MORPHOLOGY OF RINGS ON OTOLITH AND SPINE CHARACTERS FROM NORTH ATLANTIC ALBACORE OF 40-44 CM FORK LENGTH

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SUMMARY

Otoliths from 10 northern Atlantic albacore of 40-44 cm fork length were collected and daily ring counts were taken. Four out of these 10 specimens were concurrently performing its respective 1st dorsal spine cross-section ring reading.

The otolith growth pattern of daily rings can be described as (1) a clear nuclei piled with constant oval shaped ring increment to about 12 counts, yet unfortunately, this segment was often lost; (2) followed by greater ring increment alongside the oval long axis direction for a period of time; (3) then followed by a sudden shifting of growth direction of about 60 degrees toward the oval short axis, in such a way that often produced a notch alongside the oval long axis. A In company with such growth pattern, four groups of daily ring gatherings can be identified.

The spine cross-section, on the other hand, a symmetric structure alongside the sagital plane was observed. In principle, the ring mark that appeared at each side of the two structures should be identical. Often it is not the case. It is thus postulated that the least, or a common denominator, count of ring mark should be viewed as the most appropriate figure for the specimen. Judged by the totality of a spine cross-section ring mark, all four specimens contain only one ring, which is roughly at 200-250 daily ring counts of the same individual. Although evidence that the spine 1st ring mark corresponds to a growth pattern change in daily rings seems to exist, further confirmative analyses are still needed.

RÉSUMÉ

Des otolithes de 10 germons de l'Atlantique nord de 40-44 cm de longueur à la fourche ont été collectés et les comptages quotidiens des anneaux ont été réalisés. On a procédé à la lecture simultanée de l'anneau de la section transversale de la première épine dorsale respective de quatre de ces dix spécimens.

Le schéma de croissance de l'otolithe des anneaux quotidiens peut être décrit comme (1) un noyau clairement identifié par une structure ovale constante caractérisée par un incrément d'anneaux tous les 12 comptages environ, même si, malheureusement, ce segment est souvent perdu ; (2) suivi d'un plus grand incrément d'anneaux le long de l'axe ovale longitudinal plus long pour une certaine période de temps ; (3) suivi d'un brusque changement de la direction de l'axe longitudinal de la croissance de 60 degrés environ vers l'axe ovale plus court, de telle sorte qu'il se produit souvent une entaille dans l'axe ovale longitudinal plus long. Conjointement avec ce schéma de croissance, on peut identifier quatre groupes d'anneaux quotidiens.

Par ailleurs, dans la section transversale de l'épine dorsale, on a observé une structure symétrique le long du plan sagittal. En principe, la marque d'anneau apparaissant de chaque côté des deux structures devrait être identique mais ce n'est souvent pas le cas. On part donc du postulat que le comptage des marques d'anneaux le plus petit, ou un dénominateur commun, devrait être considéré comme le chiffre le plus approprié pour le spécimen. A en juger par la totalité des marques des anneaux de la section transversale de l'épine, les quatre spécimens ne comportent qu'un seul anneau, qui se situe environ entre les anneaux quotidiens 200-250 du même spécimen. Bien qu'il semble qu'il existe des preuves que la première marque d'anneaux

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de l'épine corresponde à un changement du modèle de croissance des anneaux quotidiens, il est nécessaire de procéder à de nouvelles analyses le confirmant.

RESUMEN

Se recogieron otolitos de 10 ejemplares de atún blanco del Atlántico norte de 40-44 cm de longitud a horquilla y se realizaron recuentos de anillos diarios. Se realizó simultáneamente la lectura del anillo de la sección transversal de la primera espina dorsal respectiva de cuatro de estos diez ejemplares

El patrón de crecimiento de otolito de los anillos diarios puede describirse como (1) un núcleo claramente identificado por una estructura oval constante caracterizada por un incremento de anillos aproximado cada 12 contajes, aunque, desafortunadamente, este segmento a menudo ha desaparecido, (2) seguido por un incremento mayor de anillos a lo largo del eje oval longitudinal para un periodo de tiempo; (3) seguido por un repentino cambio en la dirección del eje longitudinal del crecimiento de unos 60º hacia el eje oval más corto, de tal manera que a menudo se produce un nodo en el eje longitudinal mayor. Junto a este patrón de crecimiento, pueden identificarse cuatro agrupaciones de anillos diarios.

Por otro lado, en la sección transversal de la espina dorsal, se observó una estructura simétrica al lado del plano sagital. En principio, la marca de anillos que aparecía a cada lado de las dos estructuras debería ser idéntica, pero a menudo no fue éste el caso. Por tanto se postula que el menor, o un denominador común, de los recuentos de marca de anillos debe considerarse como la cifra más apropiada para el ejemplar. A juzgar por la totalidad de las marcas de anillos de la sección transversal de la espina, los cuatro especimenes contienen sólo un anillo, que aproximadamente se halla entre los anillos diarios 200-250 del mismo ejemplar. Aunque parece existir evidencia de que la primera marca de anillos de la espina corresponde a un cambio en el patrón de crecimiento de los anillos diarios, es necesario realizar estudios adicionales que lo confirmen.

KEYWORDS

North Atlantic albacore, otolith, spine, morphology

1. Introduction

As far as the age and growth of northern albacore is concerned, age characters as otoliths (Fernández, 1992); vertebrae (Figueras, 1957; Fernández, 1992); spines (Bard, 1981; González-Garcés and Fariña, 1983; Santiago and Arrizabalaga, 2005); and scales (Yang, 1970; Bard, 1973) as well as tagging techniques (Ortiz de Zárate and Rodriguez-Cabello, 1992; Ortiz de Zárate *et al.* 1994; Anon. 1996; Ortiz de Zárate and Parrack, 1996; Ortiz de Zárate and Restrepo, 2001) have been used and successfully provide needed growth parameters. Nevertheless, a hard proven on which is the first annulus of northern albacore is still a very interesting topic yet to be confirmed.

It is well acknowledged that otolith daily ring marks can provide valuable life history information, in particular, its early life history of a species. Acquisition on small albacore in an ocean is thus became one of the priority to be undertaken for clarifying the aforementioned purpose. Fortunately, specimens of otoliths and 1st dorsal spines of 10 northern Atlantic albacore with size of 40-44 cm fork length were successfully sampled recently in Biscay Bay by the *Instituto Español de Oceanograía*. The ring reading methods, jointly performed by the Institute of Oceanography of the National Taiwan University and by the *Instituto Español de Oceanografía*, were then applied to acquire the daily ring counts on an otolith and the ring mark count on a spine cross-section.

The main purpose of this study is thus to compare morphologically the growth pattern and its meaning of the ring mark recognized on 1st dorsal spine cross-section versus its daily ring marks appeared on the otolith from

the same individual. The results thus obtained in this study hopefully can elucidate the biological meaning in correspondence with the earliest mark appeared on the age characters of this species.

2. Materials and ethods

2.1 Procedure on otolith treatment for daily ring count

The albacore otolith samples have been collected in the North Atlantic Ocean in September 2004. A total of 10 samples were read from albacore with a Fork Length size range of 40-44 cm. Otoliths were cleaned in bleach and rinsed in distilled water. After being dried in alcohol, otoliths were embedded in clear epoxy resin (Epofix kit). Otoliths embedded with resin were sectioned transversally on each side of the nucleus by using Isomet low speed saw. The location where transverse section will be made is shown in **Figure 1**.

The section was then attached to a microscope slide with thermoplastic glue. The upper face was ground with a 1200 wet sand paper and polished with 0.05 μm aluminum powder. When the nucleus was close to the surface, the section was returned on the glass slide and the section was ground and polished again until the nucleus was clearly observed. Using 5% EDTA (ethylene-diamine tetra-acetic acid, pH =7.2) buffer makes the daily increment rings, which will then be used to estimate age of days, more clear and identifiable. The daily increments observed on the section were counted with a light microscope under x800 magnification.

3. Procedure on spine treatment for ring mark count

In order to prepare the 1st dorsal spine cross-section for ring-reading, each individual spine specimen has to undergo the following procedure (1) boiled in tap water for about 1-2 minutes; (2) brushed off the adhesive membrane; (3) dipped in 3% KOH for 1-2 hours; (4) washed and dipped in tap water for another few minutes; and (5) sliced a 0.5-0.8 mm thin layer through the basal portion of the spine by using low speed saw. The diameter of a spine (D) was the distance between two outer margins above the posterior notch where the least curvature of banding occurred (Compean-Jimenez and Bard, 1983).

The i-th ring-radius (Ri) of a spine was then determined by the diameter of the i-th growth band (di) minus the radius of the spine (D/2). Since the central portion of a dorsal spine will become vascularized when fish gets older, hence those of being affected earlier historic marks or earlier rings will inevitably be lost. Likewise, the radius of the first readable growth band, R1, will thus become an indicator of the size of the central vascularized area. This central vascularization phenomenon appeared in the spine structure is the main difficulty has to be dealt with if any usage of spine character as an effective age character is intended. Fortunately, due mainly to young age of these specimens, the process of vascularization is still not yet to totally obscured its earliest center mark. None of sampled spine cross-section in present study is completely vascularized and unreadable.

4. Results and discussions

The fork length of North Atlantic albacore collected in this study ranged from 40 to 44 cm and weighted from 1.250 to 1.818 kg. Each otolith was processed by sectioning and polishing procedures in order to enhance the image for a clearer and comprehensive picture of the sagitta. The weight of the sagitta ranged from 0.0062 to 0.0087 g. The whole view and the nucleus area of albacore's left sagitta was used in this study, as shown in **Figure 2**. The primordium, which is considered as the origin or the commencing center for consecutive daily growth, was also easily acknowledged and visible as a spot **(Figure 3)**.

The daily increments included the accretion zone and discontinuous zone and were distinguished along the counting path from the core to the edge (Tanaka *et al.,* 1981). The increments count from primordium to the margin of sagitta was performed under the light microscope. The number of increment daily rings can be identified and ranged from 215 and 324 ring counts were observed for these 10 individuals with 40-44 cm fork length **(Table 1).**

Within these 10 sagitta specimens, four of them were able to get its corresponding dorsal spine cross-section image, which were kindly provided by the Instituto Español de Oceanografia. Cross-section image of a dorsal spine often appeared a two mirror-symmetric parts alongside the sagital plane. In principle, the ring mark appeared at each side of these two parts should be mirror-imaged identical. In some cases, it is not always true. It is thus postulated that the least, or a common denominator, count of ring mark should be viewed as the most appropriate figure for the specimen. Judged by the totality of a spine cross-section ring mark, all four specimens contain only one ring **(Figure 4),** which is estimated as a corresponding position at about 200-250 daily ring counts of the same individual. Although evidence that the spine 1st ring mark corresponds to a growth pattern shift in otolith's daily ring topography seems exist, further samplings on more small sized albacores are urgently needed for formulating a more confirmative conclusion.

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Table 1. Daily increment ring counts for 10 otoliths (sagitta) of northern Atlantic albacores.

Fish_ID	*Fork length (cm)*	*Weight (kg)*	*Otoliths weight(g)*	*Daily increment counts*
1	40	1.297	0.0069	215
5	42	1.527	0.0082	255
6	41.5	1.448	0.0072	281
7	40.5	1.439	0.0080	259
8	43	1.564	0.0081	250
10	43	1.800	0.0079	244
11	41.5	1.457	0.0083	227
12	44	1.818	0.0077	324
13	42.5	1.768	0.0085	275
14	42	1.424	0.0069	272
Total=10	40	1.297	0.0069	215

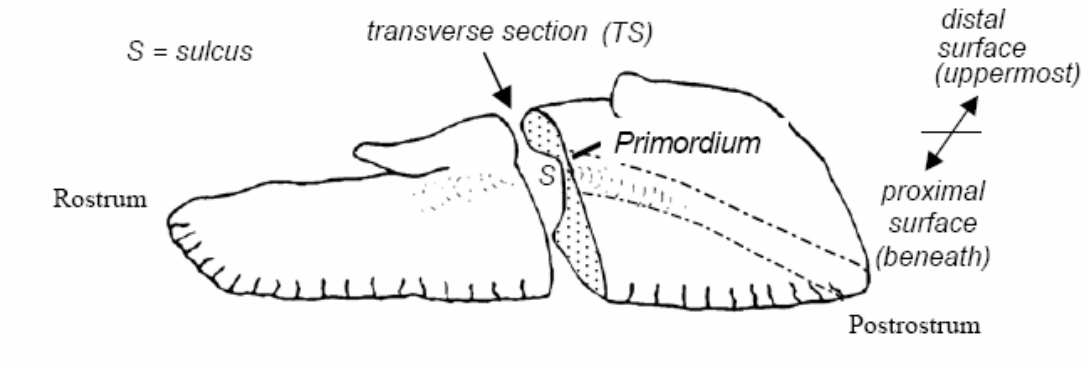

Figure 1. Left sagittal otolith of a southern bluefin tuna showing location of a transverse section (adapted from Rees *et al.*, 1996).

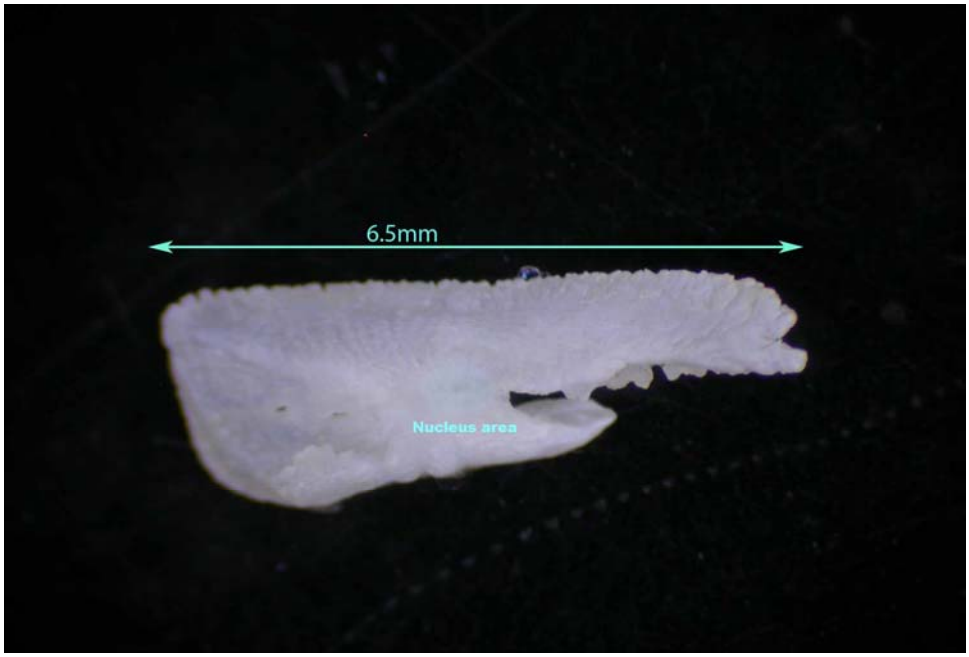

Figure 2. Left sagittal otolith of albacore in this study showing location of nucleus area.

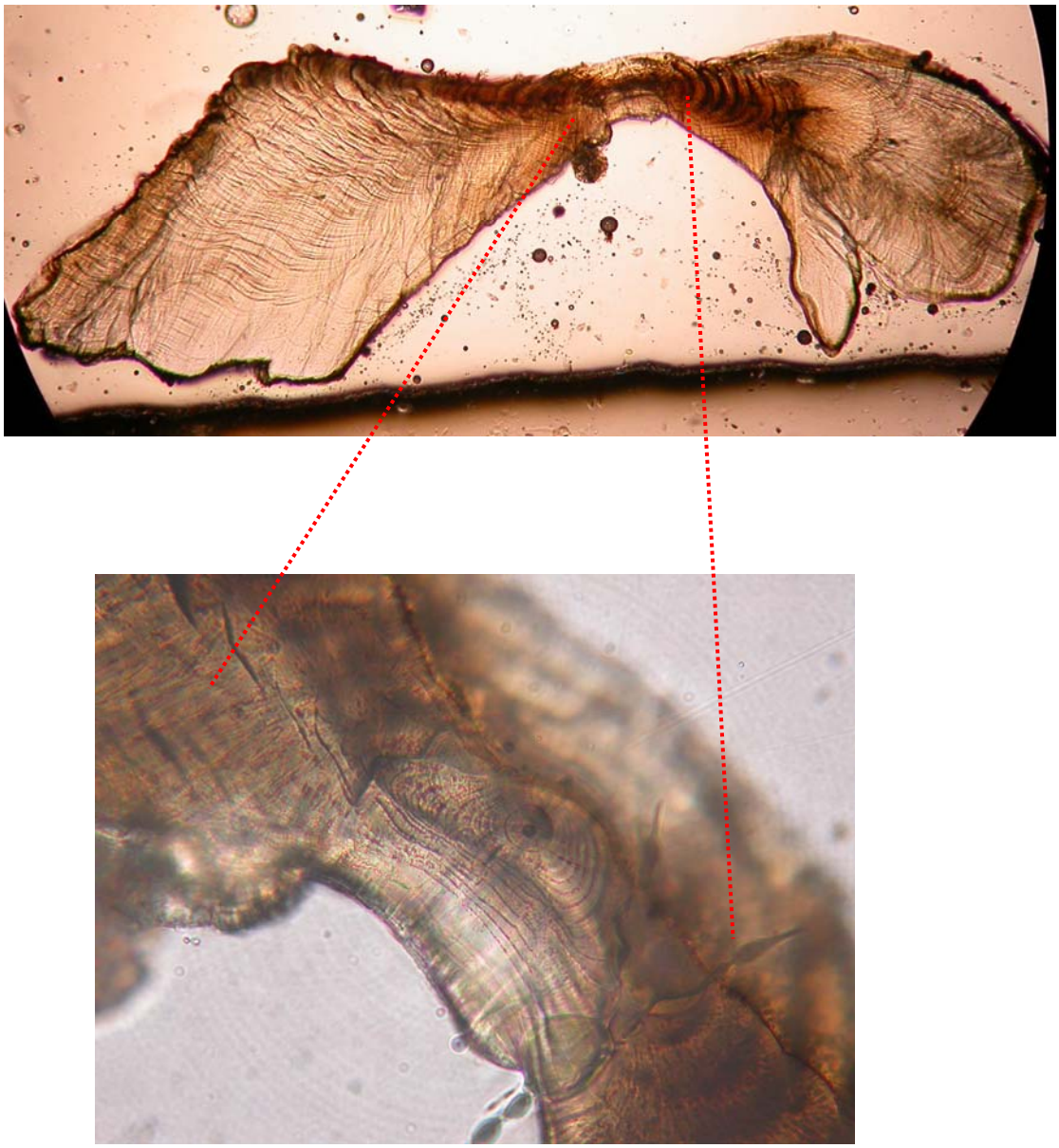

Figure 3. Microscopic image (x800) of sliced and polished otolith of north Atlantic albacore showing the nuclei and daily rings.