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A preliminary estimation of the splendid alfonsino growth equation in the south-western Indian Ocean

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Abstract

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Recommendations *(working papers only)*

1. The growth equation estimated in this study should be interpreted with caution, as it differs considerably from previous studies and the cause of the difference is unclear.

A preliminary estimation of the splendid alfonsino growth equation in the south-western Indian Ocean

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Abstract

We provide a preliminary estimate of the growth equation for splendid alfonsino *Beryx splendens* in the south-western Indian Ocean. However, the result was considerably different from the previous estimates from the same area and from different areas, and the difference is not likely to be an artifact of the age estimation procedure. Further research is required to determine the cause of those differences and to obtain a reliable growth equation.

Introduction

Growth patterns provide an essential information for stock assessments. In this document we provide a preliminary estimate of the growth equation for splendid alfonsino *Beryx splendens*.

As discussed later, the age-size relationship obtained in this study differs considerably from previous studies. To examine the possibility that the age estimation procedure caused this difference, we compared the length of each age class in our data with that in a North Pacific (the Emperor Seamounts area) population of splendid alfonsino. Since those two samples were analyzed using the same procedure, a similar result would be obtained from North Pacific sample if the procedure caused the difference.

Materials and Methods

Data collection

We used otolith-reading results of annual rings for 407 individuals of splendid alfonsino (175 males, 231 females and 1 sex-unknown individual) caught during 2016 - 2017 by Japanese trawlers and collected as scientific samples by on-board scientific observers. Sampling location is shown in Fig. 1.

Specimens were frozen on-board. Measurement of the fork length (to the nearest 0.1 mm) using calipers and extraction of otoliths were conducted in the laboratory. Presumed annual rings of the otoliths were counted with a protocol specified according to Lehodey and Grandperrin (1996).

For North Pacific specimens, we used the results of 749 individuals collected via the scientific observer program of North Pacific Fisheries Commission and processed in a similar way.

Statistics

All analyses were conducted using R version 3.6.2 (R Core Team, 2019).

To estimate growth patterns of the splendid alfonsino in the south-western Indian Ocean, data is fitted to von Bertalanffy growth equation, $L_t = L_\infty(1 - e^{-K(t-t_0)})$, using the function `nlm` the nonlinear least squares method with the Gauss-Newton algorithm implemented by the function `nls` in the package `stats` (R Core Team, 2019). The starting estimates were determined by the Ford-Walford plot using the function `vbstarts` in the package `FSA` (Ogle et al., 2020). Allowing parameters to vary with sex did not improve AIC when fitted to the data excluding a sex-unknown individual (not shown). Therefore below we show the result of the sex-combined model.

To compare the age-size relationship between the areas (Indian and Pacific oceans), we fitted the generalized linear mixed models predicting fork length, incorporating areas as a fixed factor and tows as a random factor, using the package `glmmTMB` (Brooks et al., 2017), for each age between 0 to 5 years old (6 year-old individuals were not examined because no individuals in this age class obtained from Indian Ocean). Then the significance of the area factor is tested for each age using the Wald χ^2 test.

Results

Growth equation in the south-western Indian Ocean.

The estimated parameters of von Bertalanffy growth equation is summarize in Table 1. As a result, growth equation is:

$$L_t = 383.978(1 - e^{-0.21214(t+3.88886)})$$

The estimated growth curve is shown in Fig. 2, along with the previous estimation (Santamaría et al., 2006). The estimated curves differed considerably.

Difference between Indian and Pacific Oceans

Individuals from the Indian Ocean population are significantly larger than ones from the Pacific Ocean in ages between 0 to 3 years old, but not in ages 4 and 5 years old (Fig. 3).

Discussion

We obtained an estimated growth equation for splendid alfonsino population in the southwestern Indian Ocean (Table 1). However, the result was considerably different from the previous estimates (Fig.2) from the same area (Santamaría et al., 2006) and from different areas (reviewed by Sawada et al. (2018)).

The result is not an artifact derived from the age-estimation procedure, as indicated by the significant regional difference (Fig.3) observed even though the same procedure was used. The differences between the current and the previous studies and between Indian and Pacific Oceans may result from spatiotemporal variation of growth patterns and/or different gear selectivity. Further research is required to determine the cause of those differences and to obtain a reliable growth equation.

Acknowledgements

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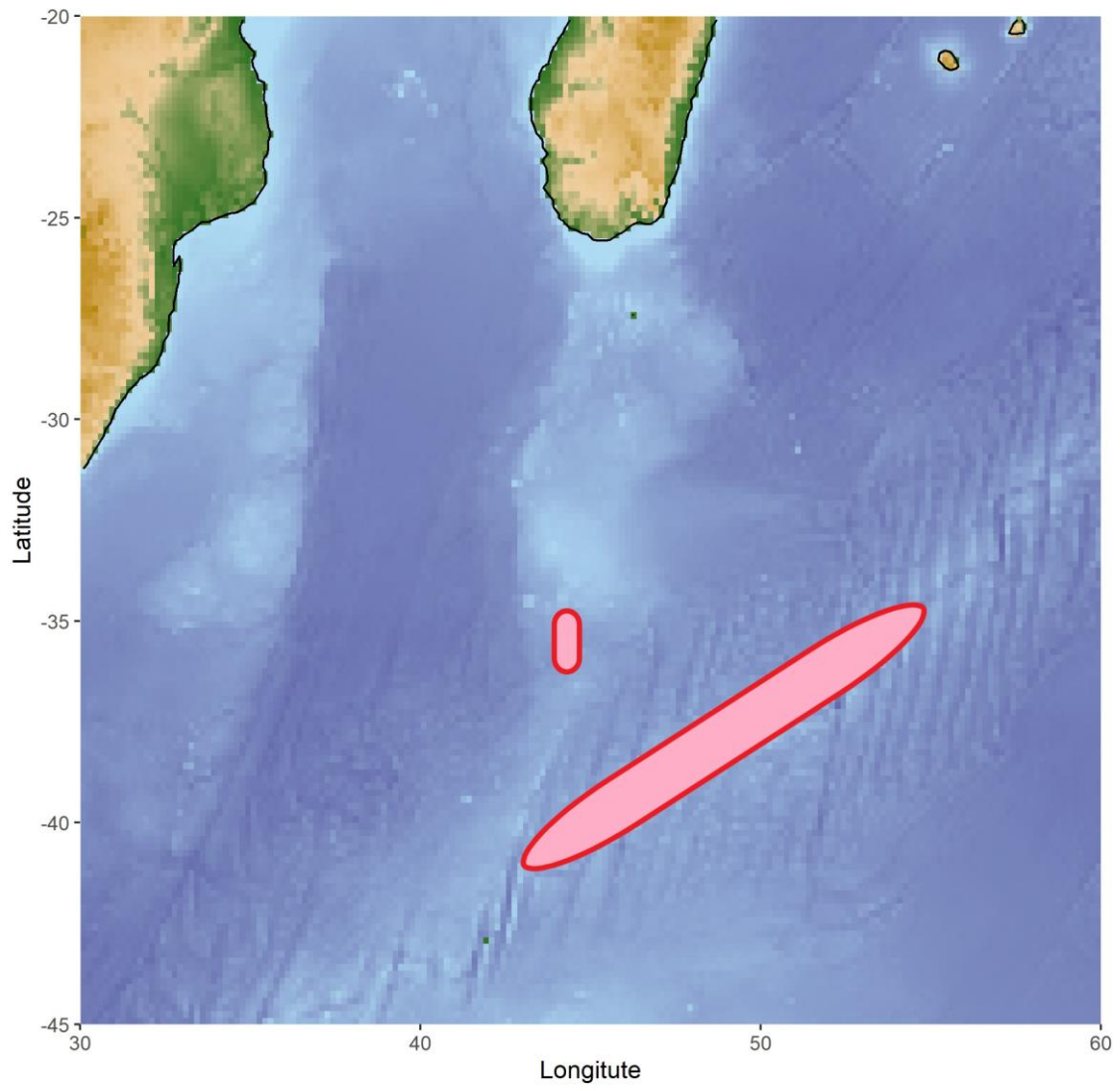


Fig. 1. Map of sampling locations.

Table 1. Estimated parameters of von Bertalanffy growth equation

Parameter	Estimate
L_{∞}	383.9784062
K	0.2121402
t_0	-3.8888590

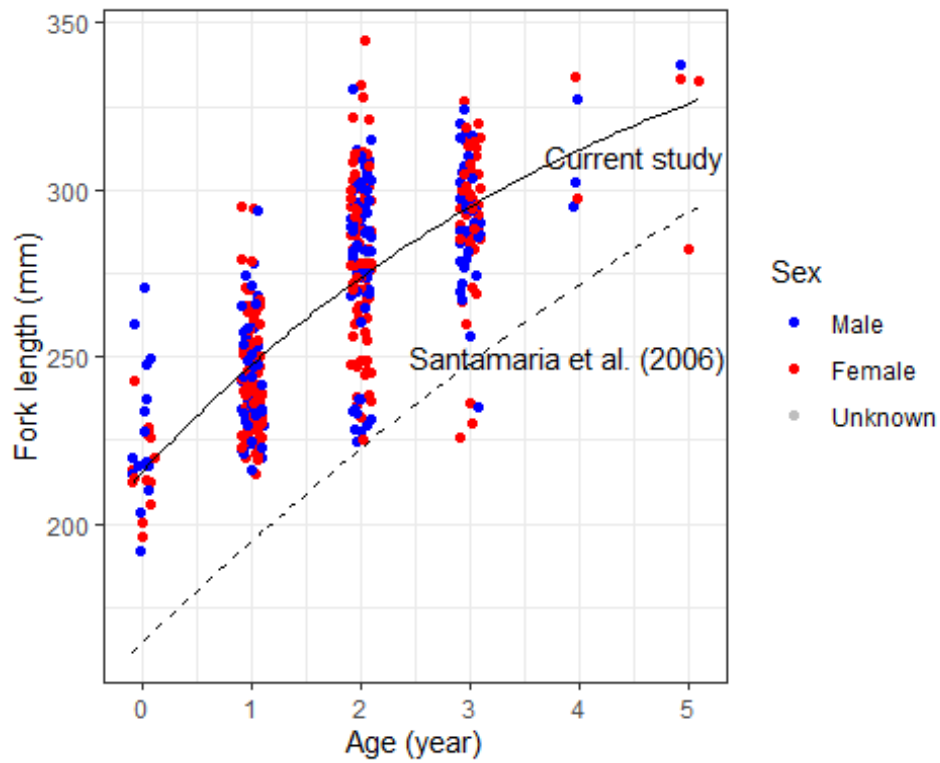


Fig. 2. Estimated growth curves by the current and previous studies.

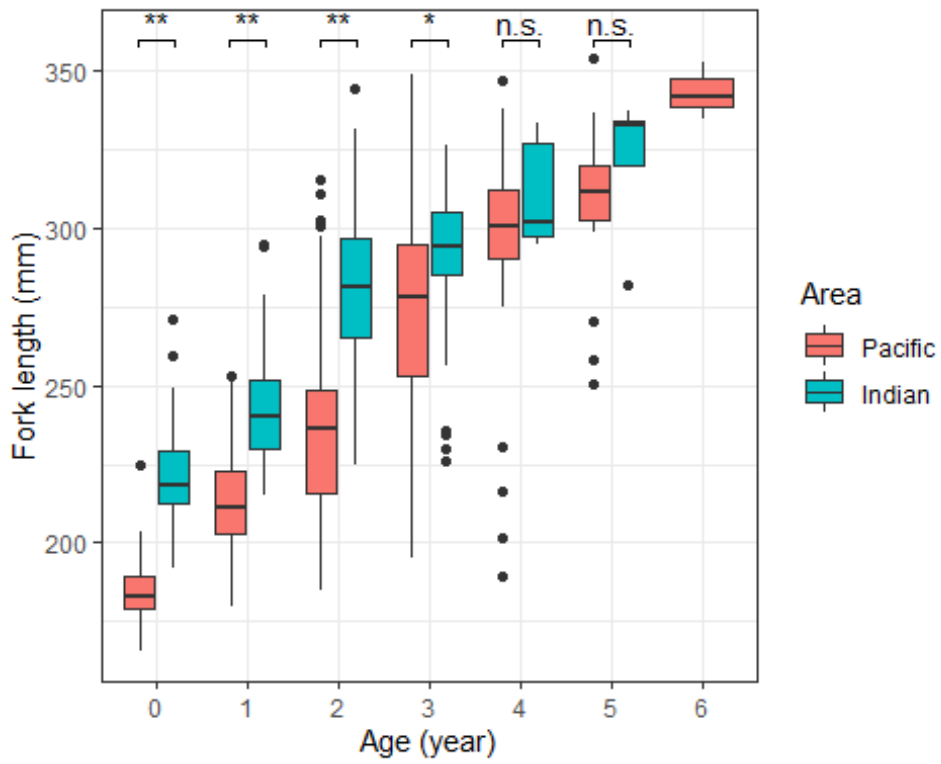


Fig. 3. Comparison of size in each age class between Indian and Pacific samples.

* and ** indicate $p < 0.05$ and $p < 0.001$, respectively.