# Interpretation of second evaluation results of otolith age estimation (Japan)

第 2 回年齢査定試験の結果の解釈（Japan）

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## Summary

In the 2nd otolith exchange test, a consistency among members on age estimation is remarkably improved comparing to that in the 1st otolith exchange test. However, there were slight systematic differences in estimated ages among members. The variation of estimated age for the same otolith ranged ±50% with average of 12 %.

## 要旨

第 2 回の耳石交換による年齢査定試験では、前回に比較してメンバー間の年齢査定結果の一致は大幅に改善した。しかし各メンバーの推定年齢はわずかながらシステマティックに異なっていた。同じ耳石に対する年齢査定の差は±50%、平均 12%である。

## Introduction

Age estimation is important for stock assessment in the Scientific Committee of CCSBT. Each member of CCSBT has developed its age estimation method based on otolith which is the most reliable structure for age estimation. Although annual deposition of otolith increments has already been validated (Clear et al. 2000), otolith increment interpretations are ambiguous sometimes and criteria for identifying annual increment should be unified among members. So far, the criteria have been established through the 1st otolith exchange test in May 2002, and Age Estimation Workshop in June 2002, which was recorded as the CCSBT age estimation manual. The 2nd otolith exchange test was conducted from December 2002 to April 2003 to examine whether the established criteria could assure a consistency of estimated ages among members. This document is interpretation for the result of the 2nd otolith exchange test from Japan.

## Data presented

All of the members presented their results of age estimation. Ages of all otoliths exchanged ($n$=60) were estimated by all members except one that Australia decided not to give its age. Scales of readability were assigned for almost all otoliths by all members, but Australia did not assign readabilities for 20 otoliths, which prepared by Australia, as well as one otolith that Australia did not determined its age. Members assigned readability in different ways. Then, these are standardized as follows. Japan assigned readabilities in four steps such as A, B, C and D, which were replaced with 5, 3.5, 2.5 and 1.5, respectively. Readabilities used by Taiwan seemed to be in a reversed order to the others, which was fixed by shuffling the order, i.e. replacing 1 with 5, and 2 with 4. Korea used readabilities with three steps, and their 1, 2, and 3 were replaced with 2, 3, and 4, respectively. NZ often assigned two readabilities to one otolith. These were fixed by taking intermediate value such as ”2/1” and ”3/2” to 1.5 and 2.5, respectively.

The following two otoliths were noted to give anomalously varied age estimations among members. SBT-JA07: estimated age was 12 by Taiwan and 3-5 by other members. SBT-AU18: estimated age was 2.5 by Taiwan, 9 by Japan, and 4-6 by other members.

## Examined otoliths

Otoliths examined in the 2nd test were obtained from fish with 93-190 cmFL (Fig. 1). This covers the range of fish caught by longline. Estimated ages ranged from 2 to 33, and medians of age estimated for each otolith ranged from 3 to 29.

## Comparison of estimated age among members

Estimated ages by each member were plotted on Fig. 2. Here, the median of all members' readings was taken as a representative age estimation of the otolith. In general, all members give consistent age estimation. However, some systematic differences among members were observed. Against the median, ages estimated by Australia tended to be lower in age < 15 and higher in age > 15. Ages estimated by Japan were similar to the median ages. Ages estimated by Korea were substantially lower than the median in several otoliths of age >15. Ages estimated by NZ tended to be higher for age <15. Ages estimated by Taiwan were generally high in all ages.

An extent of variation in age estimation is shown in Fig. 3 along with the median age. Variation in age estimation from the median is expressed as following equation.

$$\text{Variation for each age estimation } = \frac{age - Median}{Median} \times 100$$

Standardized variation were almost constant as ±50% in all age range, although slight decrease with age increased was observed (Fig. 3). An average variation of estimated ages for each otolith among members was expressed as following equation.

$$\text{Average of variation } = \frac{1}{n}\sum_{i}^{n}\frac{|age_i - Median|}{Median}\times 100$$

All but two of otoliths examined had less than 30% of average variation (Fig. 4). No relationship between average variations and ages was observed. The mean of the average variations for otoliths excluding those two was 11.5 %.

The average variation for each otolith was plotted against the median of readabilities of the otolith (Fig. 5). There seemed to be no relationship between readabilities and averages variation. This suggests that variations in age estimation among members are not attributed to ambiguity of otolith increments.

Median and range of ages estimated for each fish were plotted against fork length (Fig. 6).

## Discussion

A consistency in age estimation among members is remarkably improved comparing to that in the 1st otolith exchange test. This indicates that the criteria for identifying annual marks in otoliths established at the Age Estimation Workshop work reasonably well.

The average variation of 12 % is observed in estimated ages. In addition, systematic differences of age estimation among members were observed.

Now will be the time for the CCSBT to consider how to utilize direct age estimation data to stock assessment with the understandings on its reliability obtained through this otolith exchange test. Two approaches would be effective for further work to improve a reliability of otolith age estimation. One is to seek the reasons of difference in age estimation among members in the 2nd otolith exchange test by observing each otolith carefully and collaboratively. The other way is using otoliths whose ages are known, or almost known, such as otoliths from tag-and-recaptured fish to improve identification criteria of annual marks. The number of otoliths marked with strontium chloride may not be sufficient with this purpose. The otoliths from tag-and-recaptured fish, which have remarkable check mark in otolith at the time of release, can also be used. This is important from two points; 1) to develop more reliable criteria for identifying annual marks, which aimed to be a consistent among members, based on materials with known true age, and 2) to resolve systematic differences in age estimation among members. It should be noted that there is no way to judge whose estimation is the most appropriate without having a substantial amount of evaluated materials.

Variation of age estimation among members will exist even when the criteria for identifying annual marks in otoliths established. It is important to monitor the degree of variation of age estimation among members, as well as inter- and intra-reader variation within a member. Procedures of age estimation assuming existence of variation in age estimation among members should be considered, e.g. the need for reading otolith by multiple members routinely, the need for regular otolith exchange tests, etc.

Reference

Clear, N. P., Gunn, J., and Rees, A. J. (2000). Direct validation of annual increments in the otoliths of juvenile southern bluefin tuna, *Thunnus maccoyii*, by means of a large-scale mark-recapture experiment with strontium chloride. Fishery Bulletin 98: 25-40

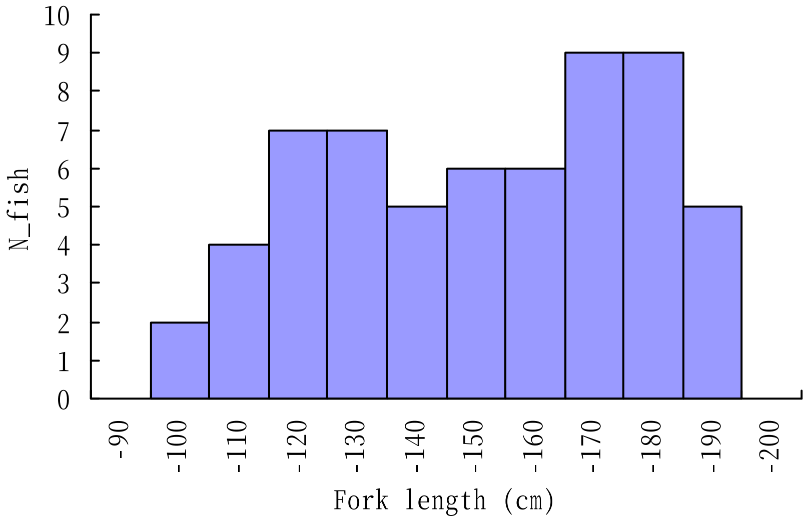


Fig. 1

Length frequency distribution of SBT whose otolith examined in the 2nd otolith exchange.

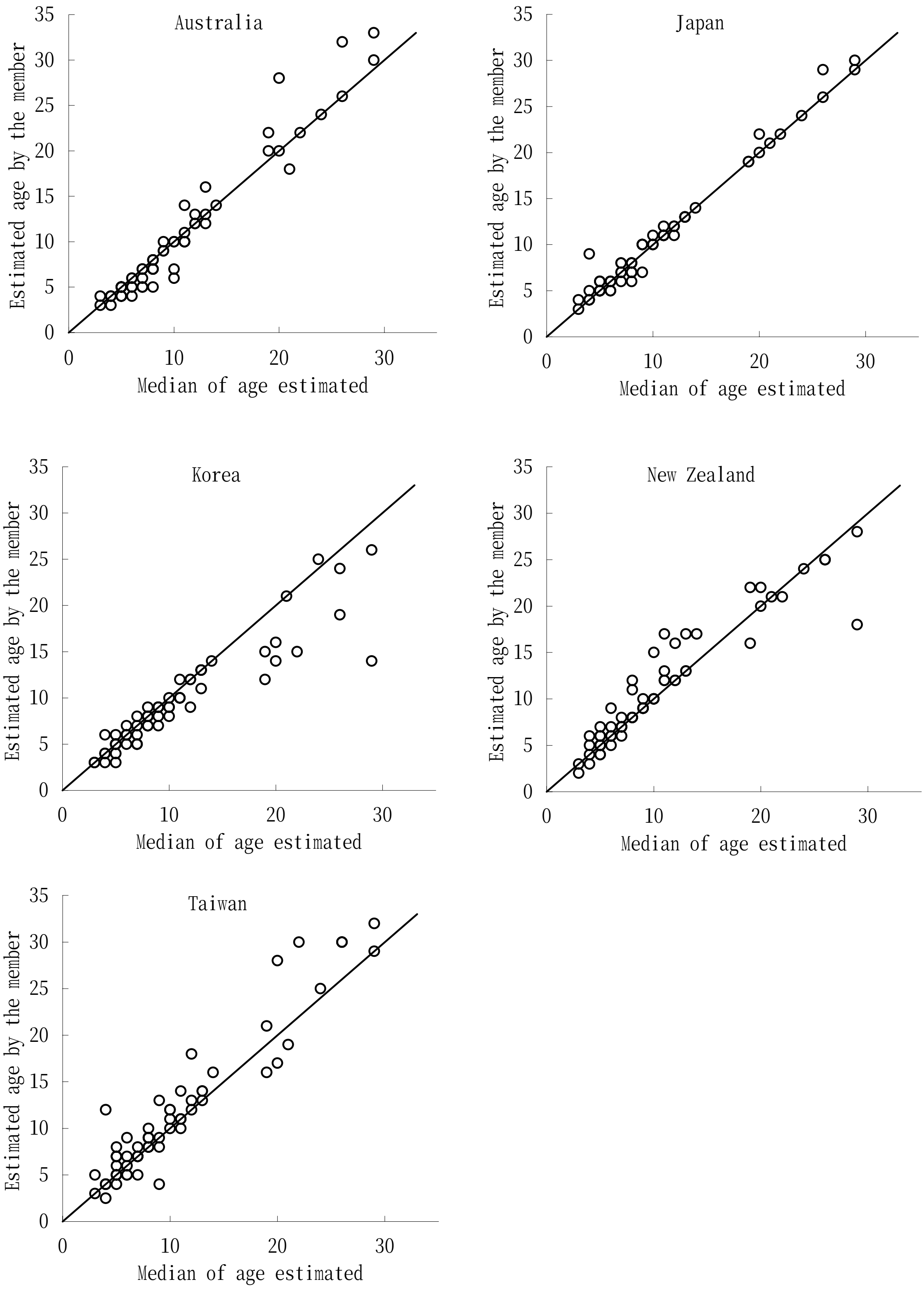


Fig. 2

Plots of age estimated by each member. Line is median of age estimated = age estimated by the member.

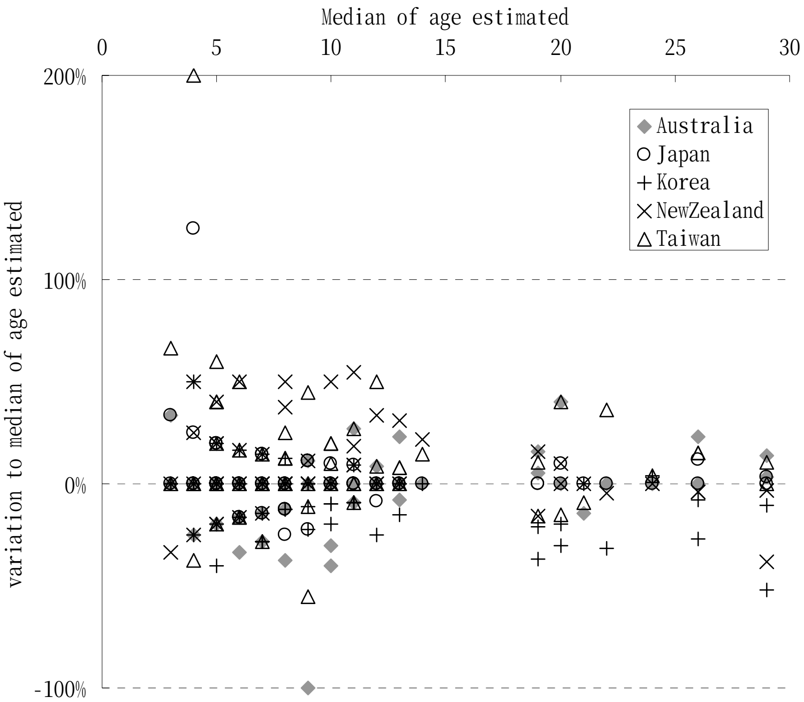


Fig. 3

Plots of variation to median of age estimated against median of age estimated.

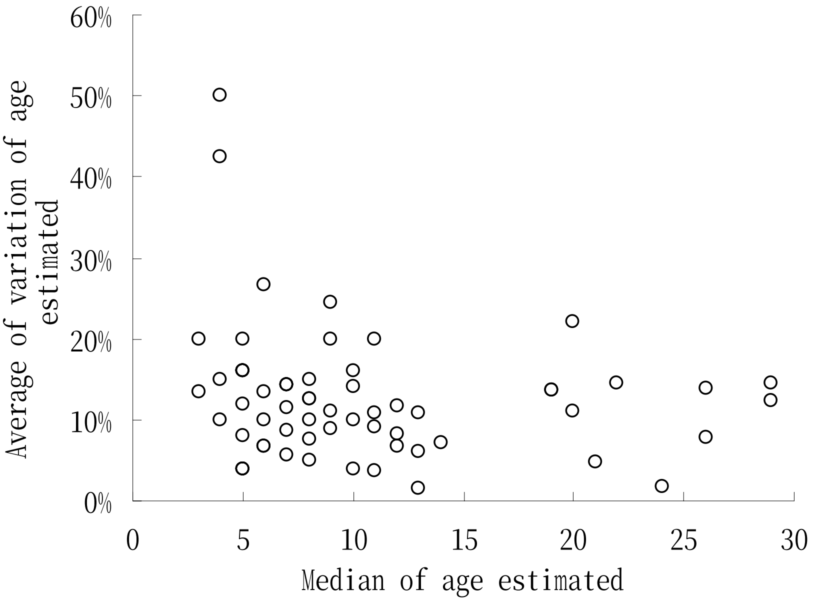


Fig. 4

Plots of average variation of age estimated against median of age estimated.

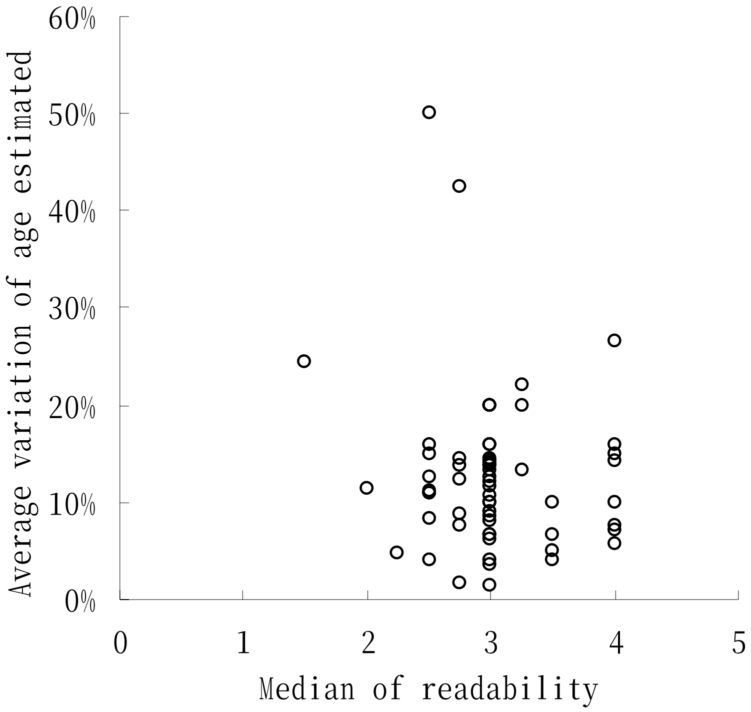


Fig. 5

Plots of average of variation of age estimated against median of readability.

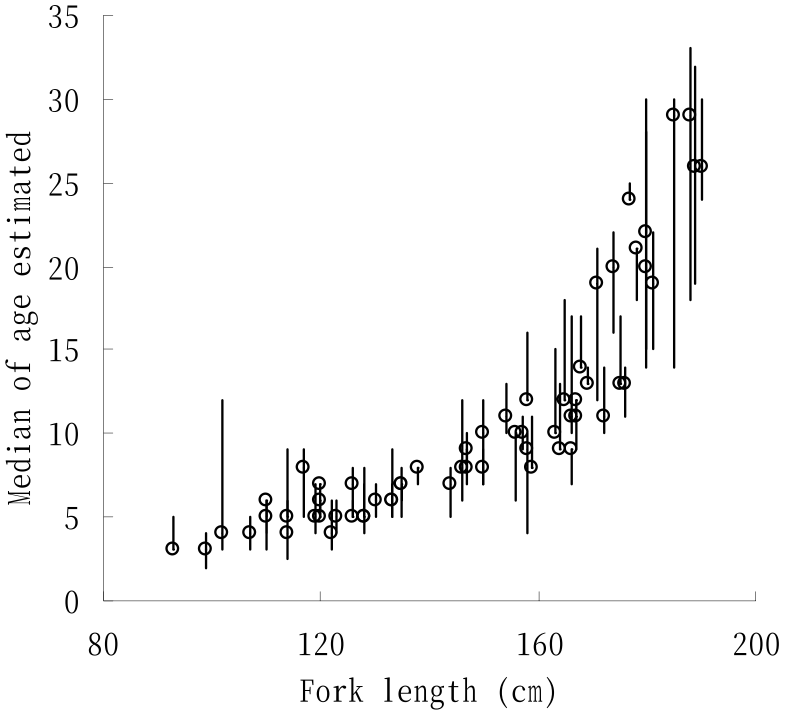


Fig. 6

Plots of median age estimated against fork length of the fish. Bar shows the range of age estimated.