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Age and Growth of the Snake Fish *Trachinocephalus myops* (Forster 1801) in Tateyama Bay, East Japan, Using Otolith Ring Marks

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Abstract

The snake fish *Trachinocephalus myops* (Forster 1801) is a commercial target, and its meat might provide an alternative material for fish paste in the future. This study reports on the relationships between otolith morphometry, age, and growth rate of *T. myops* in Tateyama Bay, and estimates of the growth parameters for the species around this coastal area in Japan. Monthly changes in the marginal growth rate and the frequency of the opaque zones indicated that the otolith edge of the opaque zone is formed once a year around June. The estimated ages of the sampled fish ranged from 2 to 11 years. The spawning season, estimated by the monthly changes in the gonadosomatic index, was August and September. The relationship between fork length (L; mm FL) and age (t; year) was expressed by the von Bertalanffy growth curve as:

male: $L_t = 378.1(1 - \exp(-0.236(t - (-0.80))))$

female: $L_t = 423.7(1 - \exp(-0.247(t - (-0.66))))$

This relationship suggested that the body is larger in the female than in the male.

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Introduction

The snake fish *Trachinocephalus myops* (Forster 1801) is a benthic fish, whose body size is around 300 mm total length. The fish is distributed widely in shallow sandy seas in tropical and temperate areas throughout the world (Nakabo 2002). The snake fish is caught using trawl nets and is becoming increasingly important as a food resource in the South-Eastern China Sea (Yang et al. 2013).

The lizardfish, genus *Saurida*, which includes four species (sp1, sp2, *Saurida elongata* (Temminck & Schlegel 1846) and *Saurida wanieso* Shindo & Yamada 1972, is a closely related species to the snake fish and is a commercially important species (Yoneda et al. 2002; Sakai et al. 2009). The meat of lizardfish has a high gel-forming ability and a whiter colour than that of other benthic fish. However, the East China Sea, the main fishing ground of the lizardfish, has been under high exploration pressure by fishermen from Japan, South Korea and China for a long time. As a result, the abundance level is now low. The lizardfish trawl net catch in the western East China Sea decreased from 8,500 tonnes in 1982 to 23 tonnes in 2006, and the catch per unit effort (CPUE) declined to less than 10% (Sakai et al. 2009). Thus, given the current situation in fish paste production, the snake fish might become an effective alternative food material in the future.

Ecologically, both fishes are classified generally as ichthyophagous species like top predators in the sea, and both strongly impact on other prey fish (Sakai et al. 2009). It appears that the larvae of lizardfish are often eaten by snake fish. A food habit study showed a high frequency of larvae in the stomach, indicating that the snake fish is a major predator (Noichi et al. 1993). Other commercial fishes, such as Pomacentridae and *Spratelloides* spp., and crabs have also been found in their stomach (Shibuno et al. 1996). Because the snake fish are found widely in warmer and temperate seas throughout the world, they might impact on many prey species more than lizardfish. Thus, the snake fish would be a key species of marine ecosystems.

In this paper, to understand the fundamental ecological characteristics of the snake fish, we examined the age and growth of the snake fish from the Tateyama Bay using fishing and set net samples obtained over 3 years. Although growth analysis has been conducted in a tropical area (Yang et al. 2013), our study was conducted in a temperate area. We reasoned that this environmental difference might be reflected in the life history of the species. In addition, only limited information was obtained in the previous study, which reported the growth equation for females only and without a detailed description. Here, we used the sagittal otolith as the primary method to examine age and growth.

Materials and Methods

Study area and sampling

Snake fish samples were collected in Tateyama Bay to obtain a wide size range from shore fishing, boat fishing and set nets in May-December 2007, May-August 2008 and July-August 2009 (Fig. 1). Tateyama Bay is located at the mouth of Tokyo Bay in east Japan between 34°8′ and 35°1′ N and 139°75′ and 139°85′ E. During winter-spring, we were unable to catch samples by fishing, and it was impossible to obtain many commercial samples because this species is not a target species and is frequently discarded. All samples were taken to the laboratory and frozen at a temperature of less than -20 °C.

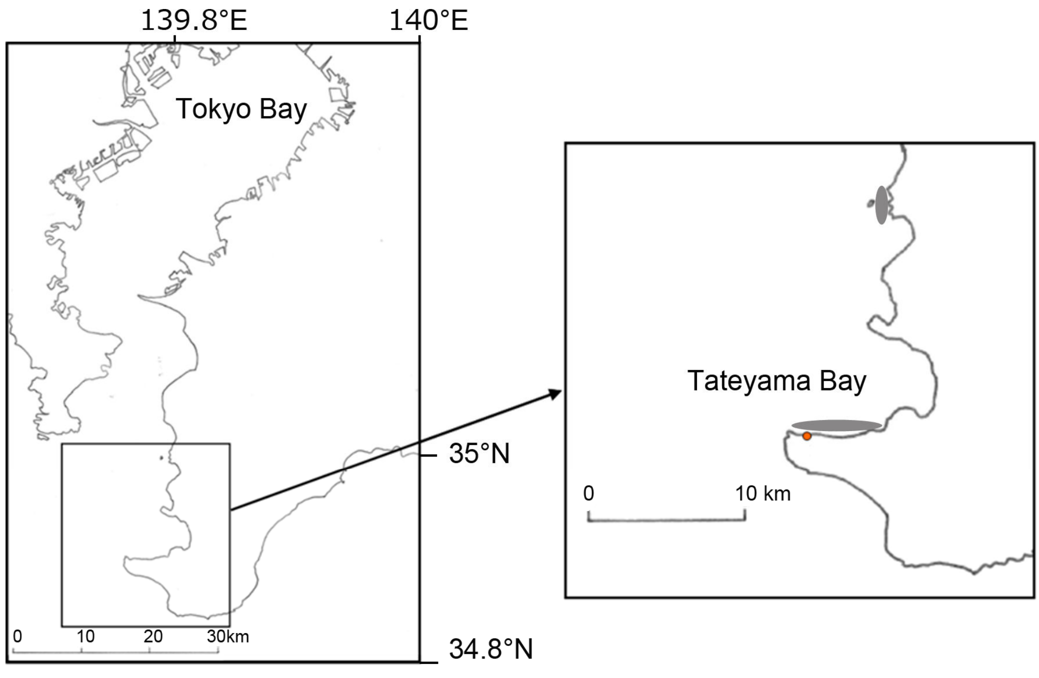

Fig. 1. Map of Tateyama Bay. Grey zones show the fishing areas.

Measurement

After decompression, the fork length (*FL*) was measured in each individual to the nearest 0.1 mm with a digital calliper. The gonad was removed and was dried in an incubator for 12 h at 37 °C. The wet body weight (*BW*) and dry gonad weight (*GW*) were measured to the nearest 0.01 g with a precision balance. The sex of each sample was identified visually by examining gonad morphology under a profile projector or with the naked eye. To estimate the reproductive season, a gonadosomatic index (*GSI*) was calculated for each sex as follows:

$$GSI = \frac{GW}{BW - GW} \times 100$$

Both sagittal otoliths were removed from each fish head and were stored in 50% glycerine solution for later analysis. The surface of the otolith was observed with transparent light under water under a profile projector or with the naked eye (Fig. 2). The outer margin of each otolith was recorded as either opaque or translucent, and the number of opaque rings was counted. To confirm the annual ring formation, we calculated the monthly changes in the marginal growth index (*MI*) of measureable otolith samples in 2007 using the following equation:

$$MI = \frac{R - r_{max}}{r_{max} - r_{max-1}}$$

where R is the otolith radius, r_{max} is the distance from the core to the inner edge of the maximum opaque zone (the outermost opaque zone), and r_{max-1} is the distance from the core to the inner edge of the immediately preceding opaque zone (Fig. 2).

The von Bertalanffy growth model was used to fit the length-at-age from the otolith-based age estimates of snake fish using the equation:

$$L_t = L_\infty(1 - \exp(-K(t - t_0)))$$

where L_t is the size (mm FL) at age t, L_∞ is the mean asymptotic length (mm FL), K is the body growth parameter (year^{-1}), and t_0 is the theoretical age at zero length. The parameters were estimated based on least square method using Excel Solver and free statistical software R. Likelihood ratio tests (Kimura 1980) were used to evaluate the significance of differences in growth parameters between sexes.

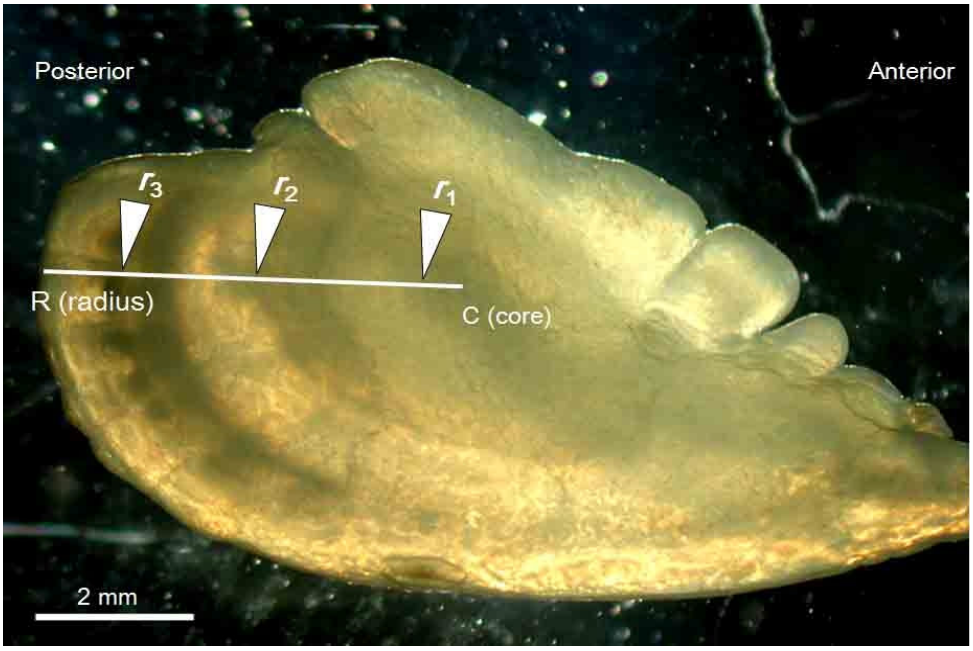

Fig. 2. Ring mark reading of a sagittal otolith section with three ring marks from a female snake fish (*FL* = 215 mm). Arrowheads indicate the ring marks on the inner margin of the opaque zone for measuring the ring radius.

Results

A total of 174 specimen otoliths were examined for age and growth from fish ranging in size from 97-408 mm FL; the number of opaque rings ranged from 1-12. The length-frequency distribution showed differences in the size range between the sexes. The size of males (*n* = 70) ranged from 107-348 mm FL and that of females (*n* = 91) from 110- 408 mm FL. All specimens larger than 350 mm FL were females. The sex ratio did not differ from the expected ratio of 1:1 (chi-square test: $p >$ 0.05). The remaining fish were either sexually immature or the sex could not be determined.

Monthly distribution of GSI

In females, fish with a large *GSI* began to appear in July; the frequency of females with a large *GSI* was highest in September and then decreased in December 2007 (Fig. 3). In males, fish with a large *GSI* appeared in August and September 2007 and in August 2008. These trends indicate that spawning occurs from August to September.

Period of ring mark formation

The frequency of the appearance of opaque rings on the outer margin of the otolith increased from June, remained high between July and September, and decreased sharply from October in 2007 (Fig. 4). The trends in other years were also similar, although the sampling size and period were limited.

The *MI* showing new translucence in the marginal zone appeared in all months of sampling except for August (Fig. 5). The *MI* values showing new opacity in the marginal zone were low in May and June, but increased from July until September. These results suggest that ring marks form once a year, between June and July, and can be considered as annual indicators.

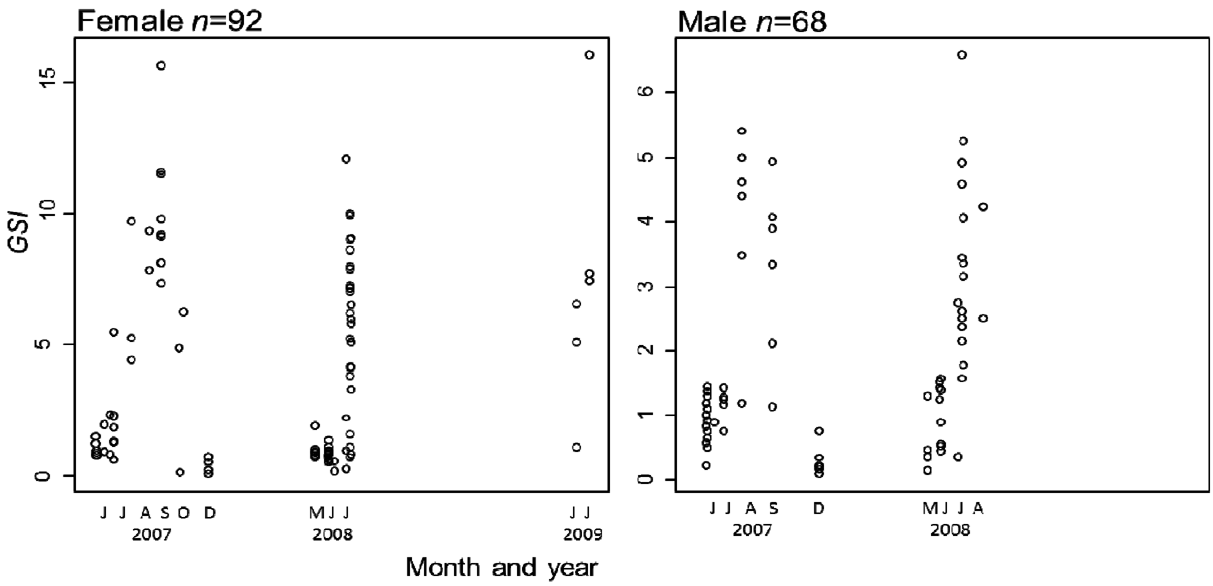

Fig. 3. Gonadosomatic index (*GSI*) distribution for female and male *Trachinocephalus myops*

Growth curve

Based on the analysis of the *GSI* and otolith surface, we assumed that the annual ring marks are formed about 9 months (0.75 year) after the peak of the spawning season. Thus, age can be assigned by counting the opaque zones and adding the sampled month and season lag (0.25 year) between ring formation and spawning.

The von Bertalanffy growth equation was fitted according to sex and age (t – 0.75) as follows:

$$\text{male: } L_t = 378.1(1 - \exp(-0.236(t - (-0.80))))$$

$$\text{female: } L_t = 423.7(1 - \exp(-0.247(t - (-0.66))))$$

The calculated maximum ages of the male and female snake fish were 11 and 9 years, respectively. Thirteen samples >350 mm FL were identified as female (Fig. 6). The likelihood ratio test showed no significant difference in L_∞ between females and males (chi-square =1.81, df = 1, $p > 0.05$).

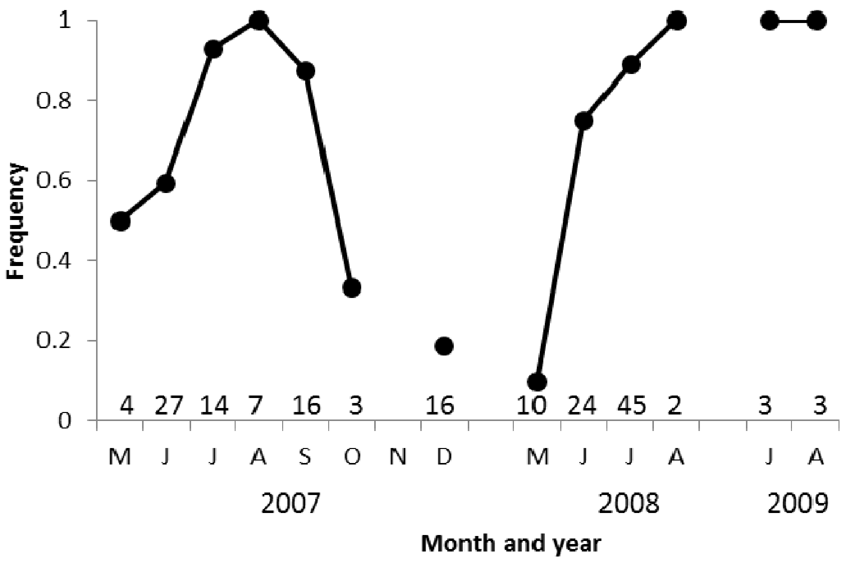

Fig. 4. The frequency of the appearance of the opaque area on the outer margin of the otolith of *Trachinocephalus myops*. Numbers indicate the sample size.

The smallest size with large *GSI* value appeared 191 mm FL and 178 mm FL in female and male, respectively. From the growth equations and the number of opaque rings, the maturity age was estimated to be 2 and 3 years old in female and male, respectively.

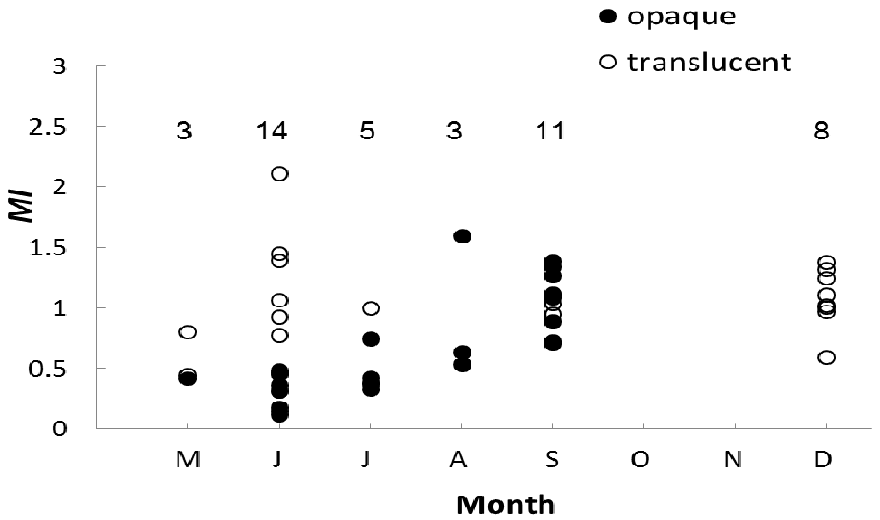

Fig. 5. Monthly distribution of the marginal growth index (*MI*) in 2007. Closed and open circles show the opaque and translucent zones of the outer margin of the otolith, respectively. Numbers indicate the sample size.

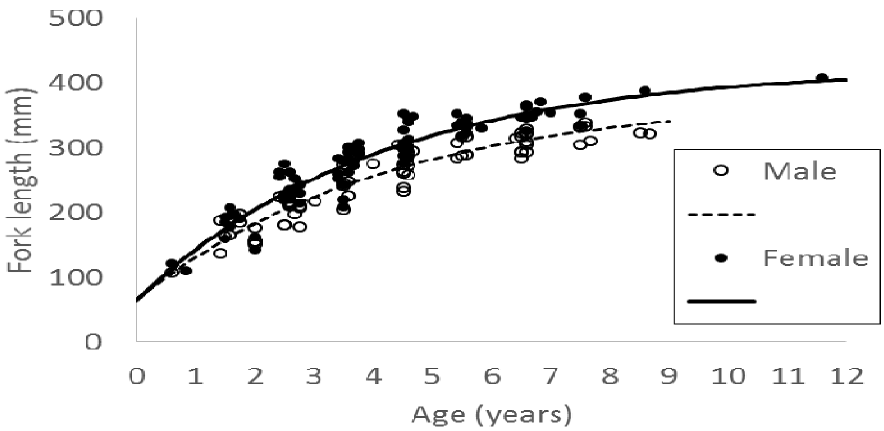

Fig. 6. Observed fork length-at-age data for females (closed circles) and males (open circles) of *Trachinocephalus myops* specimens with the von Bertalanffy growth curve fitted to the data. The solid line represents the female curve, and the dashed line represents the male curve.

Discussion

Our study of age of *T. myops* estimated the maximum ages as 9 and 11 years for males and females, respectively. The largest male was 323 mm FL and the largest female was 408 mm FL. This result indicates that female *T. myops* live longer and are larger than males. Although the statistical analysis showed no differences between sexes in the asymptotic FL of the growth curve, the larger specimens (>350 mm FL) were all female. A previous study also showed that female specimens were larger (>25 cm FL) and that no males specimens were >32 cm FL (Yang et al. 2013). Taken together, these data suggest that female snake fish grow larger than males. A similar sexual dimorphism in size has been observed for many benthic fish including *Saurida* sp1 (Yoneda et al. 2002), *S. elongata* (Sakai et al. 2009), *Sebastes schlegeli* Hilgendorf 1880 (Sasaki et al. 2004), *Inimicus japonicus* (Cuvier 1829) (Watanabe et al. 2003), and *Hippoglossoides pinetorum* (Jordan & Starks 1904) (Mihara 2002).

This study provides the first report on the age and growth of *T. myops* in a temperate area using otoliths to determine age. A previous study on growth in females in a tropical area (Yang et al. 2013) suggested that the estimated asymptotic body size is larger and the growth rate is smaller than those found in our study from a temperate area. However, a more detailed comparison cannot be made because of the limited information. The length and age data in our study may have been limited by the restricted sampling season, which may have caused a selection bias because winter-spring fish were not caught by fishing or set nets. The lack of information for all seasons in our study means that the length-at-age data fit to the growth curve are valid only for the ranges of length and age recorded in this work; thus, the adjustment for growth seasonality may be less reliable.

Larger *GSI* values were recorded in females in August and September, whereas the *GSI* values were low in October and December (Fig. 3). This suggests that hatching should occur during August and September in this area. In a detailed study of reproduction, Yang et al. (2013) revealed two spawning seasons (February-March and August-September) in the snake fish in a tropical area. However, it would be impossible for the fish to spawn in winter in temperate areas because they are inactive at low water temperature. Unfortunately, the fish could not be caught in set nets in winter and, thus, we cannot confirm the lack of spawning ability in winter. However, otolith surface analysis did not show any winter-born specimens; i.e., the core otolith was not translucent in all samples. More detailed reproductive research including histological observation and hatching time is needed to determine whether there are regional differences in reproduction.

Conclusion

This study has shown that snake fish are long lived and that the female is larger than the male. This insight may have implications for assessment of harvesting potential where this species is used as food material.

References

Kimura, D.K. 1980. Likelihood methods for the von Bertalanffy growth curve. Fishery Bulletin 77:765-776.

Mihara, Y. 2002. Growth and age of pointhead flounder *Hippoglossoides pinetorum* in the coastal waters off southwestern Hokkaido. Scientific reports of Hokkaido Fisheries Experimental Station 63:21-32.

Nakabo, T. 2002. Fishes of Japan. Tokai University Press, Tokyo. 1749 pp. (in Japanese)

Noichi, T., M. Kusano, D. Ueki and T. Senta. 1993. Feeding habit of fishes eating settled larval and juvenile Japanese flounder (*Paralichthys olivaceus*) at Yanagihama Beach, Nagasaki Prefecture. Bulletin of the Faculty of Fisheries, Nagasaki University 73:1-6.

Sasaki, M., N. Mitsutani, S. Nishiuchi, F. Shiokawa and T. Takahashi. 2004. Age and growth of *Sebastes schlegeli* in the coastal waters of Shiribeshi subprefecture, Hokkaido, Japan. Bulletin of the Japanese Society of Fisheries Oceanography 68:232-238

Sakai, T., M. Yoneda, T. Shiraishi, M. Tokimura, H. Horikawa and M. Matsuyama 2009. Age and growth of the lizardfish *Saurida elongate* from the Tsushima/Korea Strait. Fisheries Science 75:895-902.

Shibuno, T., T. Shigeta, O. Abe, H. Fujita, H. Hashimoto and K. Gushima. 1996. Feeding habits of *pinguipendid* and *synodontid* fishes at Kuchierabu-jima. Journal of the Faculty of Applied Biological Science, Hiroshima University. 35:105-111.

Watanabe, K., M. Kaita, R. Hanada and A. Ito. 2003. Age, growth and spawning season of the devil stinger, *Inimicus japonicas,* in the coastal waters of Niigata. Nippon Suisan Gakkaishi 69:201-207.

Yang, J.-L., L.-H. Chen and T.-J. Hu. 2013. Maturity and spawning of painted lizardfish, *Trachinocephalus myops* (Bloch and Schneider, 1801) in the southeastern China Sea. Journal of Applied Ichthyology 29:1050-1055.

Yoneda, M., T. Sakai, M. Tokimura, H. Horikawa and M. Matsuyama. 2002. Age and growth of the lizardfish *Saurida* sp. 1 in the East China Sea using otolith ring marks. Fisheries Research 55:231-238.

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