PRELIMINARY RESULTS OF THE AGE AND GROWTH OF LITTLE TUNNY (*EUTHYNNUS ALLETTERATUS*) IN THE SOUTHWESTERN ATLANTIC, BASED ON DORSAL FIN SPINES

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SUMMARY

Little tunny (LTA), Euthynnus alletteratus, *is an epipelagic and neritic species, distributed in tropical and subtropical waters as part of the small scombrids group, which are the target species of small and medium-scale fishing fleets, as well as by-catch of industrial tuna fisheries, with significant economic and ecological importance. Thus, this paper aims to present the preliminary results on the estimates of growth parameters of LTA from the southwestern Atlantic. Individuals were collected in two regions of the southwestern Atlantic Ocean, the northeastern and southeastern fishing areas off the coast of Brazil. We found a statistically significant and strong linear relationship between fork length (FL) and spine diameter (SD), represented by the equation (FL = 14.58 + 14.49 SD; R^2 = 0.95). We adjusted a growth equation using the von Bertalanffy equation, the paired data for FL and estimated age of 144 reliable slides (FL = 76.45 (1-exp$^{(-0.553(t+0.46)}$)). The sampling will continue aiming to expand the size range of individuals and assess potential differences in growth parameters across fishing areas off the coast of Brazil.*

RÉSUMÉ

La thonine commune (LTA) (Euthynnus alletteratus) *est une espèce épipélagique et néritique, répartie dans les eaux tropicales et subtropicales et faisant partie du groupe des petits scombridés, qui sont les espèces cibles des flottilles de pêche de petite et moyenne taille, ainsi que des prises accessoires des pêcheries thonières industrielles, avec une importance économique et écologique significative. Ainsi, ce travail vise à présenter les résultats préliminaires sur les estimations des paramètres de croissance de la LTA de l'Atlantique Sud-Ouest. Les spécimens ont été collectés dans deux régions de l'océan Atlantique Sud-Ouest, les zones de pêche du Nord-Est et du Sud-Est au large des côtes du Brésil. Une relation linéaire forte et statistiquement significative entre la longueur à la fourche (FL) et le diamètre des épines (SD), représentée par l'équation (FL = 14,58 + 14,49 SD ; R2 = 0,95), a été obtenue. Les données appariées de la longueur à la fourche (FL) et de l'âge estimé à partir de 144 lames fiables ont été ajustées à l'équation de von Bertalanffy, ce qui a donné l'équation de croissance suivante : FL = 76,45 (1-exp(-0,553(t+0,46)). L'échantillonnage se poursuivra afin d'élargir la gamme de tailles et de déterminer s'il existe une différence dans les paramètres de croissance entre les zones de pêche au large des côtes brésiliennes.*

RESUMEN

La bacoreta (LTA), Euthynnus alletteratus, es una especie epipelágica y nerítica, distribuida en aguas tropicales y subtropicales como parte del grupo de los pequeños escómbridos, que son la especie objetivo de las flotas pesqueras de pequeña y mediana escala, además de captura fortuita de las pesquerías industriales de túnidos, con una importancia económica y ecológica significativa. Por tanto, este trabajo pretende presentar los resultados preliminares sobre las estimaciones de los parámetros de crecimiento de la LTA del Atlántico suroccidental. Se recogieron individuos en dos regiones del suroeste del océano Atlántico, en las zonas de pesca del noreste y sureste de la costa de Brasil. Encontramos una relación lineal fuerte y estadísticamente significativa entre la longitud a la horquilla (FL) y el diámetro de la espina (SD), representada por la ecuación (FL = 14,58 + 14,49 SD; R2= 0,95). Ajustamos una ecuación de crecimiento utilizando la ecuación de von Bertalanffy, los datos cruzados para FL y la edad estimada de 144 diapositivas fiables (FL = 76,45 [1-exp(-0,553(t+0,46)]). El muestreo

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continuará con objeto de ampliar el rango de tallas de los ejemplares y evaluar las posibles diferencias en los parámetros de crecimiento entre las distintas zonas de pesca frente a las costas de Brasil.

KEYWORDS

Small tunas; growth parameters; growth curve

1. Introduction

The Little tunny (LTA), *Euthynnus alletteratus*, is an epipelagic and neritic species, distributed in tropical and subtropical waters, including the Atlantic Ocean, Mediterranean Sea, Black Sea, Caribbean Sea, and the Gulf of Mexico (Collete and Nauen, 1983; Collete, 2002). This species is a part of the small scombrids group, which are the target species of small and medium-scale fishing fleets, as well as by-catch of industrial tuna fisheries (Pons *et al*, 2019), with significant economic and ecological importance (Báez *et al*, 2019; Vieira *et al*, 2021).

According to the International Commission for the Conservation of Atlantic Tunas (ICCAT) database, the LTA is one of the most important small tuna species in the Atlantic Ocean and Mediterranean Sea, presenting an increase in annual catches from 14,223 Metric Tons, in 2014, to 29,484 Metric Tons in 2017. However, a decreasing trend in fish catches was observed after 2017 and most recent data show a production of 19,377 Metric Tons in 2021 (ICCAT, 2023).

Considering this, the ICCAT launched in 2018, the Small Tunas Year Programme (SMTYP), which prioritized three species of economical relevance: the LTA, *E. alletteratus*; the Atlantic bonito (BON), *Sarda sarda*; and the Wahoo (WAH), *Acanthocybium solandri* (Viñas *et al*, 2020). Since then, calcified structures (spines and otoliths) have been collected for these species in mutliple regions of the Atlantic Ocean and the Mediterranean Sea to determine age structure of individuals and to the respective growth parameters.

The growth parameters of small tunas can be estimated by the assessment of the incremental deposition of calcified structures, such as dorsal spines (Cayré and Diouf, 1983; Kahraman and Oray, 2001; Valeiras *et al*, 2008; Hattour, 2009; Hajjej *et al*, 2012; Vieira *et al*, 2021, Muñoz-Lechuga *et al*, 2024), vertebrae (Rodriguez-Roda, 1979; Hattour, 1984; Hattour, 2009; El-Haweet *et al*, 2013), and otoliths (Santamaria *et al*, 2005; Hattour, 2009; Adams and Kersteter, 2014).

The present study aims to determine age and to estimate the growth parameters of individuals captured in fishing areas in the Southwestern Atlantic. We present here the preliminary results on the growth parameters of *E. alletteratus* captured in two fishing areas off the coast of Brazil.

2. Methods

The LTA was captured by commercial fishing fleets operating in two fishing areas off the Brazilian coast (Northeastern and Southeastern) in the Southwestern Atlantic Ocean (**Figure 1**). Each LTA individual was measured by Fork Length (FL) and had the first dorsal fin spine removed and stored in plastic bags properly labelled.

The spines collected in Southeastern and Northeastern Brazil, were processed by the Portuguese (Ruben Lechuga/IPMA) and the Brazilian (Guelson Silva/UFERSA) teams following standardized protocols (Muñoz-Lechuga *et al*, 2024). In the laboratory, the spines were embedded in a polyester resin solution to obtain 0.5 mm cross-sections in the area equivalent to Condyle Width, right above its base, using a low-speed saw (Buheler Isomet®) fitted with a diamond edged blade. Cross-sections were attached to glass slides using Entellan® resin and photographed in a stereomicroscope for posterior reading of the annual increments. Measurements of the spine diameter (**Figure 2**), defined as the horizontal distance between the outer margins above the sulcus, were determined using the open-source Image Process and Analysis in JAVA program (ImageJ). To test the relationship between spine diameter (SD) and fork length (FL), the data were adjusted to a linear regression ($FL = a + b \times SD$, where: a=intercept; b=slope).

The glass slides were read twice by the same reader, with no previous knowledge of the fish size, and the reliability of the readings were accessed by the Index of Average Percent Error - IAPE (Beamish e Fournier, 1981), according to the following equation:

$$IAPE = 100x\frac{1}{N}\sum_{j=1}^{N}\left(\frac{1}{R}\sum_{i=1}^{R}\frac{Yij - Yj}{Yj}\right)$$

Where N is the number of fish analysed, R is the number of estimates for the ages, Yij is the i-th determination of the age of the j-th fish, Yj is the average found between estimates.

In the case of IAPE higher than 10%, a third reading was performed, and if persisting the error, the slide was removed from the analysis.

The paired data of fork length and age were adjusted to the von Bertalanffy growth model (von Bertalanffy, 1938) established by the equation:

$$FL_t = L_\infty(1\text{-}\exp^{(-k_1(t-t_0)})$$

Where: FL_t= estimated fork length at age t; L_∞= asymptotic length; k = growth rate; t_0 = age when theoretical length is zero.

The growth parameters were estimated by an iteration process using the non-linear least square function (*nls*) available in the R Software (R Core Team, 2024).

3. Results and Discussion

A total of 147 dorsal fin spines of *E. alletteratus* were collected in Southwestern Atlantic (SW-ATL) in two fishing regions off the coast Brazil (40 in Southeast-Brazil and 107 in Northeast-Brazil). The size distribution of the LTA collected in SW-ATL is presented in **Figure 3**.

A significant relationship between FL and SD is described by the linear equation: FL = 14.58 + 14.49 SD, which presented a strong coefficient of determination (R^2 = 0.95) (**Figure 4**).

We obtained the following equation, after adjusting the paired data of the fork length (FL) and estimated age from 144 reliable slides to the von Bertalanffy equation: FL = 76.45 (1-exp(-0.553(t+0.46)). The growth curve based on dorsal fin spines aging is shown in the **Figure 5**.

The preliminary values of asymptotic length estimated in the present study (L_∞= 76.45 cm) were similar to those estimated by Vieira *et al* (2021) (L_∞= 79.1 cm), using dorsal spines of individuals collected in the Southeastern region off the coast of Brazil in the Southwestern Atlantic. Similarly, Adams and Kersteter (2014) reported an asymptotic length of 77.9 cm, using otoliths of individuals captured in the Northwestern Atlantic.

In contrast, the asymptotic length estimated using dorsal spines of individuals captured in the Eastern Atlantic and Mediterranean Sea are higher than the estimated in the present study (Kahraman and Oray, 2001; Valeiras *et al*, 2008; Hattour, 2009; Hajjej *et al*, 2012; Muñoz-Lechuga *et al*, 2024), with values ranging from 91 cm to 127 cm. This difference could be attributed to occurrence of larger individuals in the cited studies.

The next step is to continue the sampling in fishing areas off the coast of Brazil (Northeastern and Southeastern), expanding the size range of collected individuals, to assess potential differences in growth parameters of individuals captured in these two fishing areas.

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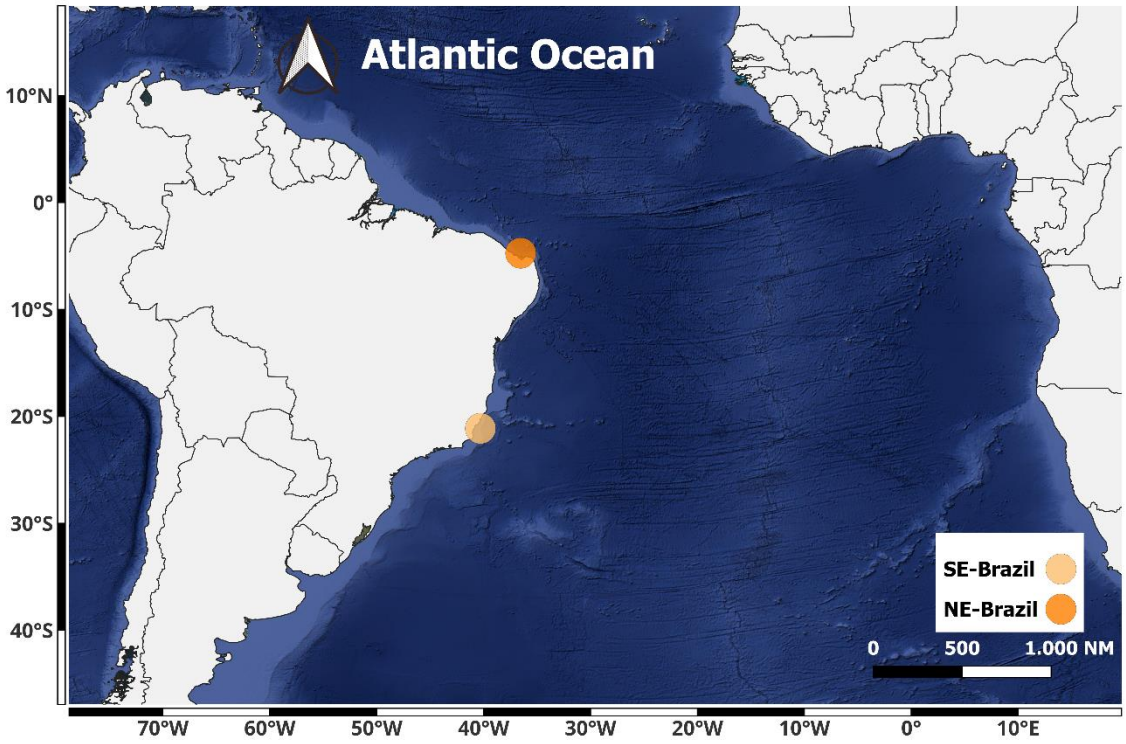

Figure 1. Map of the Atlantic Ocean highlighting the two fishing areas of sampled for Little tunny (LTA), *Euthynnus alletteratus*, off the Brazilian coast.

Figure 2. Transverse section of the first dorsal fin spine from Little tunny (LTA), *Euthynnus alletteratus*, collected in the Southwestern Atlantic (SW-ATL) off the Brazilian Southeastern coast.

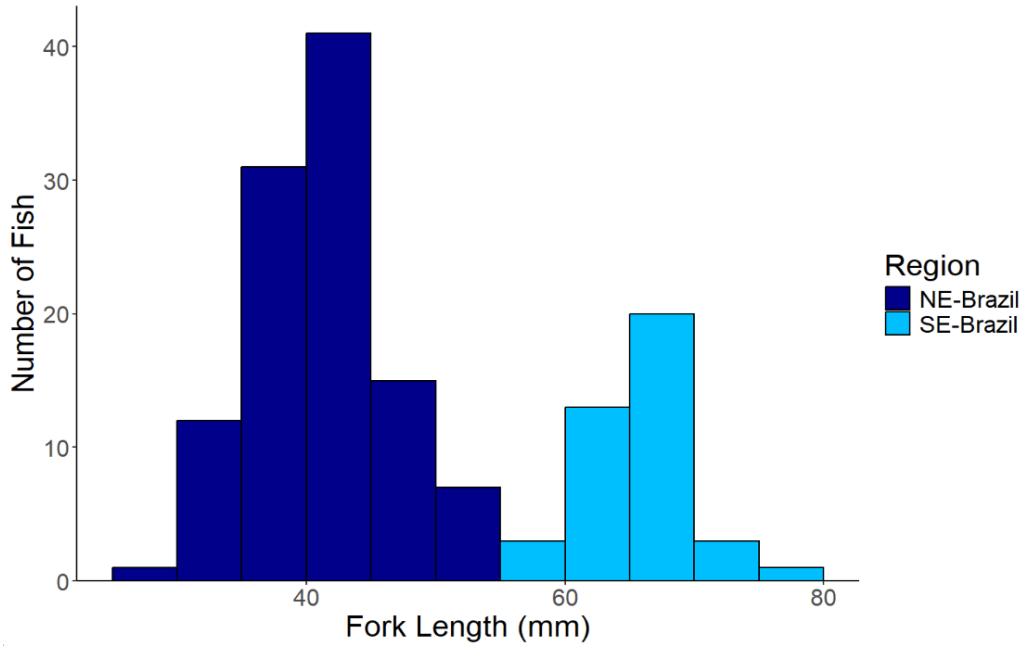

Figure 3. Size distribution of Little tunny (LTA), *Euthynnus alletteratus*, captured in two fishing areas off the Brazilian coast, in Southwestern Atlantic Ocean.

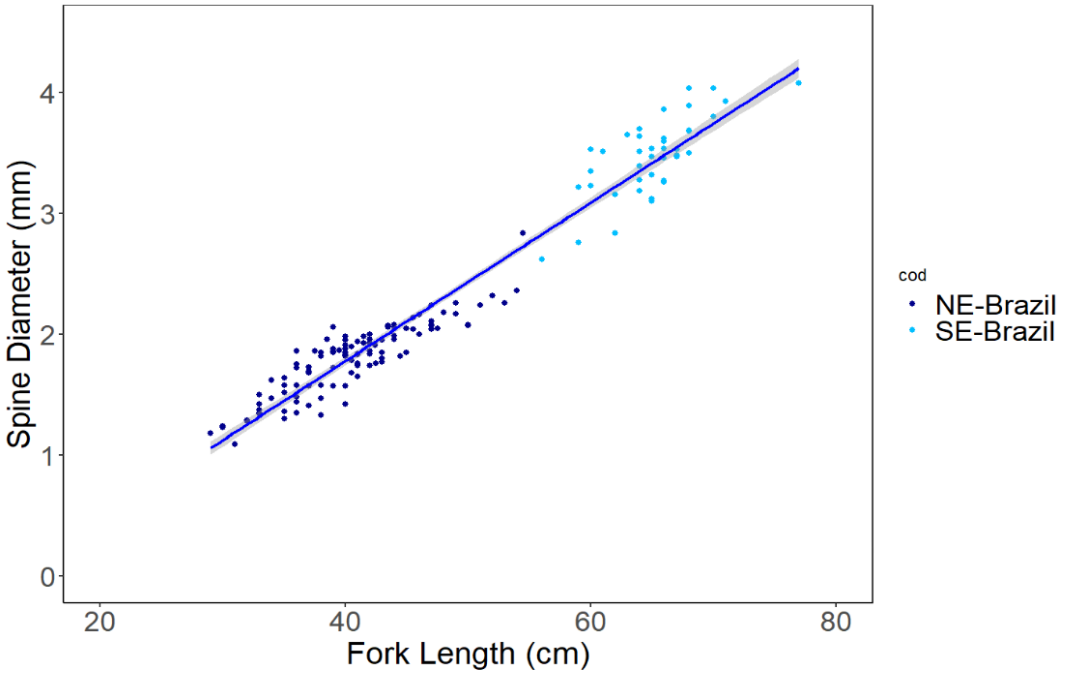

Figure 4. Linear relationship between Fork Length (FL) and Spine Diameter (SD) of Little tunny (LTA), *Euthynnus alletteratus*, from two fishing areas off the Brazilian coast, Southwestern Atlantic Ocean.

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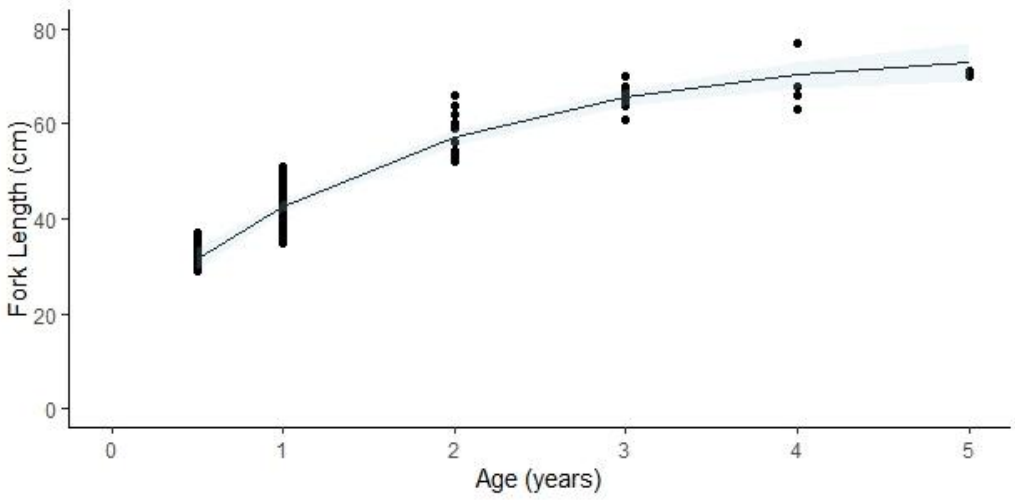

Figure 5. Preliminary growth curve with confidence intervals (2.5 and 97.5%), using dorsal fin spines, of Little tunny (LTA), *Euthynnus alletteratus*, from two fishing areas off the Brazilian coast, Southwestern Atlantic Ocean.