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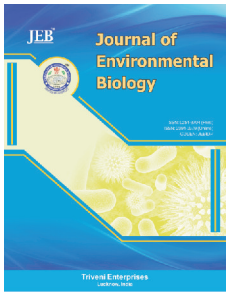

Age composition of two dominant fish species in fringing shallow water of Bidong Island, South China Sea, Malaysia

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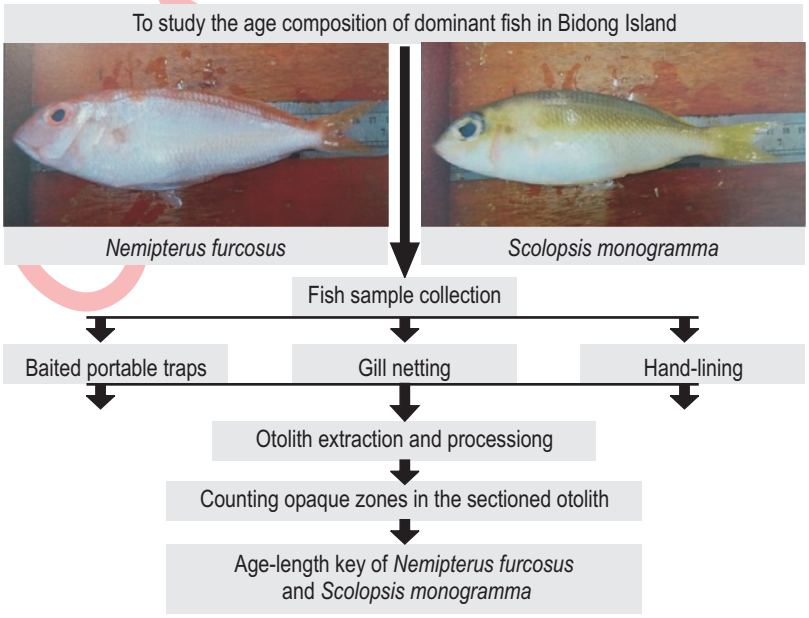
Abstract

Aim : The age composition of Monogrammed monocle bream, *Scolopsis monogramma* and Fork-tailed threadfin bream, *Nemipterus furcosus* in fringing shallow water of Bidong Island, South China Sea was studied for the first time.

Methodology : Fish samples were collected by baited portable traps, gill netting and hand-lining during pre-northeast monsoon season. A pair of otoliths were extracted by the open hatch method, cleaned and embedded in epoxy resin. The fish age was determined by counting the opaque zone in sectioned otoliths and was validated by marginal increment analysis.

Results : This study found that both species comprised of older fish with *S. monogramma* in between 4 to 9 years and 4 to 8 years in *N. furcosus*. No smaller or younger fish was observed, probably due to selective sampling efforts. The marginal increment analysis recorded an increase of 11% from August to September for *S. monogramma* and by using this increase, the growth ring was expected to be completed in April. In *N. furcosus*, a 14% increase was observed and expected to be completed in January.

Interpretation : This study concluded that the *S. monogramma* and *N. furcosus* in the fringing shallow water of Bidong Island comprised of older individuals. Further studies should be carried out by extending the duration of sampling, using a wider range of legal mesh and hook sizes to potentially obtain a more comprehensive size range to investigate the growth parameters of the fish.



Introduction

The estimation of fish population dynamics is often based on the age structure data (Bermejo, 2007; Isey and Grubowski, 2007; Pope *et al*., 2010), which is important to determine the health of a population (Smith *et al*., 2007). For young fish, such data can provide a better understanding regarding factors that affect their recruitment success. For adults, the data can be used to determine the effects of fishing on the stocks, the efficiency of management practices, and to maximize yield for sustainable resources (Jones, 1992). Jacobsen *et al.* (2001) used age information to identify the abundance stability of Atlantic salmon during their feeding period in early and late winter in Norwegian Sea, while Morgan *et al*. (2013) used age data to assess the intra-annual variations in spawning time of two gadoid species in Atlantic and North Sea.

In exploited fish stocks, fishing reduces or removes older age classes and increases the relative abundance of the younger age classes (Hidalgo *et al*., 2011). Cardinale and Arrhenius (2000) described the stock age structure as being a main factor affecting fish stock abundance because older fish contribute the highest number of recruits, due to more eggs produced that lead to better survival rates of larvae compared to smaller fish. Moreover, Stewart (2011) suggested that the removal of older age classes from the most heavily exploited reef-associated fish population has reduced their resilience to environmental change.

Isomaa and Kaitala (2013) recommended that data to create a fisheries management strategy should include reliable information on the age structure of the stock. The management options required to rebuild reserves of older individuals include reducing rates of exploitation, regulating maximum length to protect older fish, change gear selectivity and create "no take" protected areas (Stewart, 2011). Brunel and Piet (2013) reported that fishery management plan should consist of promoting selective fishing to protect the youngest fish to grow and have the opportunity to reproduce before being caught. Thus, the most appropriate management strategies to protect exploited fish stocks will depend on the life history of the species being studied (Stewart, 2011). This is to implement the most appropriate regulations to promote selective fishing in terms of creating gear designs and determining the maximum length of fish that can be taken for more effective management.

Bidong Island in the South China Sea is located off Terengganu waters that comprises well-developed coral reef ecosystems with various coral and rocky reef associated fishes (Matsunuma *et al*., 2011). However, this area is not listed as a marine park, which contribute to fishing activities in the area. Both *Scolopsis monogramma* and *Nemipterus furcosus* are the most dominant commercial species found in Bidong Island (Rumeaida *et al.,* 2014). *S. monogramma* is a benthic species, usually found on sandy bottoms close to reef areas while *N. furcosus* is a demersal fish that are reportedly caught by trawls and handlines (Ambak *et al*., 2012). Mohsin and Ambak (1996) found that *S. monogramma* are usually caught in large quantities along with *Nemipterus* spp. around coral reef areas using handlines, gill nets and traps.

The dominance of *S. monogramma* and *N. furcosus* around this island not only attracts frequent gill netting activities by fishermen but also illegal trawl net operations. These activities may directly affect the population structure of these species. Knowledge on the age composition of these two species is important and can be used to assess the status of its population and will contribute to the management of the island. Therefore, this study was carried out to determine the age composition of *S. monogramma* and *N. furcosus* around Bidong Island, which are the most commercially important fish species in the area, and to observe if fisheries activities are reducing their numbers of older individuals.

Materials and Methods

Fish sampling and sample analysis : This study was carried out at Bidong Island (Lat. 5.62°, Long 103.07°), South China Sea, Malaysia. Fish sampling was carried out at three stations located in the fringing shallow waters of the island from 15th to 17th August and 12th to 14th September, 2013 (Fig. 1). Fish samples were captured during the pre-monsoon season on a three-day sampling trip once a month, by deploying baited portable traps, gill nets and handlines. Fish were measured to nearest 0.01 cm in terms of total length (TL) and standard length (SL) whereas the body weight (b.w.) was measured to the nearest 0.01 gram (g).

Otolith extraction, preparation and sectioning : The open hatch method was used to extract a pair of otoliths from fish following the procedures by Secor *et al*. (1991). Age determinations were based on the standard methods widely used in fish biology (Secor *et al*., 1991; Kendal *et al*., 2009; Pope *et al.,* 2010). One otolith from each pair was embedded in BUEHLER epoxy resin (20-8128-032) with BUEHLER epoxy hardener at a ratio of 5:1. Otolith sectioning was performed using BUEHLER Isomet 1000 precision saw equipped with diamond watering blade (15.2 cm diameter). Three thin transverse sections (0.3mm) near the otolith centre were taken, which covered a wide range. The sections were dipped in 0.02 % HCl for 15 sec before being mounted on a glass slide with a BUEHLER mounting wax Crystalbond (flow at 135°C). The otolith section was examined under a stereomicroscope with reflected light or transmitted light to enhance the detail.

Age determination : The age of fish was estimated by counting the number of opaque zones in each otolith section as shown in Fig. 2, following the methods of Akita and Tachihara (2014) and Puentes Granada *et al*. (2004). To verify the age estimates, each otolith was viewed and read twice without prior knowledge of the

Fig. 1 : Location of sampling area of the fringing shallow water of the Bidong Island, South China Sea (Source: modification of google map)

fish length or the sampling date. If the two counts differed by more than one, the otoliths were excluded from the analysis.

Age validation : Marginal increment analysis was used to validate the fish age following the methods of Kendall *et al*. (2009) and Farley *et al*. (2013). For fish with two or more opaque growth rings, the marginal increment (MI) was defined as the distance from the most recently completed zone to the otolith edge as proportion of previous completed increment (Kendall *et al.,* 2009).

Results and Discussion

A total of 35 *S. monogramma* and 33 *N. furcosus* specimens was collected and analysed. The size of *S. monogramma* range were between 12.60-22.40 cm standard length with an average of 16.40 ± 0.60 cm. Meanwhile, the size range of *N. furcosus* were just 11.00 – 18.00 cm standard length with an average of 13.20 ± 0.40 cm. The length frequency distribution showed that *S. monogramma* in the narrow band of

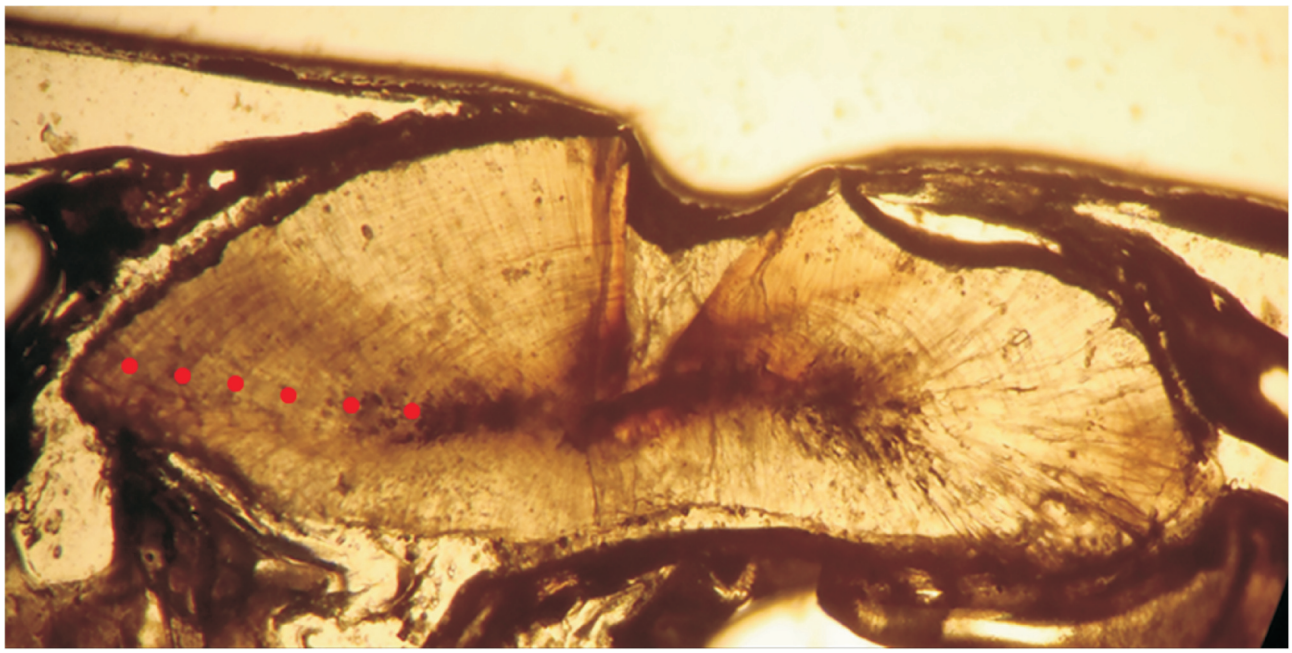


Fig. 2 : Transverse section of an otolith from a 6 year-old *Nemipterus furcosus* viewed under stereomicroscope, the point shows the opaque zones (dark) and between the points shows the translucent zones (light)

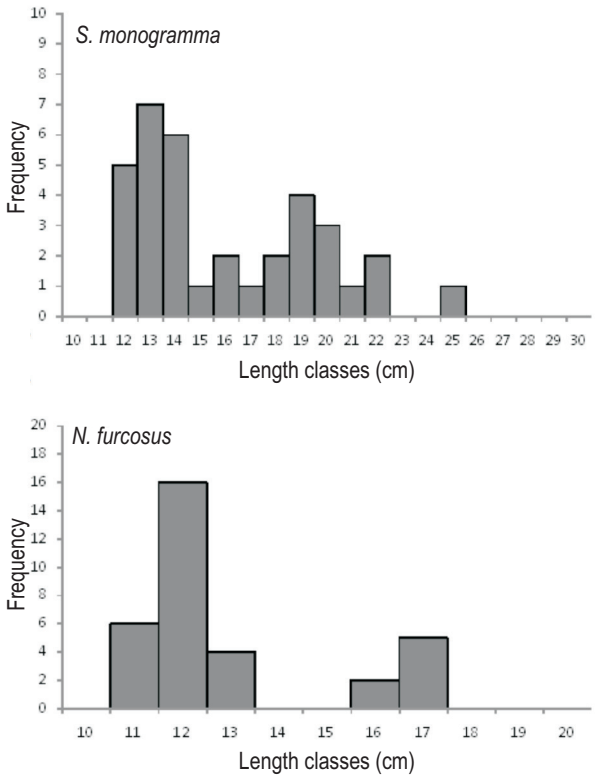


Fig. 3 : Length frequency distribution of *S. monogramma* (n=35) and *N. furcosus* (n=33) in Bidong Island, South China Sea

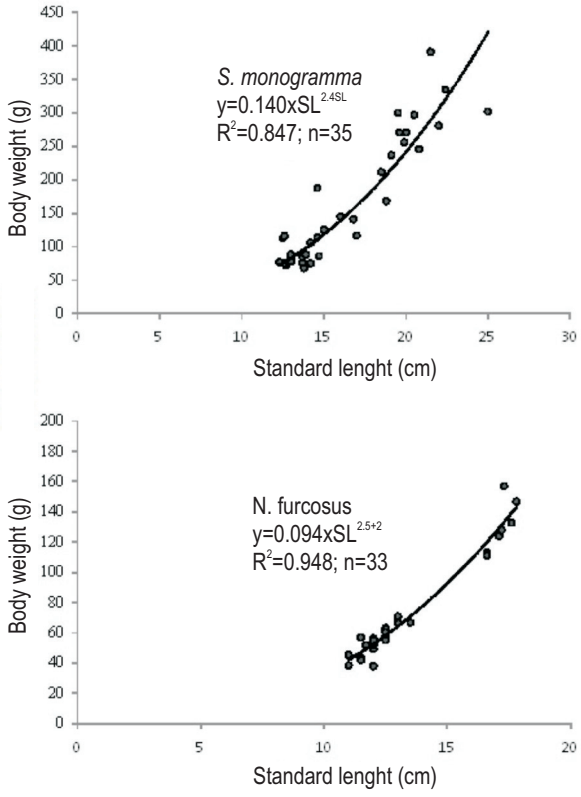


Fig. 4 : The length-weight relationship of *S. monogramma* (n = 35) and *N. furcosus* (n= 33) in Bidong Island, South China Sea

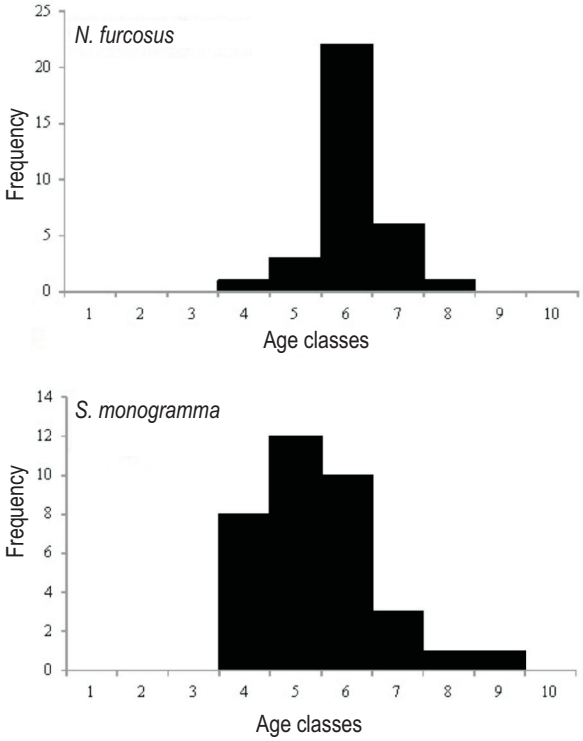


Fig. 5 : Age structure of *N. furcosus* and *S. monogramma* in Bidong Island, South China Sea

shallow water off Bidong Island was dominated by fish with a length size of 12.00 to 14.00 cm and fish with a total length of 12.00 cm dominated the catch of *N. furcosus* (Fig. 3).

The length weight relationships for both species showed that the b values were lower compared to the value of 3 for fish of isometric growth with 2.49 for *S. monogramma* and 2.54 for *N. furcosus* (Fig. 4).

Age composition analysis showed that *N. furcosus* in the shallow water of Bidong Island comprised of fish between 4 to 8 years of age with the dominant age of 6 years old. Meanwhile, *S. monogramma* aged between 5 to 9 year, dominated by 5 year old fish (Fig. 5). Limited age-length key of *S. monogramma* showed that the smallest fish collected in this study were 12 cm and up to 7 year old, while the oldest fish were 9 years old and 19 cm (Table 1). For *N. furcosus* the smallest and the largest collected fish collected were the youngest and the oldest fish, respectively, and average age and size were 6 years old at 16 cm in length (Table 2).

Limited marginal increment analysis of *S. monogramma* found that the MIA in August was 0.42 and then increased at 11% to 0.47 in September. Limited marginal increment analysis of *N. furcosus* also showed an increase of 14 % from August at 0.49 to September at 0.56, respectively.

This study found that the sample size of both species were small, even though these two species were commercially most dominant fish in this area (Rumeaida *et al*., 2014). Mohsin and Ambak (1996) reported that *N. furcosus* was abundant from July to September in Terengganu waters, which was also the sampling time in this study. Isa *et al*. (1998) reported that a survey in the east coast of Peninsular Malaysia in 1995 and 1996 found that both *Scolopsis* spp. and *Nemipterus* spp. commonly occur in deeper waters at 50-70 m in depth during pre-northeast monsoon season, which may be the reason for the small sample size for both species collected in Bidong Island.

The length frequency distribution analysis of *N. furcosus* in the shallows water of Bidong Island indicates that the size distribution was smaller than common size caught in Malaysia, that ranged between 15-25 cm with maximum size of 35 cm (Mohsin and Ambak, 1996). Mohsin and Ambak (1996) also reported that the common length of this fish in the east coast of Peninsular Malaysia was 20 cm compared to 12 cm found in this study. No study has been found on *S. monogramma* in Malaysia. However, a study by Akita and Tachihara (2014) in Japan recorded the bigger fish compared to fish in Bidong Island. These decreases in sizes for both species may be caused by their abundance and prey or predator species or by fishing intensity and genetic differences between local populations (Puentes Granada *et al.,* 2004).

Length weight relationship analysis showed that both species have negative allometric growth. Isa *et al*. (1998) reported that the b value for *Nemipterus* spp. in pre-monsoon season were in between 2.74 to 3.20 while Mohsin and Ambak (1996) found that the value of b was in between 2.62 to 3.11. Samad *et al*. (2013) however found that a study in neighboring waters also recorded negative allometric growth of *N. furcosus* for all months except in October.

This study found that the youngest fish collected for both species were 4 year old. The absence of younger fish in this study was probably due to the sampling efforts carried out by gill netting, portable traps deployment and hand-lining. Fishing gear selectivity may influence the size and age of fish collected, since fish can avoid and escape from traps, while mesh size and hook size also may select for, or against capture of certain sizes of fish (Cappo and Brown, 1996; Santos *et al*., 2002). However, use of effective fishing gear such as trawl net is prohibited in this island.

Akita and Tachihara (2014) reported that the maximum age for *S. monogramma* was 10 years, and the mature fish would be 3 to 5 years old. In this study, the dominant age classes found were between 4 to 6 years which may indicate that *S. monogramma* in Bidong Island are mature fish. The age composition of *N. furcosus* was similar to the finding of Puentes Granada *et al.* (2004) who reported that *Nemipterus spp.* did not live beyond 10 years. However, a study by Kimoto and Johari

Table 1 : Limited age-length key of *Scolopsis monogramma* in fringing shallow waters of Bidong Island, South China Sea

Length	Number of growth checks (age)										Total
class	1	2	3	4	5	6	7	8	9	10	(n)
12				1	1	1	12				5
13				2	2	3					7
14				1	3	2					6
15						1					1
16				1		1					2
17					1						1
18				1	1						2
19				1	1	1			1		4
20					2			1			3
21					1						1
22				1		1					2
23											0
24											0
25							1				0
Total (n)	0	0	0	8	12	10	3	1	1	0	35

Table 2 : Limited age-length key of *Scolopsis monogramma* in fringing shallow waters of Bidong Island, South China Sea

Length	Number of growth checks (age)										Total
class	1	2	3	4	5	6	7	8	9	10	(n)
15				1	3						4
16						14					14
17						4					4
18						2	1				3
19						2					2
20											0
21							2				2
22							1				1
23							1				2
24											0
25								1			1
Total	0	0	0	1	3	22	6	1	0	0	33

(1996) in the east coast of peninsular Malaysia reported that the maximum age of this fish was 6 years, but the age determination was carried out by length-frequency analysis which may underestimate their age. Otoliths have been reported as the most suitable structure to be used as aging tools in Nemipterid fishes (Eggleston, 1972; Puentes Granada *et al*., 2004), especially in older and larger fishes (Samuel, 1990).

The increase in marginal increment analysis from August to September was used to predict the timing of opaque zone formation for both species. A 11 and 14 percent increase in *S. monogramma* and *N. furcosus* showed that the growth ring or band will be completed in April for *S. monogramma* and in January for *N. furcosus*. The ring formation is closely associated with seawater temperature (Pajuelo *et al*., 2006). Distribution of sea surface temperature in South China Sea changes during monsoon (Akhir, 2012) and January was at the end of the Northeast-monsoon season in Malaysia (Mohsin and Ambak, 1996; Tan *et al*., 2002).Tan *et al.* (2002) reported that December was the coldest month, recording the lowest sea surface temperature in South China Sea and the temperature starts to increase in January. Temperature change may influence the formation of new growth ring in these two species. Pajuelo *et al*. (2006) also found that the opaque band of coastal sparid fish was deposited during summer when the sea water temperature increases.

In the present study, the age composition of most dominant commercially important fishes in the shallow water of Bidong Island was investigated for the first time. This preliminary

study found that both *S. monogramma* and *N. furcosus* generally comprised of older individuals.

As selectivity of fishing gear involved in the sampling effort may influence the size, hence the age of fish collected and use of age composition data as indicator of population health in Bidong Island, further study should be carried out by improving sampling strategies through the deployment of fishing traps and gill nets with more diverse legal mesh sizes so the probability of capturing smaller and younger size fish would be higher. Further study should also be carried out by extending the duration of sampling as well as investigate the reproductive state of both species so that a better understanding on these species populations can be achieved.

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