
	IV		2	5	**10**	3							20
	V			1	5	**18**	2						26
	VI					3	**7**	4					14
	VII					2	5	**4**	1				12
	VIII						3	3	**5**	1			12
	IX					1	5	1	3	**3**			13
	X								1		**1**	1	3
	XI					1		2	1			**1**	5
	Tot	13	99	36	18	28	22	14	11	4	1	2	248

		Reader 8											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 7	I	**48**	29										77
	II		**34**	5									39
	III		5	**21**	3								29
	IV			5	**7**								12
	V		1	3	13	**8**							25
	VI				4	8	**6**						18
	VII				2	10	3	**3**					18
	VIII				1	3	4	2					10
	IX						4	1					5
	X						2						2
	XI												0
	Tot	48	69	34	30	29	19	6	0	0	0	0	235

		Reader 9											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 7	I	**13**	63	1									77
	II		**32**	7									39
	III		1	**23**	5								29
	IV			2	**8**	2							12
	V			1	5	**17**	2						25
	VI					4	**11**	3					18
	VII					2	5	**6**	5				18
	VIII						2	2	**3**	2	1		10
	IX						1	1	1	**2**			5
	X											2	2
	XI												0
	Tot	13	96	34	18	25	21	12	9	4	1	2	235

		Reader 9											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 8	I	**12**	35	1									48
	II	1	**59**	12									72
	III		4	**21**	8	2							35
	IV			2	**10**	13	4	2					31
	V					**11**	10	7	2	1			31
	VI					1	**8**	5	2	2	1	2	21
	VII							**1**	6	1			8
	VIII								**1**				1
	IX												0
	X												0
	XI												0
	Tot	13	98	36	18	27	22	15	11	4	1	2	247

Table 7.11 - Results of the Bowker's symmetry (A) and Wilcoxon matched-pair signed-rank tests (B).

A

	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9
Reader 1	-	0,0000	0,0001	0,0000	0,0000	0,0000	0,0000	0,0001	0,0000
Reader 2		-	0,0000	***0,6320***	0,0000	0,0009	0,0083	0,0000	0,0000
Reader 3			-	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
Reader 4				-	0,0000	0,0003	0,0094	0,0000	0,0000
Reader 5					-	0,0000	0,0000	0,0009	0,0000
Reader 6						-	**0,0141**	0,0000	0,0000
Reader 7							-	0,0000	0,0000
Reader 8								-	0,0000
Reader 9									-

B

	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 7	Reader 8	Reader 9
Reader 1	-	0,0000	***0,1157***	0,0000	0,0000	0,0000	0,0000	***0,3612***	0,0000
Reader 2		-	0,0000	***0,6588***	***0,0961***	0,0000	**0,0256**	0,0000	0,0000
Reader 3			-	0,0000	0,0000	0,0000	0,0000	0,0008	0,0000
Reader 4				-	***0,4036***	0,0000	**0,0443**	0,0000	0,0000
Reader 5					-	0,0000	**0,0352**	0,0000	0,0000
Reader 6						-	0,0000	0,0000	***0,9443***
Reader 7							-	0,0000	0,0000
Reader 8								-	0,0000
Reader 9									-

Table 7.13 - Results on Average Percent Error for each reader. No - number of otoliths read; APE(bf) - Beamish and Fournier index; APE(c) - Chang index.

	No	APE(bf)	APE(c)
Reader 1	128	13,15	18,60
Reader 3	130	26,72	37,78
Reader 4	131	5,78	8,18
Reader 5	129	14,10	19,94
Reader 6	131	13,77	19,48

Table 7.14 - Results of the test of symmetry for each reader.

READER 1

		2nd reading											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
first read	I	**8**	5	1									14
	II		**8**	22	12								42
	III		2	**23**	22	2	1						50
	IV			2	**6**	3	1	1					13
	V					**2**	2	1	1				6
	VI							1	1				2
	VII							**1**					1
	VIII												0
	IX												0
	X												0
	XI												0
	Tot	8	15	48	40	7	4	4	2	0	0	0	128

READER 3

		2nd reading											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
first read.	I	**0**	8	4	1	5							18
	II		**1**	16	24	7							48
	III			**5**	21	10	1						37
	IV				**4**	8	2		1				15
	V					**3**		2					5
	VI						**1**	1					2
	VII								1				1
	VIII												0
	IX												0
	X												0
	XI												0
	Tot	0	9	25	50	33	4	3	2	0	0	0	126

READER 4

		2nd reading											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
first read	I	**9**		1									10
	II	4	**2**										6
	III		9	**35**		1							45
	IV			14	**33**		1						48
	V				5	**3**		1					9
	VI					3		1	1				5
	VII					1		**3**					4
	VIII								**1**				1
	IX								1	**1**			2
	X									1			1
	XI												0
	Tot	13	11	50	38	8	1	5	3	2	0	0	131

READER 5

		2nd reading											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
first read.	I	**5**	4										9
	II	2	**3**	2		1	1						9
	III			**16**	15	6	1						38
	IV			6	**13**	4							23
	V			3	7	**3**			1				14
	VI			2	7	3	**2**						14
	VII			2	5	2		**1**		2			12
	VIII				1	2	2						5
	IX					1							1
	X						1	2		1			4
	XI											**1**	1
	Tot	7	7	31	48	22	7	3	1	3	0	1	130

READER 6

		2nd reading											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
first read	I	**1**											1
	II	11	**1**	1									13
	III	1	14	**21**	2								38
	IV		13	20	**21**	2							56
	V		3	1	1	**4**							9
	VI				1	2	**1**	1					5
	VII				1								1
	VIII					1		2	**2**				5
	IX												0
	X												0
	XI								1				1
	Tot	13	31	43	26	9	1	3	3	0	0	0	129

	Test	d.f.	Prob
Reader 1	65	15	2.99e-08
Reader 3	112	16	1.87e-16
Reader 4	42	13	0.0001
Reader 5	40	21	0.0074
Reader 6	64	15	4.48e-08

Table 7.15 - Cumulative age composition by age reader in percentage. Cumulative age composition of all and best readers obtained from the modes.

	All Readers								
AGE	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(SA) Reader 9	ALL readers	BEST readers
0	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	6%	8%	0%	10%	5%	10%	7%	8%	8%
2	18%	13%	10%	18%	11%	34%	18%	14%	14%
3	55%	48%	29%	56%	35%	67%	69%	48%	47%
4	87%	82%	68%	85%	72%	87%	93%	83%	82%
5	92%	90%	93%	92%	89%	94%	97%	92%	91%
6	95%	94%	96%	92%	94%	95%	99%	94%	95%
7	98%	97%	98%	96%	96%	97%	99%	98%	98%
8	100%	98%	100%	98%	97%	99%	99%	99%	98%
9	100%	99%	100%	100%	99%	100%	99%	100%	100%
10	100%	100%	100%	100%	99%	100%	99%	100%	100%
11	100%	100%	100%	100%	100%	100%	99%	100%	100%
12	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 7.16 - Age composition by age reader (in numbers of otoliths read). Age composition of all and best readers obtained from the modes.

	All Readers								
AGE	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(SA) Reader 9	ALL readers	BEST readers
0	-	-	-	-	-	-	-	-	-
1	8	10	-	13	7	13	9	11	11
2	15	7	13	11	8	31	14	7	7
3	48	46	25	50	31	43	67	45	43
4	40	44	50	38	48	26	32	46	47
5	7	10	33	8	22	9	5	11	11
6	4	5	4	1	7	1	3	3	5
7	4	4	3	5	3	3	-	5	4
8	2	2	2	3	1	3	-	2	1
9	-	1	-	2	3	1	-	1	2
10	-	1	-	-	-	-	-	-	-
11	-	-	-	-	1	-	-	-	-
12	-	-	-	-	-	-	1	-	-
	128	130	130	131	131	130	131	131	131

Table 7.17 - Mean length at age by otolith reader (without correction for measured below). Age modes of all and best readers used for the calculation of mean length.

	All Readers								
AGE	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(SA) Reader 9	ALL readers	BEST readers
0	-	-	-	-	-	-	-	-	-
1	17,5	17,7	-	17,8	17,8		17,8	17,7	17,7
2	18,8	18,3	17,8	19,0	17,9	19,6	19,4	18,6	18,8
3	20,0	19,9	19,5	20,0	19,5	20,0	19,9	19,8	19,8
4	20,4	20,3	20,0	20,4	20,3	20,7	20,6	20,4	20,3
5	21,2	21,0	20,7	21,0	20,7	21,3	21,8	21,2	21,2
6	21,9	21,0	21,7	20,4	20,8	21,5	21,8	20,6	20,9
7	22,5	22,0	22,0	21,8	22,1	21,7	-	21,8	22,0
8	21,5	21,6	23,4	21,8	21,6	23,1	-	23,4	21,7
9	-	22,2	-	23,3	21,8	22,2	-	22,2	23,6
10	-	25,0	-	-	-	-	-	-	-
11	-	-	-	-	25,0	-	-	-	-
12	-	-	-	-	-	-	25,0	-	-

Tabela 7.18a - Agreement (%) of otolith readings. All cases and split by year classes and differences (%) between all readers and the best ones for each case.

All readers, all otoliths

	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(SA) Reader 9	Mean per reader
Reader 1	-	49,22%	44,53%	52,34%	47,66%	40,16%	43,75%	46,28%
Reader 2		-	51,16%	67,69%	55,38%	50,39%	43,08%	52,82%
Reader 3			-	41,54%	53,08%	31,01%	29,23%	41,76%
Reader 4				-	50,38%	58,46%	48,85%	53,21%
Reader 5					-	37,69%	41,22%	47,57%
Reader 6						-	41,54%	43,21%
Reader 9							-	41,28%
Dif in % between best readers and all:					4,61%			46,59%

Excluding older than 7 years (#121)

	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(SA) Reader 9	Mean per reader
Reader 1	-	51,26%	47,06%	55,46%	51,26%	43,22%	47,06%	49,22%
Reader 2		-	50,83%	69,42%	56,20%	50,83%	46,28%	54,14%
Reader 3			-	42,15%	54,55%	28,33%	29,75%	42,11%
Reader 4				-	51,64%	60,33%	52,46%	55,24%
Reader 5					-	38,02%	43,44%	49,18%
Reader 6						-	43,80%	44,09%
Reader 9							-	43,80%
Dif in % between best readers and all:					4,60%			48,26%

Only year classes 1 and 2. (#19)

	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(SA) Reader 9	Mean per reader
Reader 1	-	50,00%	38,89%	61,11%	66,67%	72,22%	61,11%	58,33%
Reader 2		-	38,89%	68,42%	57,89%	68,42%	57,89%	56,92%
Reader 3			-	5,56%	44,44%	11,11%	33,33%	28,70%
Reader 4				-	47,37%	89,47%	47,37%	53,22%
Reader 5					-	57,89%	52,63%	54,48%
Reader 6						-	47,37%	57,75%
Reader 9							-	49,95%
Dif in % between best readers and all:					3,54%			51,34%

3-6 year classes (#102)

	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(SA) Reader 9	Mean per reader
Reader 1	-	51,49%	48,51%	54,46%	48,51%	38,00%	44,55%	47,59%
Reader 2		-	52,94%	69,61%	55,88%	47,52%	44,12%	53,59%
Reader 3			-	48,54%	56,31%	31,37%	29,13%	44,47%
Reader 4				-	52,43%	54,90%	53,40%	55,56%
Reader 5					-	34,31%	41,75%	48,20%
Reader 6						-	43,14%	41,54%
Reader 9							-	42,68%
Dif in % between best readers and all:					4,79%			47,66%

7 and older year classes (#10)

	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(SA) Reader 9	Mean per reader
Reader 1	-	20,00%	10,00%	20,00%	0,00%	0,00%	0,00%	8,33%
Reader 2		-	50,00%	40,00%	50,00%	40,00%	0,00%	33,33%
Reader 3			-	30,00%	30,00%	60,00%	20,00%	33,33%
Reader 4				-	30,00%	30,00%	0,00%	25,00%
Reader 5					-	30,00%	10,00%	25,00%
Reader 6						-	20,00%	30,00%
Reader 9							-	8,33%
Dif in % between best readers and all:					4,44%			23,33%

Table 7.18b - Agreement (%) of otolith readings split by ICES Sub-Divisions and differences (%) between these samples and the overall sample.

Sample VIIIc-W (#28)

	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(SA) Reader 9	Mean per reader
Reader 1	-	65,52%	55,17%	62,07%	55,17%	58,62%	65,52%	60,34%
Reader 2		-	75,86%	68,97%	58,62%	75,86%	44,83%	64,94%
Reader 3			-	68,97%	75,86%	75,86%	41,38%	65,52%
Reader 4				-	65,52%	89,66%	55,17%	68,39%
Reader 5					-	62,07%	37,93%	59,20%
Reader 6						-	55,17%	69,54%
Reader 9							-	50,00%
Dif in % between this sample and the overall sample:						15,97%		62,56%

Sample IXa-N (#38)

	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(SA) Reader 9	Mean per reader
Reader 1	-	37,84%	13,51%	48,65%	27,03%	56,76%	29,73%	35,59%
Reader 2		-	40,54%	76,32%	63,16%	65,79%	47,37%	55,17%
Reader 3			-	24,32%	35,14%	24,32%	21,62%	26,58%
Reader 4				-	55,26%	68,42%	42,11%	52,51%
Reader 5					-	52,63%	55,26%	48,08%
Reader 6						-	50,00%	52,99%
Reader 9							-	41,01%
Dif in % between this sample and the overall sample:						-2,03%		44,56%

Sample IXaCN (#34)

	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(SA) Reader 9	Mean per reader
Reader 1	-	55,88%	67,65%	61,76%	64,71%	18,18%	50,00%	53,03%
Reader 2		-	50,00%	67,65%	58,82%	27,27%	35,29%	49,15%
Reader 3			-	47,06%	55,88%	12,12%	41,18%	45,65%
Reader 4				-	58,82%	33,33%	41,18%	51,63%
Reader 5					-	21,21%	44,12%	50,59%
Reader 6						-	30,30%	23,74%
Reader 9							-	40,34%
Dif in % between this sample and the overall sample:						-1,71%		44,88%

Sample IXa-CS (#30)

	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(SA) Reader 9	Mean per reader
Reader 1	-	39,29%	46,43%	35,71%	46,43%	25,00%	32,14%	37,50%
Reader 2		-	41,38%	55,17%	37,93%	31,03%	44,83%	41,61%
Reader 3			-	30,00%	50,00%	16,67%	13,33%	32,97%
Reader 4				-	20,00%	43,33%	60,00%	40,70%
Reader 5					-	13,33%	23,33%	31,84%
Reader 6						-	30,00%	26,56%
Reader 9							-	33,94%
Dif in % between this sample and the overall sample:						-11,57%		35,02%

Table 7.19 - Disagreement of one year (%) between otolith readings. (This could be due to the misinterpretation of the hyaline/opaque edge of the otolith).

All Readers

	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(SA) Reader 9	Mean per reader
Reader 1	-	46,09%	40,63%	42,19%	41,41%	45,31%	47,66%	43,88%
Reader 2		-	36,92%	30,00%	36,92%	38,46%	43,08%	38,58%
Reader 3			-	42,31%	40,00%	45,38%	52,31%	42,92%
Reader 4				-	39,69%	38,46%	38,93%	38,60%
Reader 5					-	40,77%	38,17%	39,49%
Reader 6						-	47,69%	42,68%
Reader 9							-	44,64%
								41,54%

Table 7.20 - Disagreement of two or more years (%) between otolith readings.

All Readers

	Portugal Reader 1	Portugal Reader 2	Portugal Reader 3	Sp(IEO) Reader 4	Sp(IEO) Reader 5	Sp(IEO) Reader 6	Ext(SA) Reader 9	Mean per reader
Reader 1	-	4,69%	14,84%	5,47%	10,94%	14,53%	8,59%	9,84%
Reader 2		-	11,91%	2,31%	7,69%	11,15%	13,85%	8,60%
Reader 3			-	16,15%	6,92%	23,61%	18,46%	15,32%
Reader 4				-	9,92%	3,08%	12,21%	8,19%
Reader 5					-	21,54%	20,61%	12,94%
Reader 6						-	10,77%	14,11%
Reader 9							-	14,08%
								11,87%

Table 7.21 - Results of the test of symmetry among readers.

		Reader 2											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 1	I	**6**	2										8
	II	4	**2**	7	2								15
	III		2	**27**	18	1							48
	IV			12	**23**	5							40
	V				1	**3**	2	1					7
	VI					1	**1**	2					4
	VII						1		1	1	1		4
	VIII							1	**1**				2
	IX												0
	X												0
	XI												0
	Tot	10	6	46	44	10	4	4	2	1	1	0	128

		Reader 3											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 1	I	**7**	1										8
	II		**6**	2	3	4							15
	III			**19**	22	7							48
	IV			2	**25**	13							40
	V			1		**5**		1					7
	VI					1	**2**	1					4
	VII					1	1		2				4
	VIII						1	1					2
	IX												0
	X												0
	XI												0
	Tot	7	7	24	50	31	4	3	2	0	0	0	128

		Reader 4											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 1	I	**8**											8
	II	5	**4**	5	1								15
	III		3	**28**	16								48
	IV		3	15	**20**	2							40
	V			1	1	**4**		1					7
	VI					1		3					4
	VII							1	2	1			4
	VIII								1	1			2
	IX												0
	X												0
	XI												0
	Tot	13	10	50	38	7	0	5	3	2	0	0	128

		Reader 5											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 1	I	**5**	3										8
	II	2	**5**	6	2								15
	III			**22**	21	5							48
	IV			3	**24**	12	1						40
	V					**4**	2	1					7
	VI						**1**	2	1				4
	VII						1			2		1	4
	VIII						1			1			2
	IX												0
	X												0
	XI												0
	Tot	7	8	31	47	21	6	3	1	3	0	1	128

		Reader 6											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 1	I	**8**											8
	II	5	**5**	4	1								15
	III		13	**23**	11								47
	IV		11	16	**11**	2							40
	V		1		1	**4**		1					7
	VI					2		1	1				4
	VII				1				2	1			4
	VIII						1	1					2
	IX												0
	X												0
	XI												0
	Tot	13	30	43	25	8	1	3	3	1	0	0	127

		Reader 9											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 1	I	**6**	1	1									8
	II	3	**4**	7	1								15
	III		5	**33**	10								48
	IV		3	25	**12**								40
	V			1	5	**1**							7
	VI				1	3							4
	VII				1		2					1	4
	VIII					1	1						2
	IX												0
	X												0
	XI												0
	Tot	9	13	67	30	5	3	0	0	0	0	1	128

		Reader 3											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 2	I		9	1									10
	II		**4**	1	1								6
	III			**18**	19	9							46
	IV			5	**30**	9							44
	V					**9**	1						10
	VI					4	**1**						5
	VII					1		**3**					4
	VIII						1		**1**				2
	IX						1						1
	X								1				1
	XI												0
	Tot	0	13	25	50	32	4	3	2	0	0	0	129

		Reader 4											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 2	I	**10**											10
	II	3	**3**	1									7
	III		6	**37**	3								46
	IV		2	11	**30**	1							44
	V			1	5	**4**							10
	VI					3		2					5
	VII							**3**	1				4
	VIII								**1**	1			2
	IX								1				1
	X									1			1
	XI												0
	Tot	13	11	50	38	8	0	5	3	2	0	0	130

		Reader 5											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 2	I	**6**	4										10
	II	1	**3**	2	1								7
	III		1	**24**	15	5	1						46
	IV			5	**28**	11							44
	V				4	**4**	2						10
	VI					1	**3**		1				5
	VII							**3**		1			4
	VIII						1			1			2
	IX									**1**			1
	X											1	1
	XI												0
	Tot	7	8	31	48	21	7	3	1	3	0	1	130

		Reader 6											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 2	I	**10**											10
	II	3	**3**	1									7
	III		21	**23**	1								45
	IV		5	17	**21**	1							44
	V		2	2	2	**4**							10
	VI				2	2		1					5
	VII					1		**2**	1				4
	VIII						1		**1**				2
	IX									**1**			1
	X								1				1
	XI												0
	Tot	13	31	43	26	8	1	3	3	1	0	0	129

Table 7.21 - (Continued)

		Reader 9											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 2	I	**6**	4										10
	II	2	**3**	2									7
	III	1	4	**33**	8								46
	IV		2	29	**13**								44
	V		1	3	5	**1**							10
	VI			3	2								5
	VII				2	2							4
	VIII						2						2
	IX						1						1
	X											1	1
	XI												0
	Tot	9	14	70	30	3	3	0	0	0	0	1	130

		Reader 4											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 3	I												0
	II	12	**1**										13
	III	1	4	**18**	2								25
	IV		4	21	**25**								50
	V		1	11	11	**7**	1	2					33
	VI					1		1	1				4
	VII							**2**	1				3
	VIII								**1**	1			2
	IX												0
	X												0
	XI												0
	Tot	13	10	50	38	8	1	5	3	2	0	0	130

		Reader 5											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 3	I												0
	II	7	**6**										13
	III		2	**16**	6	1							25
	IV			12	**30**	8							50
	V			3	11	**13**	5	1					33
	VI						**2**		1	1			4
	VII							**2**		1			3
	VIII									1		1	2
	IX												0
	X												0
	XI												0
	Tot	7	8	31	47	22	7	3	1	3	0	1	130

		Reader 6											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 2	I												0
	II	12	**1**										13
	III	1	12	**10**	2								25
	IV		11	22	**16**								49
	V		6	11	8	**8**							33
	VI					1	**1**	1		1			4
	VII							**2**	1				3
	VIII								**2**				2
	IX												0
	X												0
	XI												0
	Tot	13	30	43	26	9	1	3	3	1	0	0	129

		Reader 9											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 3	I												0
	II	8	**4**	1									13
	III	1	3	**19**	2								25
	IV		3	35	**12**								50
	V		3	12	17	**1**							33
	VI					2	**2**						4
	VII				1	2							3
	VIII						1					1	2
	IX												0
	X												0
	XI												0
	Tot	9	13	67	32	5	3	0	0	0	0	1	130

		Reader 5											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 4	I	**7**	6										13
	II		**2**	4	2	2	1						11
	III			**25**	19	6							50
	IV			2	**26**	10							38
	V				1	**3**	4						8
	VI					1							1
	VII						1	**3**	1				5
	VIII								3				3
	IX						1					1	2
	X												0
	XI												0
	Tot	7	8	31	48	22	7	3	1	3	0	1	131

		Reader 6											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 4	I	**13**											13
	II		**7**	4									11
	III		23	**24**	2								49
	IV		1	15	**22**								38
	V				1	**7**							8
	VI					1							1
	VII				1	1		**2**	1				5
	VIII							1	**1**	1			3
	IX						1		1				2
	X												0
	XI												0
	Tot	13	31	43	26	9	1	3	3	1	0	0	130

		Reader 9											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 4	I	**7**	5	1									13
	II	2	**4**	5									11
	III		2	**38**	10								50
	IV		3	22	**13**								38
	V			1	5	**2**							8
	VI				1								1
	VII				3	2							5
	VIII					1	2						3
	IX						1					1	2
	X												0
	XI												0
	Tot	9	14	67	32	5	3	0	0	0	0	1	131

		Reader 6											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 5	I	**7**											7
	II	6	**2**										8
	III		12	**17**	1								30
	IV		11	20	**16**	1							48
	V		6	5	7	**4**							22
	VI			1	2	3	**1**						7
	VII					1		1	1				3
	VIII							1					1
	IX							1	1	**1**			3
	X												0
	XI								1				1
	Tot	13	31	43	26	9	1	3	3	1	0	0	130

		Reader 9											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Tot
Reader 5	I	**5**	2										7
	II	4	**3**	1									8
	III		2	**28**	1								31
	IV		3	29	**16**								48
	V		3	9	9	**1**							22
	VI		1		4	1	**1**						7
	VII				2	1							3
	VIII					1							1
	IX					1	2						3
	X												0
	XI												0
	Tot	9	14	67	32	5	3	0	0	0	0	0	130

Table 7.21 - (Continued)

		Reader 9											
		I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**Tot**
Reader 6	**I**	**7**	5	1									13
	II	2	**4**	22	3								31
	III		3	**29**	11								43
	IV		2	13	**11**								26
	V			1	6	**2**							9
	VI						**1**						1
	VII				1	2							3
	VIII					1	1					1	3
	IX						1						1
	X												0
	XI												0
	Tot	9	14	66	32	5	3	0	0	0	0	1	130

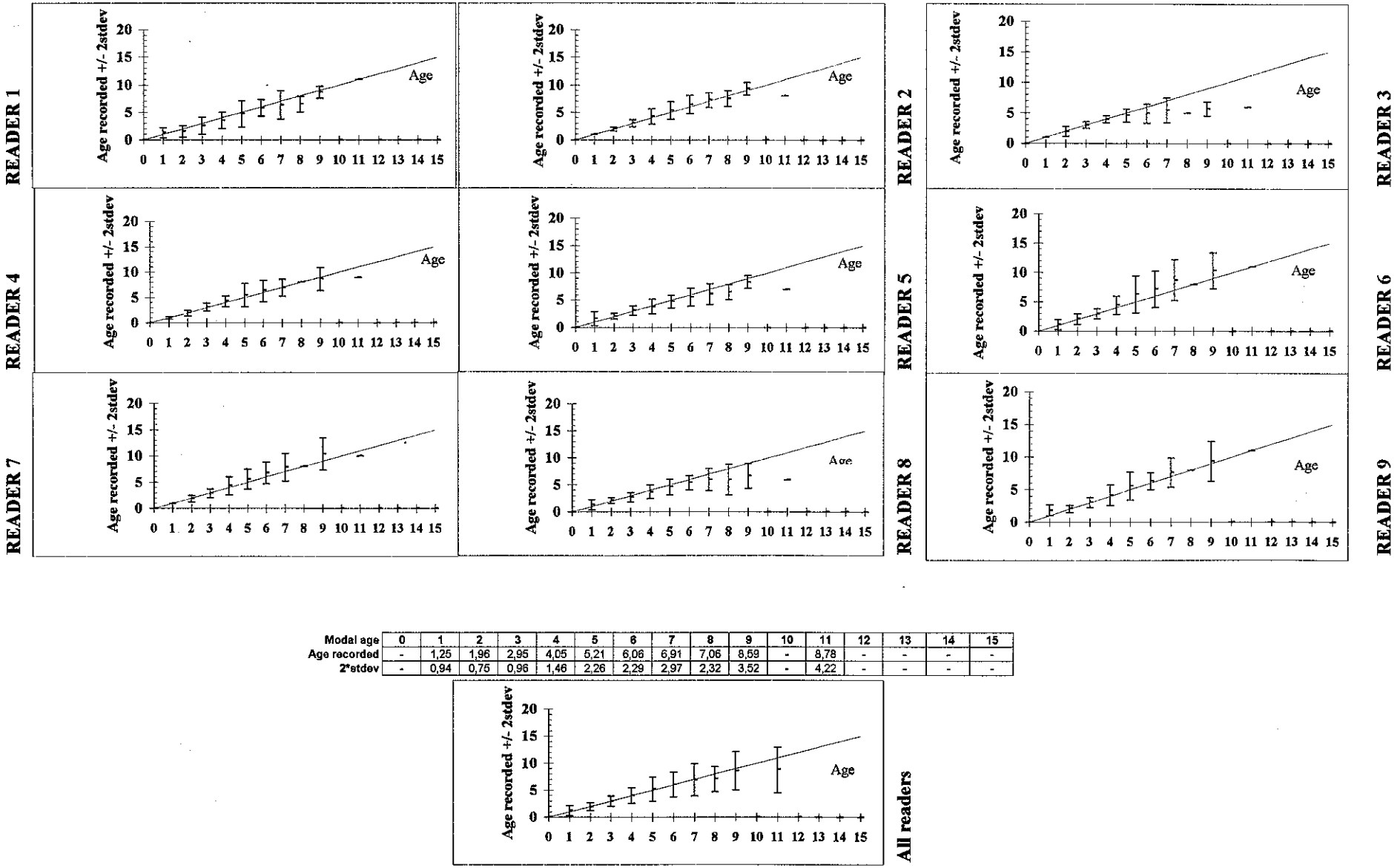
Table 7.22 - Results of the Bowker's symmetry (A) and Wilcoxon matched-pair signed-rank (B) tests.

A

	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 9
Reader 1	-	***0,3021***	0,0000	***0,1547***	0,0000	**0,0137**	0,0000
Reader 2		-	0,0000	**0,0136**	***0,0544***	0,0000	0,0008
Reader 3			-	0,0000	**0,0240**	0,0000	0,0000
Reader 4				-	0,0000	0,0011	**0,0139**
Reader 5					-	0,0000	0,0000
Reader 6						-	***0,1797***
Reader 9							-

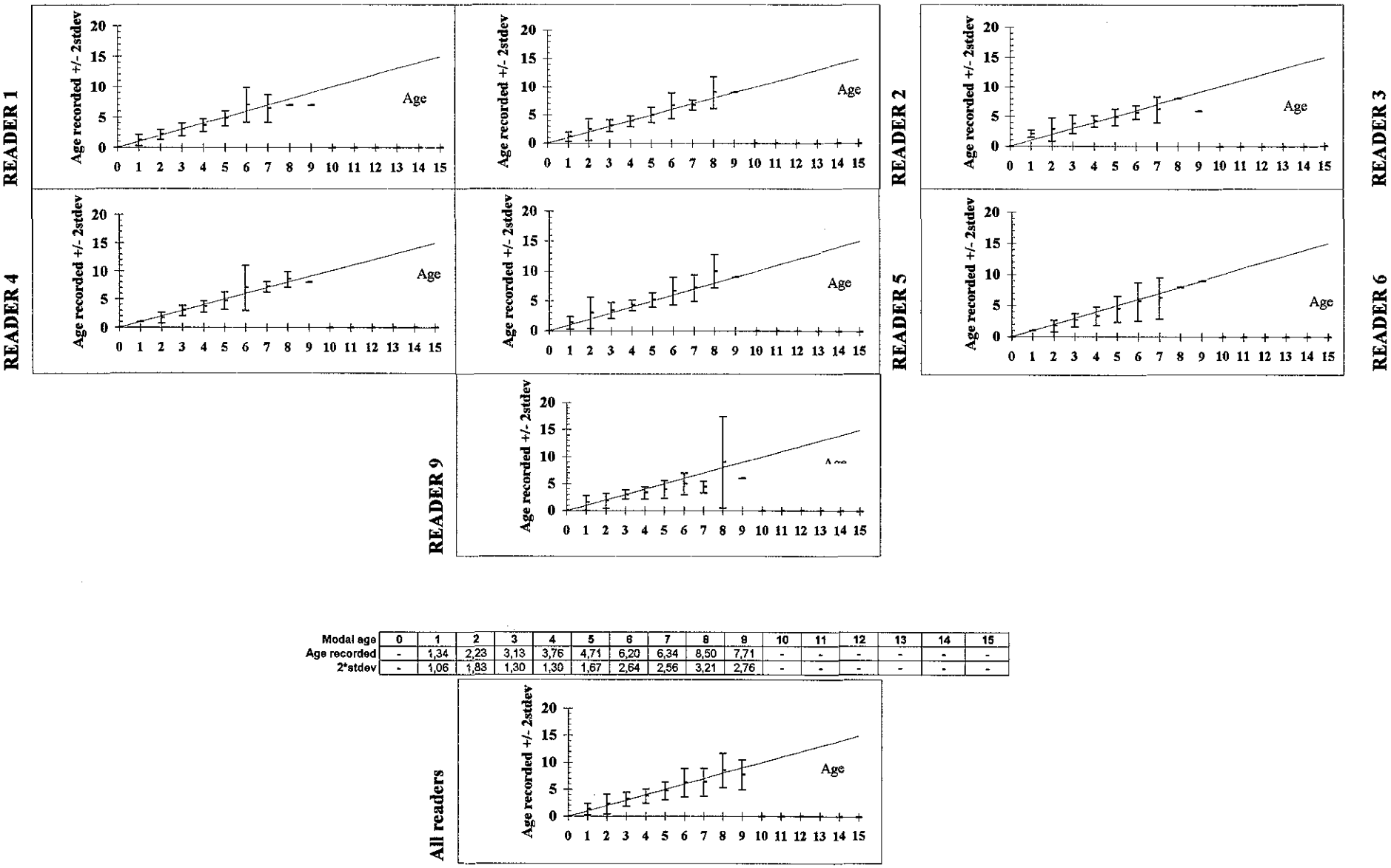
B

	Reader 1	Reader 2	Reader 3	Reader 4	Reader 5	Reader 6	Reader 9
Reader 1	-	0,0029	0,0000	***0,8376***	0,0000	0,0009	0,0008
Reader 2		-	0,0001	0,0002	0,0000	0,0000	0,0000
Reader 3			-	0,0000	***0,5825***	0,0000	0,0000
Reader 4				-	0,0000	0,0000	0,0010
Reader 5					-	0,0000	0,0000
Reader 6						-	***0,6563***
Reader 9							-



Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Age recorded	-	1,25	1,96	2,95	4,05	5,21	6,06	6,91	7,06	8,59	-	8,78	-	-	-	-
2*stdev	-	0,94	0,75	0,96	1,46	2,26	2,29	2,97	2,32	3,52	-	4,22	-	-	-	-

Figure 7.1 - Age bias plots average age +/- 2stdev of each age reader and all age readers is plotted against modal age.



Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Age recorded	-	1,34	2,23	3,13	3,76	4,71	6,20	6,34	8,50	7,71	-	-	-	-	-	-
2*stdev	-	1,06	1,83	1,30	1,30	1,67	2,64	2,56	3,21	2,76	-	-	-	-	-	-

Figure 7.2 - Age bias plot average age +/- 2stdev of each reader and all age readers is plotted against modal age.