North Pacific Fisheries Commission

NPFC-2022-SSC BFME03-WP06

Sexual maturity of Splendid alfonsino (*Beryx splendens*) in the Emperor seamounts

by

Bungo Nishizawa and Kota Sawada

Oceanic Resources Group, Fisheries Resources Institute,
Japan Fisheries Research and Education Agency, Japan

December 2022

This paper may be cited in the following manner:

Nishizawa, B. and Sawada, K. 2022. Sexual maturity of Splendid alfonsino (*Beryx splendens*) in the Emperor seamounts. NPFC-2022-SSC BFME03-WP06. 8 pp. Available at https://www.npfc.int/

Sexual maturity of Splendid alfonsino (*Beryx splendens*) in the Emperor seamounts

Bungo Nishizawa and Kota Sawada

Oceanic Resources Group, Fisheries Resources Institute,
Japan Fisheries Research and Education Agency, Japan

Abstract

We analyzed biological data of splendid alfonsino *Beryx splendens* in the Emperor seamounts shared by NPFC Members to define the reproductive season and maturity stages and to estimate size at sexual maturity (FL_{50}). Monthly changes in gonadosomatic index and maturity stages based on macroscopic and microscopic analyses suggests that reproduction occurs between March and December. The FL_{50} values estimated by a logistic regression model ranged between 257 and 365 mm. This differences in estimates may be related to differences in fish size used in the analysis, sampling location, and year. Therefore, further analysis considering temporal and spatial variability is needed to estimate more reliable FL_{50} for stock assessment of *Beryx splendens* in the Emperor seamounts area.

Introduction

The splendid alfonsino *Beryx splendens* Lowe 1834 is a demersal fish which has a worldwide distribution in tropical and temperate water. This species has been exploited as an important fisheries resource in the waters between 200 and 800 m in depth over seamounts including the Emperor seamounts (Sawada et al. 2018). Although it is one of the most important resources in bottom fisheries in the region, its biological characteristics and life history is still unclear. To manage the stock of *Beryx splendens*, a previous work attempted to apply surplus production models but resulted in an unreliable estimation possibly due to the biased CPUE (Sawada et al. 2018). Other ways to avoid this issue include life history-based approaches such as SPR (spawning per recruit) analysis, which require life history parameters including spawning seasons and the size at sexual maturity. Hasegawa and Sawada (2021) estimated these parameters by using samples collected by Japanese commercial and research vessels and requires further analysis with larger sample size to provide more reliable estimates. SWG NPA-SA agreed to share the biological data of *Beryx splendens* in the Emperor seamounts and continue work on the life history based approaches as a collaborative work among members.

This report presents the results by analyses on the maturity of *Beryx splendens* using combined data from each Member. We aimed at (1) defining the reproductive season of *Beryx splendens*, using monthly changes in gonadosomatic index and maturity stages based on macroscopic and microscopic analyses and (2) estimating size at sexual maturity (50% of the population attain sexual maturity: FL_{50}) using both macroscopic and microscopic data.

Materials and Methods

Shared data includes fork length (FL, mm), total mass (M_T, g), and gonad mass (M_G, g) for 8422 individuals (4423 females and 3999 males) of *Beryx splendens*.

A gonadosomatic index (GSI) was calculated using the value of M_G relative to M_T for each fish: $GSI = 100M_G(M_T - M_G)^{-1}$ (Flores et al. 2012).

The reproductive condition was assessed in both sexes using a macroscopic analysis of gonads according to the maturity scale. We note here that macroscopic analysis was conducted at different criteria between NPFC Members (i.e., five maturity stages described in Korean samples collected between March through July and six stages in Russian samples collected between January through December).

Histological analyses were also performed using 115 ovaries collected by Japan between April and October. Those ovaries were embedded in paraffin wax, sectioned in 7-8 μm and stained with hematoxylin and eosin. We characterized the gonad development to determine the different maturity stages according to the criteria developed by Lehodey et al. (1997). Maturity stages used in this study are the following seven categories: A; Chromatin nucleolus, B; Peri nucleolus, C; Yolk vesicle, D; Early yolk, E; Late yolk, F; Maturation, G; Spawning.

Size at sexual maturity (FL_{50}), which is often used as the size at which 50% of the population attain sexual maturity, was estimated by using a logistic regression model: $pFL = (1 + e^{(\alpha + \beta * FL)})^{-1}$, where α and β are parameters estimated using maximum likelihood and assuming binomial error distribution. In this analysis, fish collected in possible reproductive season (i.e., between March and December) which had reached at least stage 3 of macroscopic scales and stage D-G were considered as mature, respectively.

Results and Discussion

The monthly average of GSI of females showed weakly seasonal patten and high values occurred in April, July, and September (Fig. 1). Males showed similar GSI variation with females and the highest value was observed in April (Fig. 1).

The analysis of macroscopic maturity stages revealed maturity stage 3 (i.e., matured gonad) occurred between March through July except June in both sexes (Fig. 2). High frequency of individuals in more advanced maturity stages (≧3) occurred in July (80%) in both sexes (Fig. 2). These results indicate that main reproductive season was in spring and summer. However, advanced maturity stages were observed in December (Fig. 3), suggesting reproduction also takes place in winter.

Result from histological analysis showed that spawning individuals occurred in April and between July through September with a highest frequency in July (30%) (Fig. 4). This indicates that main reproductive season occur in summer as in the result of macroscopic analysis.

The FL_{50} values estimated by a logistic regression model ranged between 257 and 365 mm (Table

1), depending on the subsets of shared data used for estimation. Although these values are consistent with the FL_{50} estimates of *Beryx splendens* from other populations (Lehodey et al. 1997, González et al. 2003, Flores et al. 2012), the range is too to be used for assessments. The differences of estimates from different subsets of data may be related to differences in the fish size used in the analysis, sampling location (i.e., seamounts), and year. Thus, further analysis considering temporal and spatial variations is needed to estimate more reliable FL_{50} for stock assessment of *Beryx splendens* in the Emperor seamounts area.

Acknowledgement

This work is conducted as part of Research and assessment program for fisheries resources, the Fisheries Agency of Japan and submitted under the approval of the Agency. We thank the participants of SWG NPA-SA for their helpful comments and constructive discussions.

References

Flores, A., Wiff, R., Gálvez, P., Díaz, E., 2012. Reproductive biology of alfonsino *Beryx splendens*. J. Fish Biol. 81, 1375–1390.

Gonzalez J. A., Rico V., Lorenzo J. M., Reis S., Pajuelo J. G., Dias M. A., Mendonca A., Krug H. M., and Phinho M. R., 2003. Sex and reproduction of the alfonsino *Beryx splendens* (Pisces, Berycidae) from the Macaronesian Archipelagos. J. Appl. Ichthyol., 19, 104–108

Hasegawa, T. and Sawada, K. 2021. Preliminary report of estimating size at sexual maturity for Splendid alfonsino (*Beryx Splendens*) in the Emperor seamounts. NPFC-2021-SSC BF-ME02-WP08. 9 pp.

Lehodey, P., Grandperrin, R., and Marchal, P., 1997. Reproductive biology and ecology of a deep-demersal fish, alfonsino *Beryx splendens* over the seamounts off New Caledonia. Mar. Biol. 128, 17–27.

Sawada, K., Nishida, K., Yonezaki, S. and Kiyota, M. 2018. Review of biology and fisheries of splendid alfonsino *Beryx splendens*, especially in the Emperor seamounts area. NPFC-2018-SSC BF01-WP03. 26 pp.

Table 1. FL_{50} estimated by logistic regression models and coefficients fitted for the maturity ogives of *Beryx splendens*. The asterisk represents significant values at $p < 0.01$.

Maturity scale	Sex	α	SE_{α}	β	SE_{β}	FL_{50} (mm)	n	Data covered
Macroscopy (5 stages from Korea)	Females	-10.767*	0.730	0.042*	0.003	257.38	1476	Mar. through Jul.
	Males	-11.531*	0.711	0.043*	0.003	271.16	2256	Mar. through Jul.
Macroscopy (6 stages from Russia)	Females	-7.618*	0.309	0.021*	0.001	365.20	2928	Mar. through Dec.
	Males	-8.220*	0.353	0.023*	0.001	354.59	2756	Mar. through Dec.
Histology (Japan trawl)	Females	-14.093*	3.997	0.047*	0.015	299.09	115	Apr. through Oct.

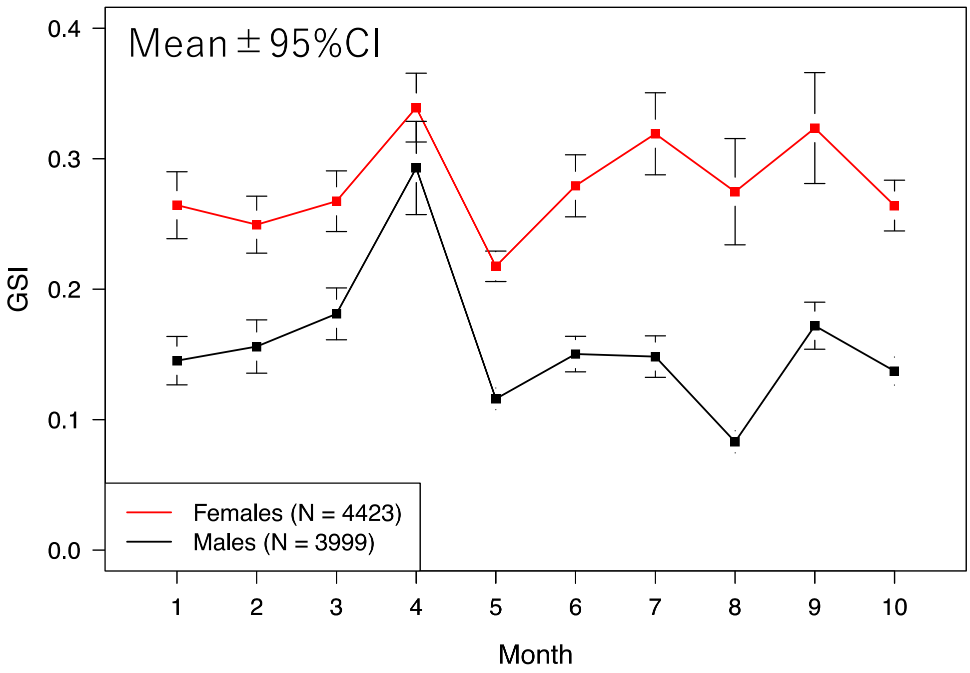

Fig. 1. Monthly variation of gonadosomatic index (GSI) of *Beryx splendens*.

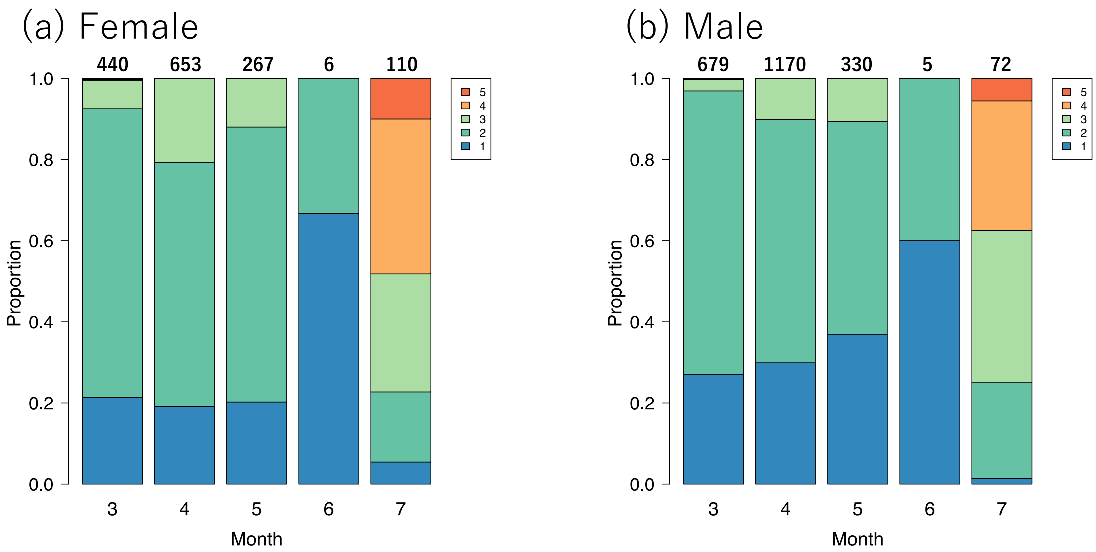

Fig. 2. Monthly variation of macroscopic mature stage (5 stages from Korea) of (a) female and (b) male *Beryx splendens*. Numbers indicate the sample size.

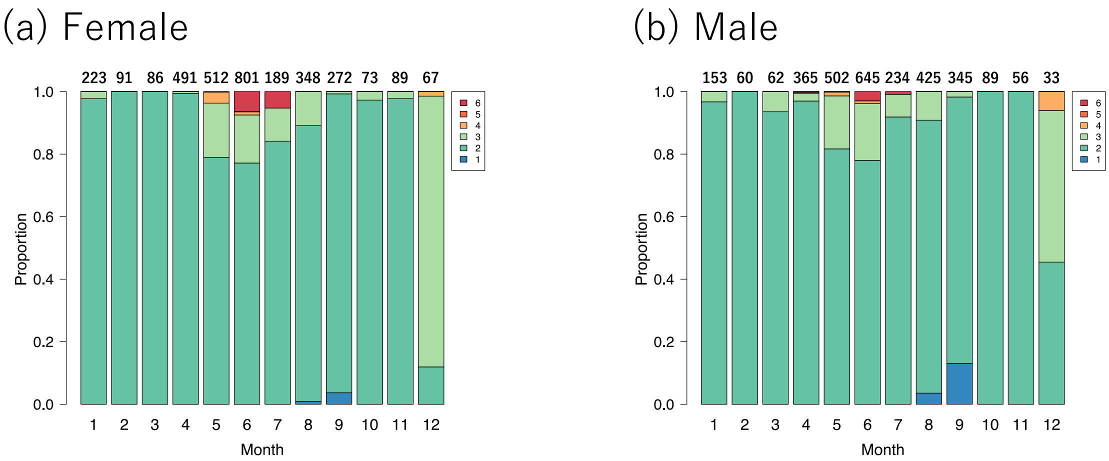

Fig. 3. Monthly variation of macroscopic mature stage (6 stages from Russia) of (a) female and (b) male *Beryx splendens*. Numbers indicate the sample size.

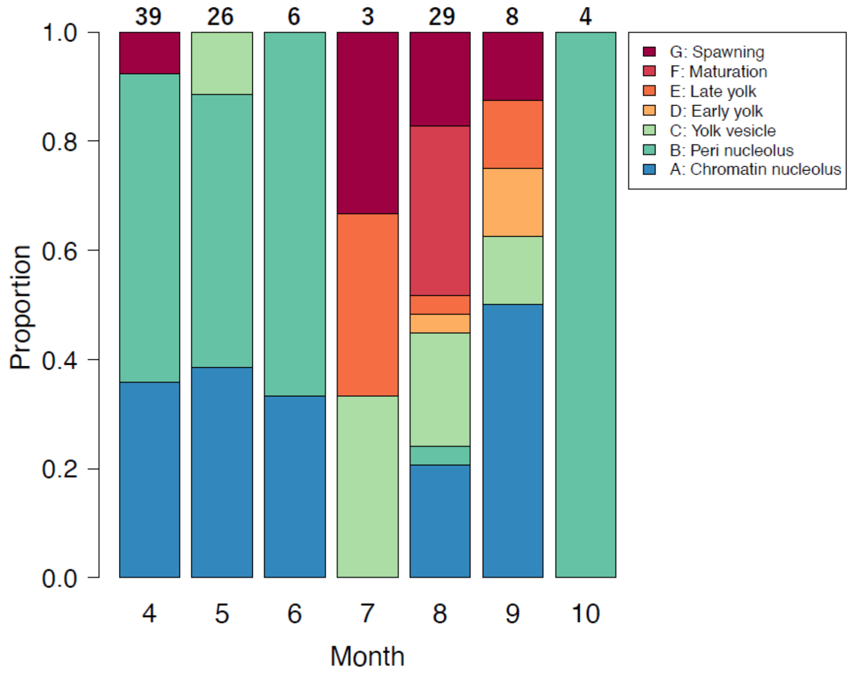

Fig. 4. Monthly variation of histological mature stages of female *Beryx splendens* (from Japanese trawl). Numbers indicate the sample size.