Early growth of juvenile albacore, *Thunnus alalunga* based on increments in sagittal otolith

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Abstract

In the present study, early growth of juvenile albacore *Thunnus alalunga* was deduced by analyzing otolith increments of 80 specimens (24.3 to 117.3 mm SL) collected by midwater trawling in the sub-tropical western Pacific from 2015 to 2017. Increments on the transverse plane were counted by otolith-measuring system equipped with a light microscope. If the number of increments is verified as daily growth, then the growth rate could be calculated as 3.8 mm/day in 2015, 5.5 mm/day in 2016, 1.1 mm/day in 2017 based on the regression line.

Introduction

Study of early growth facilitates a better understanding of recruitment process in populations (Bergenius et al., 2002; Takahashi and Watanabe, 2004). The daily increments of otolith are known as a useful tool to investigate the growth of larva and juvenile of fishes, and tropical fishes with no clear annuli. Regarding young to adult albacore, the formation of daily increment in otolith has already verified based on otolith marking with oxytetracycline (Laurs et al., 1985). Chen et al. (2002) also confirmed the annual rings of albacore was formed annually based on the deposition rate of outer margin and suggested the growth curve for young to adult fishes (over 50 cm FL). However early growth of albacore (less than 20 cm FL) has never been studied.

In this study, we examined otolith of juvenile albacore collected from the tropical and sub-tropical western Pacific to reveal the general microstructural pattern and to provide information on the early growth. The results could assist improvement of growth study of albacore in future.

MATERIALS AND METHODS

Sampling of juvenile albacore specimens

Juvenile albacore utilized in this study (n = 80) was collected in the tropical and subtropical western Pacific by midwater trawling during the research cruises of R/V Shunyo-Maru in 2015–2017 (Table 1, Figs. 1, 2). They were identified as albacore by morphological characters such as a black fin membrane of the first dorsal fin (Fig. 3) and mitochondria DNA analysis.

Otolith analysis

Procedure of otolith extracting and sectioning followed methodologies of Tanaka et al. (2017) and Nikolic et al. (2017), respectively. Both counting of the number of increments and measuring of increment widths were conducted using an otolith-measurement system (ARP/W; Ratoc System Engineering, Tokyo, Japan)

Result and discussion

Otolith microstructure

A microphotograph of the sectioned otolith of an albacore specimen (46.6 mm) is shown in Fig. 5 which are showing optically transparent and dense zones. These two bands were formed alternately and repeatedly formed. The nucleus was presented as a black point in the central region of the transverse plane (Figs. 4, 5). Initial increments were usually clear which width was 2 to 5 μm. The width of increments gradually increased in the seventh to 12th (5 to 15 μm) and the shape changed to arc-like, which was caused by an extension along ventral and dorsal edge. Regarding the increments after 12th, the width of increments varied from 15 to 47 μm along the growth axis.

Number of increments

Twelve to 33 increments were observed in the otoliths of juvenile albacore (24.3-117.3 mm). A positive correlation and linear relationship between SL and the number of increments were recognized (Fig. 6). Thought daily formation of the increments has not been validated in the juvenile albacore, the growth rate was calculated as 3.8 mm/d in 2015, 5.5 mm/d in 2016, 1.1 mm/d in 2017. The daily growth rate of juvenile albacore in 2015–2016 was approximately 3–5 mm. This growth rate resembles juvenile skipjack tuna that is known as a species with rapid growth in early stage (Tanabe et al., 2003). But daily growth rate of juvenile albacore in 2017 was slower than that of other two years (Fig. 6). The following factors might be considered as the reason; 1) differences of marine environment between years (e.g. sea surface temperature, intensity of chlorophyll); 2) difference of sampling season and location. To consider the difference of early growth among years, additional samples and continuous research should be required.

Future work

・Continuous sampling to cover more various season and area.
・Verifying the periodicity of increment formation based on the measuring of the marginal growth otoliths

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Table 1. Collection data for albacore specimens used for the sagittal otolith daily increment analysis.

Year	Data	Locations	*n*	SL (mm)
2015	Feb. 3 – Mar. 3; Nov. 6 – Dec. 21	12-13°N, 130–136°E	10	24.3–117.3
2016	May 17 – 28; Aug. 31 – Sep. 11	17-20°N, 135–140°E	18	24.8–109.6
2017	Nov. 9 – Dec. 15	8-22°N, 130–139°E	52	20.6–51.6

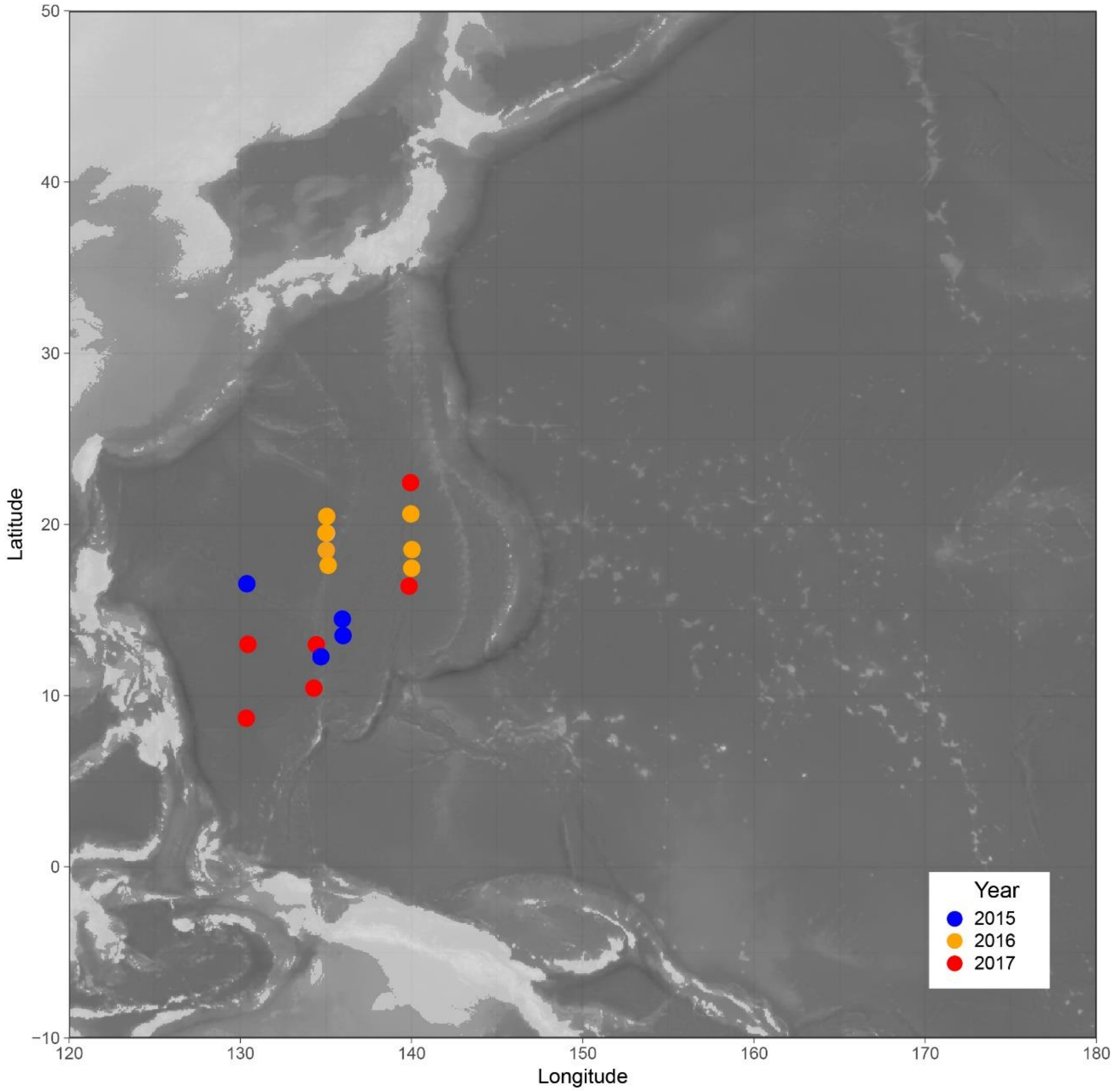

Fig. 1. Sampling locations of juvenile albacore in cruises by the R/V Shunyo-Maru.

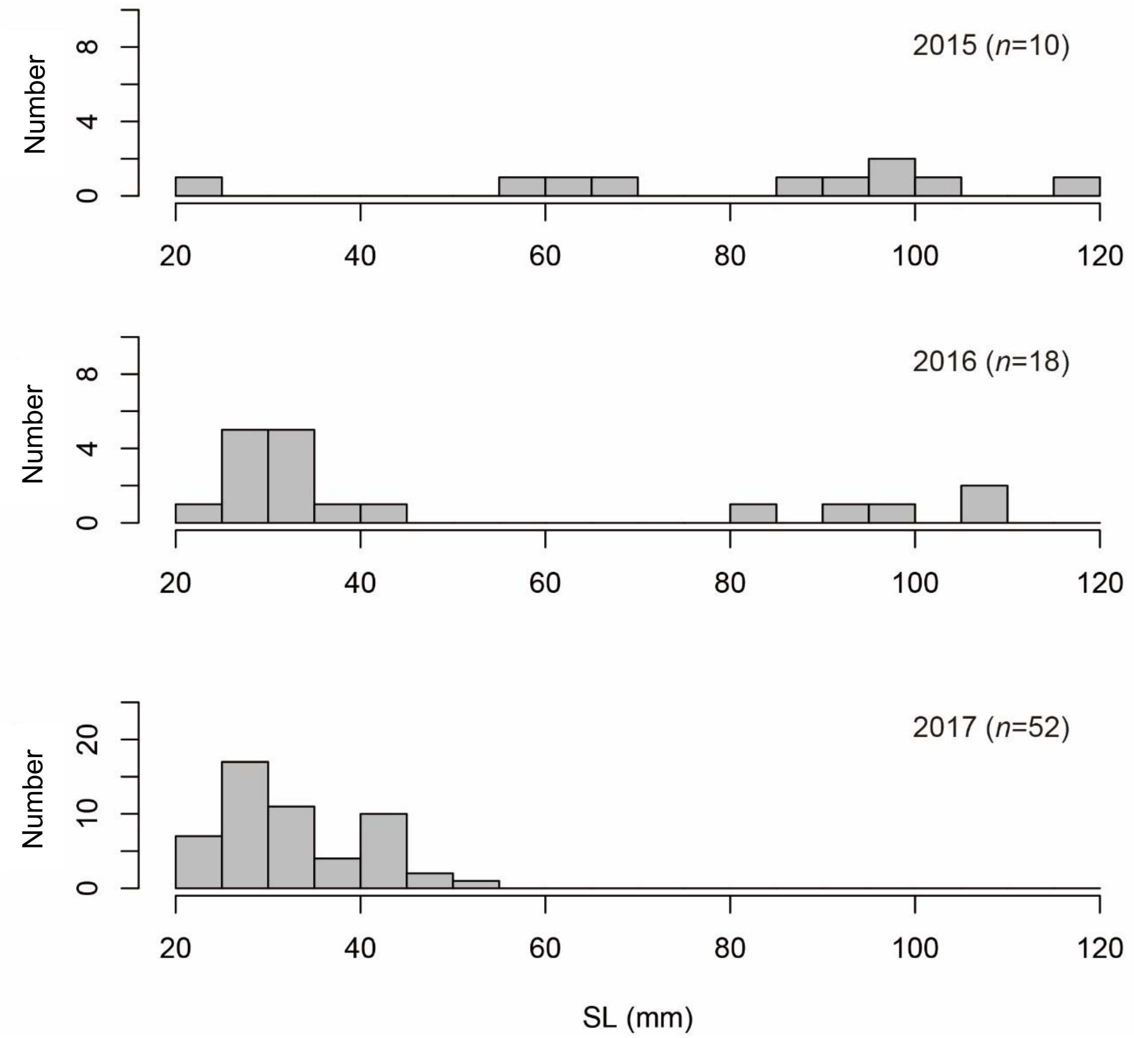

Fig 2 Size distribution of juvenile albacore used for the sagittal otolith daily increment analysis.

Fig. 3 Fresh condition of juvenile albacore *Thunnus alalunga,* 50.0 mm SL (SHU1703).

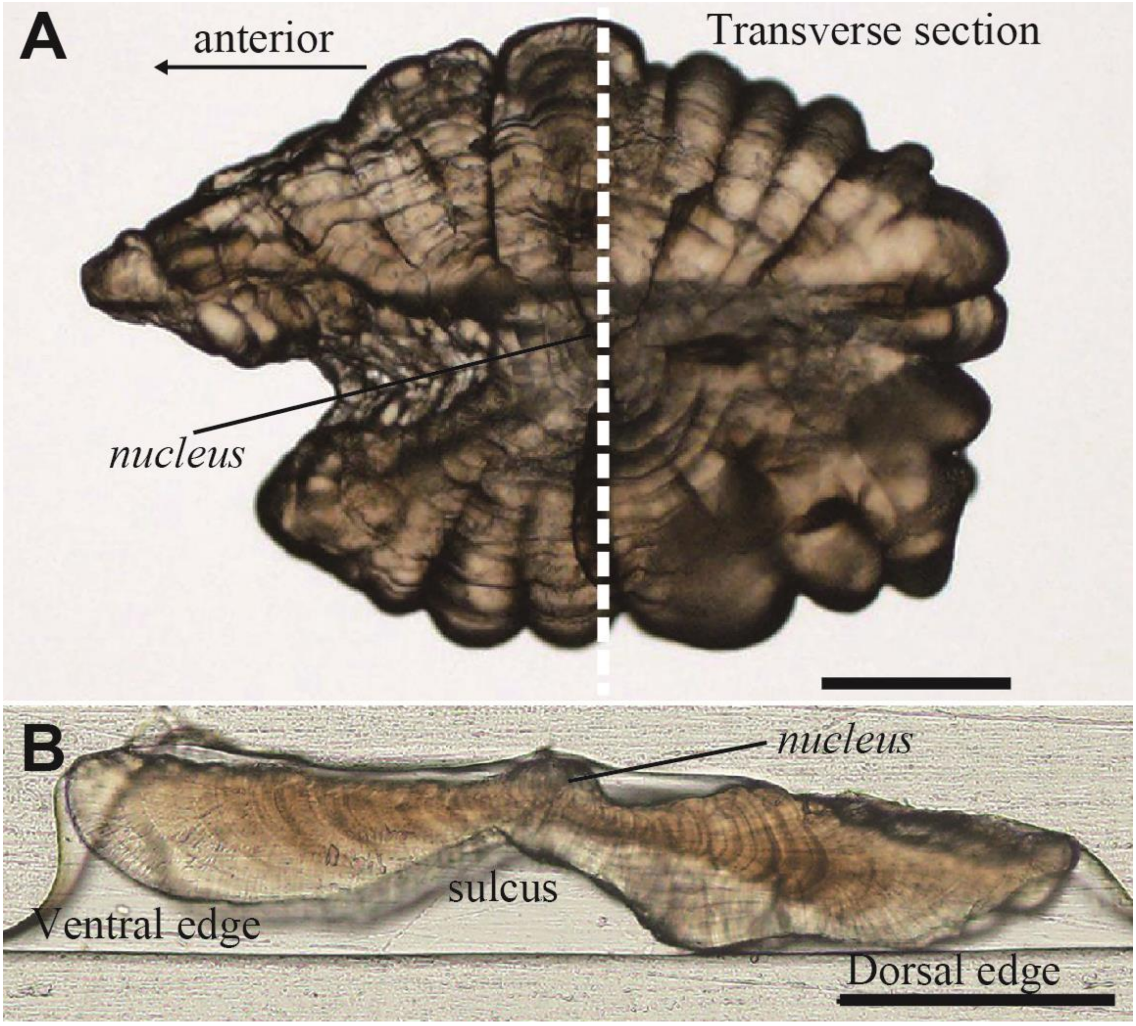

Fig. 4 Lateral view (**A**) and transverse section (**B**) of otolith of a 44.1 mm SL juvenile albacore. Ber in 200μm.

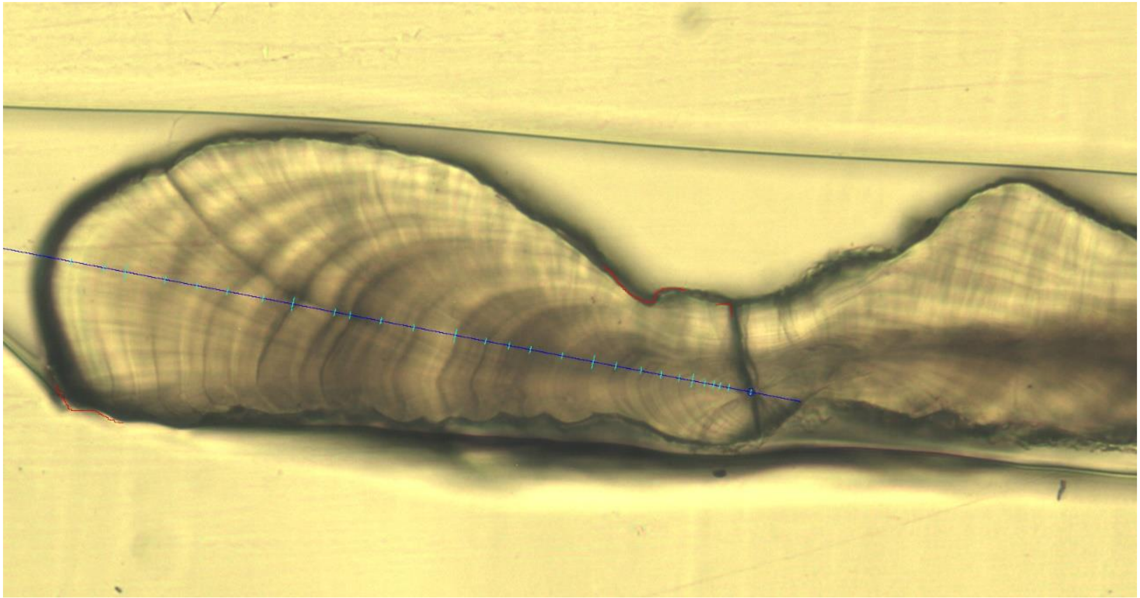

Fig. 5 Transmitted light micrograph of a sagittal otolith from a 46.6 mm standard length juvenile albacore *Thunnus alalunga*. The number of daily increments counted with the otolith measurement system was 27.

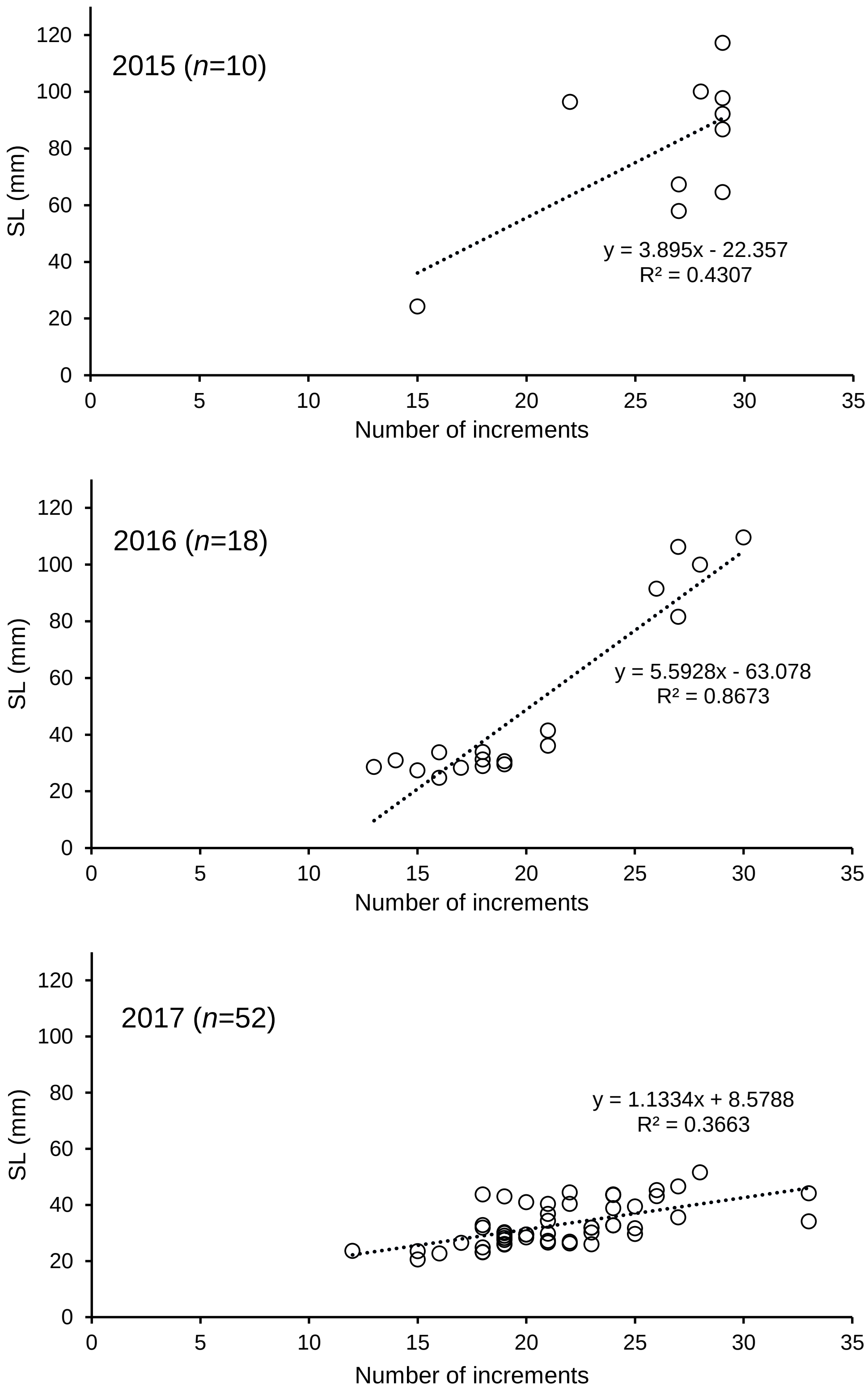

Fig. 6 Relationship between SL (mm) and the number of increments within otoliths of juvenile albacore.

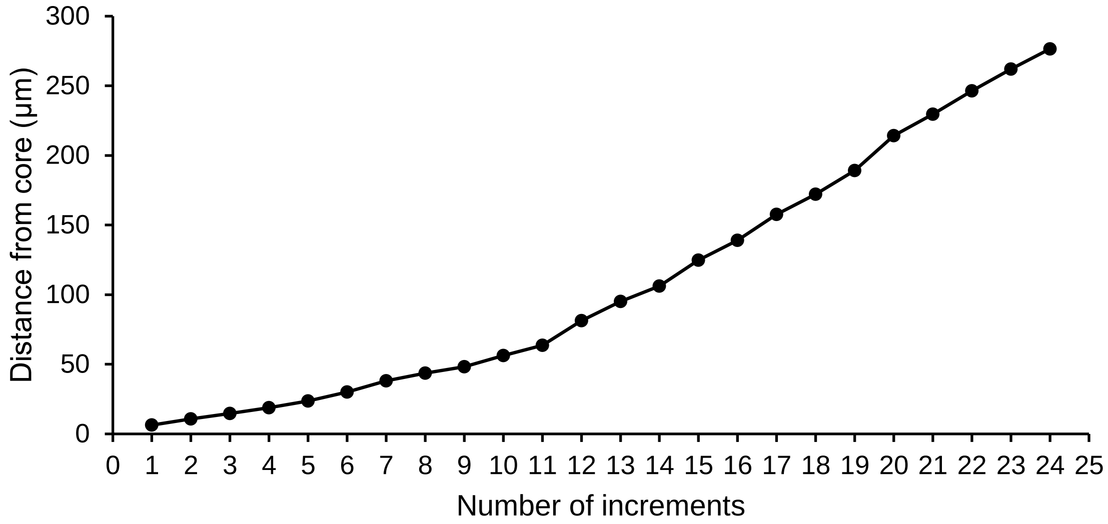

Fig. 7 Relationship between the number of daily increments and distance from the core in a sagittal otolith from a 32.7 mm SL juvenile albacore.