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RESULTS OF THE ANCHOVY (*Engraulis encrasicholus*, L.) OTOLITH EXCHANGE PROGRAMME IN 1996.

by

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ABSTRACT

The 1995 Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy agreed to carry out an anchovy otolith exchange programme in order to compare otolith age readings made by the scientists of the different countries, which fish anchovies.

In total, 650 pairs of otoliths were exchanged, of which 200 were from ICES Division VIIIab, 250 were from ICES Division VIIIc and 200 were from ICES Sub-division IXa North, and three readers from the two countries (France and Spain) took part in the exchange. The comparison of otolith readings of the three areas was carried out separately.

Taking into account the few ages read, due to the anchovy being a species with a short life-span, the average general agreement between readers was unsatisfactory in Division VIIIab (71%) and VIIIc (80%). In Division IXa North agreement was greater than in the other two areas (96%) owing to the sample of otoliths consisting of specimens of one single age. Agreement between readers varied between 59% and 88% for the Division VIIIab, between 77% and 82% for Division VIIIc and between 94% and 97% for Sub-division IXa North.

Standard deviations by age groups increase from age 2 for the Division VIIIab and VIIIc area sample. In Division VIIIc the standard deviations also increase in age 0.

The age bias plots of each reader against the modal age show variability in the samples from Divisions VIIIab and VIIIc. The age bias plots for all readers combined show that bias increases with

age, and that those from age 2 tend to be underestimated in Division VIIIab and that those of age 0 tend to be overestimated in Division VIIIc. In Division IXa North the level of bias is very low.

Considering the importance of age readings in assessment, new investigations are needed to increase agreement, and to standardize ageings.

INTRODUCTION

The last anchovy otolith workshop was carried out in 1990 (Astudillo et al., 1990), which was the first experiment in Bay of Biscay anchovy otolith reading comparison among the different readers of the different countries.

In the 1995 Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy, an anchovy otolith reading workshop was recommended with the aim of comparing otolith readings among the different readers of the different countries which fish anchovy in different ICES areas (Anon, 1996). Before holding this workshop, a limited otolith exchange has been carried out in 1996. In this otolith exchange, Bay of Biscay anchovy otoliths and those from Sub-division Ixa North have been read, but not those from Sub-division IXa South due to a lack of time available. In future experiments otolith readings of anchovies from all areas of distribution in the ICES area must be compared.

This exchange was organized by Begoña Villamor, (IEO, Spain) and Andrés Uriarte (AZTI, Spain).

The anchovy otolith readers that participated in the otolith exchange were:

Patrick Prouzet . IFREMER. Sant Pee sur Nivelle. France
Iñaki Rico. AZTI. San Sebastian. Spain
Orestes Cendrero. IEO. Santander. Spain

Three series of otoliths from different areas were gathered by the three scientific organizations (IFREMER, AZTI and IEO) covering all seasons in which fisheries take place.

This paper presents the results and analysis of the 650 otolith readings by the above mentioned readers in the otolith exchange.

MATERIAL AND METHODS

A sample of 650 pairs of otoliths were examined. Of these otoliths, 200 came from Division VIIIab, caught between February and November, covering a length range from 9.7 to 19.7 cm; 250 were from Division VIIIc, caught from April to December, covering a length range from 10.2 to 18.3 cm; and 200 from Sub-division IXa North, caught in June-July, covering a length range from 12.5 to 18 cm.

The otoliths and corresponding dates of capture and fish lengths were sent to the readers of each country.

The otolith readers gave an absolute value to each pair of otoliths wherever possible. Doubtful ages were indicated by the mark "?" after the age, and otoliths which were too difficult to be aged or which had been damaged in transit were assigned the mark "-". Doubtful ages were included in the analysis.

Otoliths damaged in transit and those readings in which a mode was not obtained were excluded from the analysis, and so 195 otoliths from Division VIIIab, 245 otoliths from Division VIIIc and 200 otoliths from Sub-division Ixa North have been included in the analysis.

The comparison of otoliths from the three areas was made separately. An Excell spreadsheet was used for this purpose (Eltink, 1994).

From each otolith, mean age, mode, range and standard deviation have been estimated. The percentage of agreement between individual readers, the mean percentage of agreement of each reader compared to all readers and the mean percentage of agreement of all readers have been calculated. Those readers who have a higher mean percentage of agreement with all readers than the mean agreement of all readers are considered the "best" readers.

The cumulative age composition as a percentage has been calculated so that it is independent of the number of otoliths unread by each reader, and the age composition in number of each reader, of all readers (based on the modes obtained from all readers) and that of the best reader (based on the modes obtained for the best readers) have also been calculated. The cumulative age composition shows which readers are closer to agreement and the ages at which agreement is lower.

The percentage of disagreement by one year and by two or more years in the age readings of each reader compared with the rest of the readers have been calculated. Furthermore, the mean disagreement by one year and by more than two years of each reader and the mean disagreement by one year and by more than two years of all readers have also been calculated.

The mean length at each anchovy age was estimated by each reader to show differences in growth curves obtained for each reader and to diagnose individual reader tendencies.

Functional regressions have been made between age readings of each reader. Readers whose age readings show a close agreement will have values of 1 and 0 for the slope and intercept respectively.

The frequency distribution of standard deviations of estimated ages has also been estimated. The standard deviations have been ordered by age groups (0, 1, 2, 3, 4 and 5) for all readers and for the best readers.

In addition to all these comparisons made on the spreadsheet, the age bias plot has also been performed, in which the mean recorded age ± 2 standard deviations for each reader and all readers combined is plotted against modal age.

This last method is one of the procedures recommended by the Workshop on Sampling Strategies for age and maturity (Anon., 1994).

RESULTS

1- Division VIIIab otoliths exchange sample

The readings of each reader together with the basic information concerning each otolith (year, sample number, otolith number, fish length and month of capture) are shown in Table 1.1, as are the mean age, mode, range and standard deviation for each otolith. Of the 195 otoliths examined, 194 were assigned an age by all readers and 110 were assigned the same age by all readers.

Readers 2 and 3 have a higher average percentage of agreement with all readers than the average general percentage of agreement (see Tables 1.1 and 1.5) and are considered the best readers.

Table 1.2 shows the cumulative age composition as a percentage for each individual reader, for all readers and for the best readers.

In Table 1.3 the age composition in number for each reader is shown. In Figure 1.2 the ageing of each reader can be compared with the ages obtained from the modes of readings of the best readers.

The average length by age of each reader is shown in Table 1.4 and Figure 1.3 . The readers show higher agreement at ages 1 and variability is greater at age 3.

The percentage of agreement between readers is presented in Table 1.5 and varies between 59% and 88%. Taking into account the few ages read, the average general percentage of agreement of all readers is low (71%). The highest agreements are found in readers 2 and 3 (88%) . Reader 1 has a lower average percentage of agreement than the average general agreement.

The average general disagreement by 1 year is 29% (Table 1.6). The highest diagreements are found in reader 1 (38%).

There is no disagreement by 2 or more years between readers (Table 1.7).

If the otoliths were read using the same criteria, the functional regression slope should be 1 and the intercept should be 0. The values of regression obtained (Tables 1.8 and 1.9) show a high level of agreement between readers. The greatest deviations were found in reader 1.

Nevertheless, disagreements are better illustrated by calculating the standard deviations by age group. In Figure 1.4 the frequency distribution of the standard deviations has been drawn based on the readings of all readers, providing information on the current level of precision of readings by age groups and showing how the standard deviations increase for ages >2 years. In Figure 1.5 the frequency distribution of the standard deviations has been drawn based on the readings of the best readers, providing information on the maximum level of precision of readings by age groups and showing that the standard deviations diminish in all age groups in comparison with Figure 1.4.

Figures 1.6 and 1.7 show the age bias plots by reader and all readers combined. Reader 1 tends to overestimate age 1 and considerably underestimate from age 2. All readers combined tend to underestimate ages 2 and 3. The confidence intervals increased from the youngest ages to the oldest ages. This is especially evident in the age bias plot of all readers combined. Table 1.10 shows, for each modal age, the mean age recorded, 2* stdev and the number at ages read by each reader and by all readers.

2- Division VIIIc otoliths exchange sample

The readings of each reader together with the basic information concerning each otolith (year, sample number, otolith number, fish length and month of capture) are shown in Table 2.1, as are the mean age, mode, range and standard deviation for each otolith. Of the 245 otoliths examined, 242 were assigned an age by all readers and 170 were assigned the same age by all readers.

Reader 2 has a higher average percentage of agreement with all readers than the average general percentage of agreement (see Tables 2.1 and 2.5) and is considered the best reader.

Table 2.2 shows the cumulative age composition as a percentage for each individual reader, for all readers and for the best readers.

In Table 2.3 the age composition in number for each reader is shown. In Figure 2.2 the ageing of each reader can be compared with the ages obtained from the modes of readings of the best readers.

The average length by age of each reader is shown in Table 2.4 and Figure 2.3 . The readers show higher agreement at ages 2 and variability is greater at ages 0 and 3.

The percentage of agreement between readers is presented in Table 2.5 and varies between 77% and 82%. Taking into account the few ages read, the average general percentage of agreement of all readers is low (80%). The highest agreements are found in readers 1 and 2 (82%) .

The average general disagreement by 1 year is 19% (Table 2.6). The disagreement by 2 or more years between readers is very low, at 1% (Table 2.7).

If the otoliths were read using the same criteria, the functional regression slope should be 1 and the intercept should be 0. The values of regression obtained (Tables 2.8 and 2.9) show a high level of agreement between readers.

Nevertheless, disagreements are better illustrated by calculating the standard deviations by age group. In Figure 2.4 the frequency distribution of the standard deviations has been drawn based on the readings of all readers, providing information on the current level of precision of readings by age groups and showing how the standard deviations increase for ages >2 years and also for age 0.

Figures 2.6 and 2.7 show the age bias plots by reader and all readers combined. Reader 1 tends to underestimate age 2 and 3, reader 2 tends underestimate ages 1 and 3 and reader 3 tends to overestimate ages 0 and 3. All readers combined tend to overestimate age 0 and underestimate age 3. The confidence intervals increased from the youngest ages to the oldest ages. Table 2.10 shows, for each modal age, the mean age recorded, 2* stdev and the number at ages read by each reader and by all readers.

3- Sub-Division IXa North otoliths exchange sample

The readings of each reader together with the basic information concerning each otolith (year, sample number, otolith number, fish length and month of capture) are shown in Table 3.1, as are the mean age, mode, range and standard deviation for each otolith. Of the 200 otoliths examined, 198 were assigned an age by all readers and 190 were assigned the same age by all readers.

Reader 2 has a higher average percentage of agreement with all readers than the average general percentage of agreement (see Tables 3.1 and 3.5) and are considered the best reader.

Table 3.2 shows the cumulative age composition as a percentage for each individual reader, for all readers and for the best readers.

In Table 3.3 the age composition in number for each reader is shown. In Figure 3.2 the ageing of each reader can be compared with the ages obtained from the modes of readings of the best readers.

The average length by age of each reader is shown in Table 3.4 and Figure 3.3 . The readers show higher agreement at ages 1 and variability is much greater at age 2.

The percentage of agreement between readers is presented in Table 3.5 and varies between 94% and 97%. The average general percentage of agreement of all readers is 96%.

The average general disagreement by 1 year is 4% (Table 3.6). There is no disagreement by 2 or more years between readers (Table 3.7).

Disagreements are better illustrated by calculating the standard deviations by age group. In Figure 2.4 the frequency distribution of the standard deviations has been drawn based on the readings of all readers, providing information on the current level of precision of readings by age groups and showing how the standard deviations are very low.

Figures 3.6 and 3.7 show the age bias plots by reader and all readers combined. In this sample the level of bias is very low.

CONCLUSIONS

Taking into account the few ages read, due the anchovy being a species with a short life-span, the results of the present paper show a low level of agreement between the readings of the different readers in the Division VIIIab and VIIIc samples. Nevertheless, in the sample from Division Ixa North the percentage of agreement between readers is high, a fact which may be due to the sample consisting of specimens of one single age . Of the 640 otoliths examined, 634 were assigned ages by all readers, and in 470 otoliths was the same age was assigned by all readers.

The average lengths present higher agreement at age 1 and variability is greater from age 2. Furthermore, they show great variability at age 0 in Division VIIIc sample.

The average disagreements by 1 year between readers are lower in the sample from Division VIIIc (19%) than in the sample from Division VIIIab (29%). This may be due to the otoliths of the sample from Division VIIIab being badly mounted on the slides thus making their reading more difficult. In Division IXa North the average disagreements by 1 year between readers was very low (4%), the reason possibly being that already commented on at the beginning of this section.

There are no disagreements by 2 or more years between readers in any of the samples.

The values obtained from the functional regression indicate that the otoliths were read using similar criteria.

The standard deviations estimated by age groups increase from age 2 for the Division VIIIab and VIIIc area samples. In Division VIIIc the standard deviations also increase at age 0. When we consider the readings of the best readers, standard deviations diminish.

The age bias plots of each reader against the modal age show variability in the samples from Divisions VIIIab and VIIIc. The age bias plots for all readers combined show that bias increases with age, and that those from age 2 tend to be underestimated in Division VIIIab sample and that those of age 0 tend to be overestimated in Division VIIIc sample. In Division IXa North the level of bias is very low.

The absence of bias is a minimum requirement and in view of the results and considering the importance of age reading in the assessment, new investigations are necessary to increase agreement and to standardize ageings.

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