Age and size composition of southern bluefin tuna (*Thunnus maccoyii*) caught by Taiwanese longliners in the central Indian Ocean

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Introduction

Southern bluefin tuna (SBT) have been fished since early 1950s mainly by Japan and Australia. New Zealand, Taiwan, Indonesia, and Korea started fishing SBT in 1970s. The Australian surface fishery targets the young recruitment in the Great Australian Bight (GAB); the Japanese and New Zealand-Japan chartered longline fishery targets the adult individuals in the southern oceans and in the New Zealand coastal waters, respectively. Korean fishing ground is roughly overlapped with Japanese fishing ground in the southern oceans. Taiwanese longline fishery targets mostly the young SBT across the central Indian Ocean (Gunn et al. 2003).

The Australian surface fishery in the GAB was dominated by 2 to 4 year-old SBT. The Japanese catches of SBT in the southern oceans comprised 2 to 30+ year-old fish (Gunn et al., 2003). However, the information on age and size structure of SBT across central Indian Ocean is very spare and incomplete. Furthermore, there were very few direct ageing data of SBT available from the central Indian Ocean. The only indirect data of age composition estimated from parts of Taiwanese longline fishery by Gunn et al. (2003) were dominated by 3 and 4 year-olds. These age composition data were compiled from weight-length relationship and age-length key.

To have a more comprehensive understanding of SBT population structure in the central Indian Ocean, this study reports 3-years commercial catch-at-age data of Taiwanese longline fishery. Central Indian Ocean was predominantly exploited by Taiwanese longliners and the commercial catch data was mostly useful to understand the SBT population in this area. SBT otoliths collected from the central Indian Ocean were examined to provide the direct evidence of the age composition. The increasing knowledge derived from Taiwanese catches will be helpful in understanding the SBT stock and conservation of this species.

Methods and Materials

Otolith collection

The scientific observers were deployed in the longline vessels to collect the samples and fishery data since 2002. Once the SBT was caught, their dressed weight and fork length (straight line distance from the tip of the upper jaw to the fork of the tail) were measured after the fish were cleaned of gills and the viscera. The otoliths were extracted by a hole-saw and drill to reduce the damage on the fish body to the minimal. The otoliths were cleaned immediately after extraction. After air-drying, otoliths were stored in the plastic eppendorfs. Each scientific observer was requested to collect otoliths from every SBT on board until the goal of 100 pairs of otolith collection was achieved. Otoliths were not collected in the first year of the scientific observer program in 2002, but the fork lengths of 591 individuals were measured on 2 longline vessels. Otoliths of 102 individuals were collected on a longline vessel in 2003 and 316 pairs were collected on 3 longline vessels in 2004. There is no specific requirement for the size composition of SBT sampled for otolith due to the uncertainty of SBT capture and shortage of the scientific observers.

Preparation of otolith section for age estimates

To prepare the otolith thin section and to conduct the direct ageing, we generally followed the disciplines given in the "Manual for age determination of southern bluefin tuna *Thunnus* maccoyii (anonymous 2002)".

Results

Otolith collection and size composition of SBT

In 2002, there was no otolith collected but fork lengths of 591 SBT were measured by the scientific observers. The mean fork length was 123.3 ± 19.3 cm. In 2003, an observer collected otoliths from 102 SBT individuals, which were caught around 30 – 32 °S and 67 – 89 °E from Indian Ocean. The mean length and weight of these 102 SBT individuals were 129.2 ± 21.6 cm (range: 92 - 177 cm) and 34.3 ± 17.0 kg (rang: 12 - 76 kg), respectively. In 2004, 316 pairs of SBT otoliths were collected around 29 – 32 °S and 65 – 90 °E on 3 fishing vessels. The mean length and weight of these SBT were 117.1 ± 14.6 cm (range: 87 - 170 cm) and 26.7 ± 10.8 kg (range: 11 - 79 kg), respectively. The length and weight of SBT sampled for otolith almost covers

the full size range of the total catch in each year. In the years of 2002, 2003 and 2004 the fork lengths of total length show a normal distribution with a mean length about 120 -130 cm (Fig. 1). The size 80 – 190 cm consisted of approximately 99% of the total catch. The dressed weights of total length was skewed to small size with a mean weight about 30 kg. The size 20 – 90 kg consisted of approximately 99% of the total catch (Fig. 2).

Age composition

The estimated age of the otoliths collected in 2003 (n = 102) ranges from 2 to 15 year old with mean age of 5.2 ± 3.1 (SD) while the estimated age of the otoliths collected in 2004 (n = 199) ranges from 2 to 27 year old with mean age of 6.4 ± 3.2 (Fig. 3). The total aged SBT cannot represent the real age composition of the total catches in Taiwanese longline fishery since the sampling is not based on the size composition of the total catches. However, the aged SBT individuals by reading otolith annuli provide the direct and solid data of the age range of the total catches.

The commercial catch data was transformed to age data according to the growth curve provided by Takahashi (personal comm.). The young SBT (<5 years) consisted of 30 – 40% of the total catches. SBT of 5 – 7 years consisted of 40 – 50% of the total catches. Adult SBT (> 7 years) consisted of approximately 10% of the total catches. The mean age of the total catches are 4.4 ± 2.1, 5.2 ± 2.4 and 4.9 ± 1.9 years in 2002, 2003 and 2004 (Fig. 4).

Geographic difference of size and weight at catch

Taiwanese longliners targeted for SBT bounded by 25 - 40 °S and 45 - 110 °E in the southern Indian Ocean. In the central Indian Ocean, fishing was mainly operating in austral winter while fishing was operated in austral summer in the southeastern Indian Ocean. The mean dressed weight and fork length at catch were stratified by 5 × 5 degree square and months. SBT caught across this area were predominantly immature fish less than 50 kg dressed weight or less than 150 cm fork length. The sizes were similar across all fishing ground, except the southeastern Indian Ocean around 35 - 40 °S and 95 - 105 °E. SBT caught in southeastern Indian Ocean were relatively larger fish (50 - 100 kg and 150 - 180 cm). SBT in this size rang was considered mature fish. The mean size and weight does not show apparently geographical trend, excluding the southeastern Indian Ocean.

Summary

The estimated age composition of SBT in this study is in agreement with previous studies (Gunn et al. 2003) that suggest most SBT caught in the central Indian Ocean are immature individuals. The young individuals of age 2 – 4 account approximately 30 - 50% of the total catch. The larger immature individuals of age 5 – 7 account approximately another 40 – 50 % of the total catch. The remaining 10 – 20 % of the total catches were the individuals order than age 8. Majkowski and Hampton (1983) found that the estimated age classes based on age-length relationship became unreliable after age 14. The most reasonable explanation for this high uncertainty is due to a reduction in growth rate, high overlap in length distribution and a lower length-dependent predictive powder. More than 99% SBT in Taiwanese catches are younger than 14 years. Therefore, age-length key based method to compute SBT age structure in Taiwanese catches is useful and reliable.

Reference

Anonymous (2002) A manual for age determination of southern bluefine tuna *Thunnus maccoyii*: otolith sampling, preparation and interpretation. Technique report of the direct age estimation workshop of the CCSBT.

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Majkowski J, Hampton J (1983) Deterministic partitioning of the catch of southern bluefin tuna, *Thunnus maccoyiii*, into age classes using an age-length relationship. In proceeding of the international workshop on age determination of oceanic pelagic fishes: tunas, billfishes, and sharks. US Department of Commerce, NOAA Technique Report NMFS 8: 87-90.

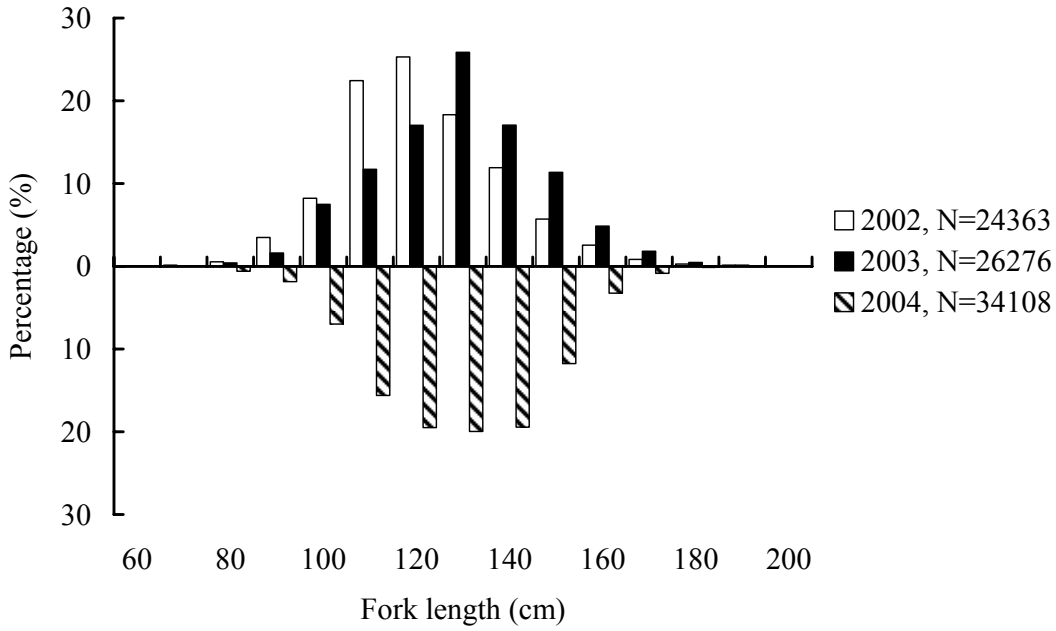

Figure 1. Length frequency distribution of the SBT caught by Taiwanese longliners in 2002, 2003 and 2004.

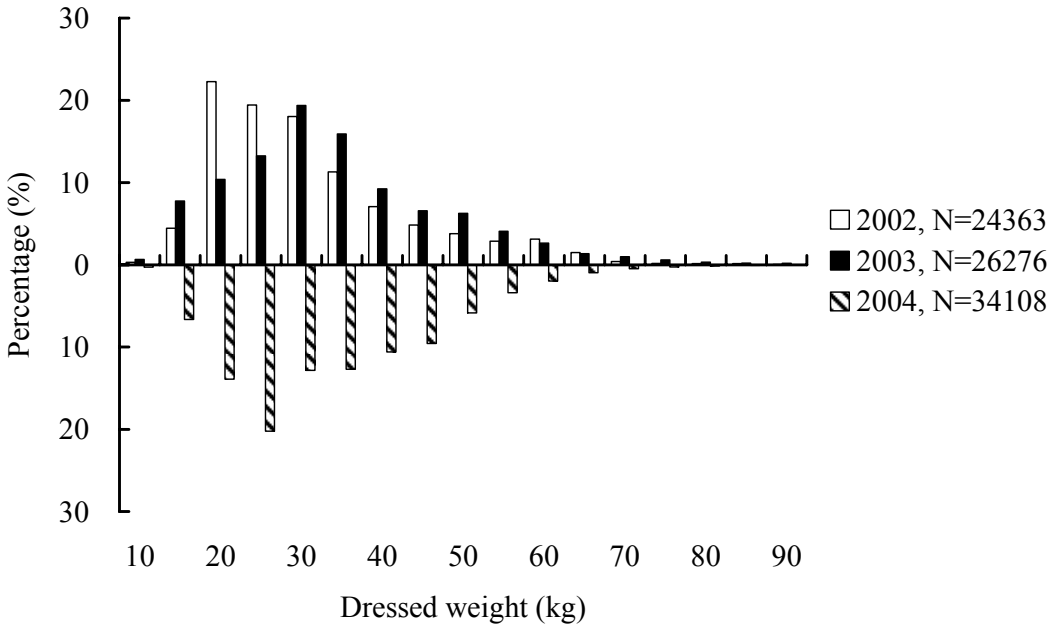

Figure 2. Weight frequency distribution of the SBT caught by Taiwanese longliners in 2002, 2003 and 2004.

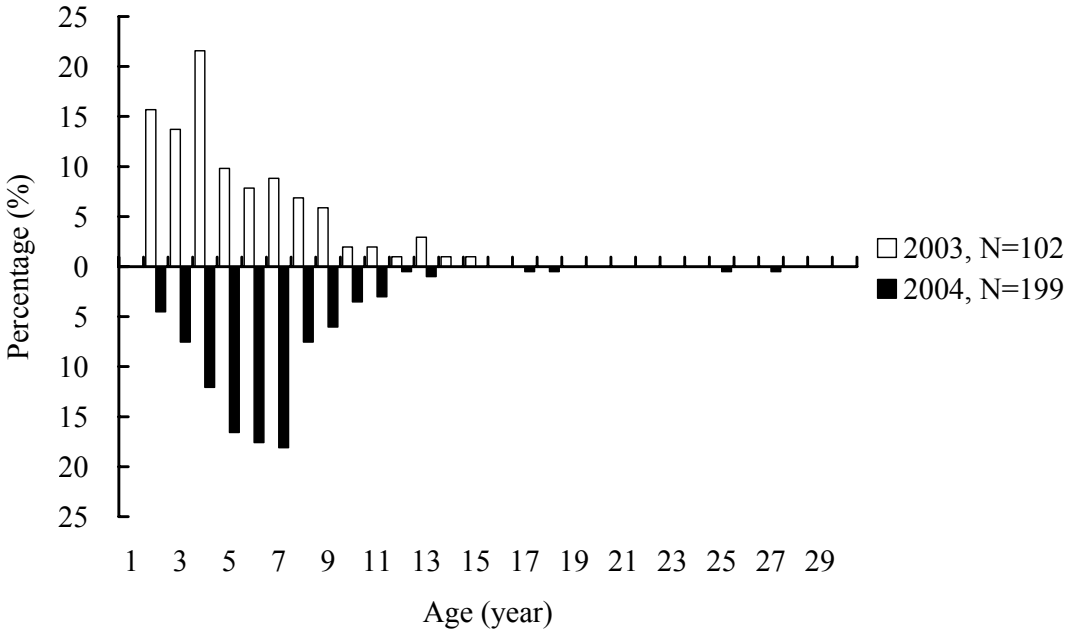

Figure 3. Age composition of the SBT sampled for otoliths in 2003 and 2004.

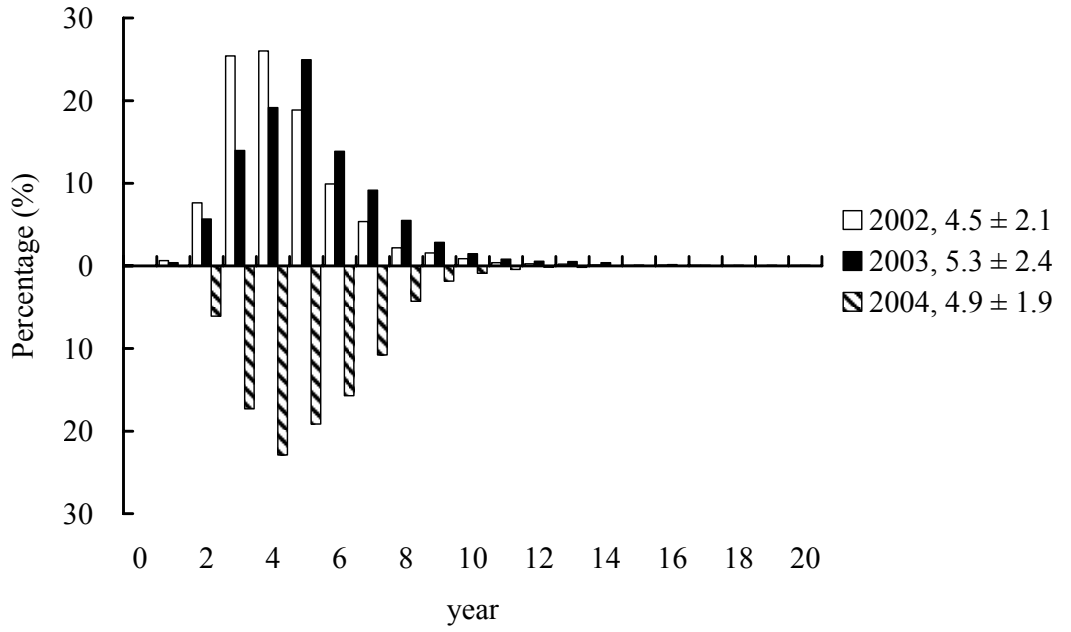

Figure 4. Age composition of the SBT caught by Taiwanese longliners in 2002, 2003 and 2004.