

## Length-frequency Distribution and Age Composition of Groupers (Serranidae) of Exclusive Economic Zone (EEZ) East Coast of Peninsular Malaysia: implication to Fisheries Management

RUMEAIDA MAT PIAH<sup>1\*</sup>, SITI AZRINA KAMARUDDIN<sup>1</sup>, MUHAMMAD SYAZWANNUDIN JAMALUDDIN<sup>1</sup>, NURUL SAKINAH FAIZOL<sup>1</sup>, SITI NURHIDAYU BOKHRI<sup>1</sup>, TUN NURUL AIMI MAT JAAFAR<sup>1</sup>, MIN PAU TAN<sup>1</sup> and ALIAS MAN<sup>2</sup>

<sup>1</sup>*School of Fisheries and Aquaculture Sciences, Universiti Malaysia Terengganu, 21030 Kuala Nerus, Terengganu, Malaysia.*

<sup>2</sup>*Department of Fisheries Malaysia, Ministry of Agriculture and Agro-Based Industry, Federal Government Administrative Centre, 62628 Putrajaya, Malaysia*

\*Corresponding author: rumeaida@umt.edu.my

**Abstract:** Length-frequency distribution and age composition of fish stock is important parameters in determining the biological status of the population. This study aims to investigate those parameters of grouper population lives in the Exclusive Economic Zone of the East Coast of Peninsular Malaysia. Fishes were sampled during the National Demersal Trawl Survey in the Exclusive Economic Zone of East Coast of Peninsular Malaysia by the Department of Fishery Malaysia. Age of the fish was determined from the observation on the annuli in the cross section of the otolith. Result shows that *Epinephelus areolatus*, *E. sexfasciatus* and *E. heniochus* in this area comprise of small of 6 cm to 40 cm in total length and dominated by young individuals of 4-year old. The findings from this study can be used as reference for future development of management measures in managing fisheries in the country.

**Keywords:** Age composition, groupers, Malaysian fisheries, EEZ

**Abstrak:** Taburan frekuensi panjang dan komposisi umur stok ikan adalah parameter penting untuk menentukan status biologi populasi. Kajian ini bertujuan untuk mengkaji parameter populasi ikan kerapu dari Zon Ekonomi Eksklusif Pantai Timur Semenanjung Malaysia. Ikan-ikan disampel semasa Survei Ikan Demersal Kebangsaan menggunakan pukot tunda di Zon Ekonomi Eksklusif Pantai Timur Semenanjung Malaysia oleh Jabatan Perikanan Malaysia. Umur ikan ditentukan dari pemerhatian ke atas annuli pada keratan rentas otolith. Kajian ini mendapati bahawa *E. areolatus*, *E. sexfasciatus* dan *E. heniochus* di kawasan ini terdiri daripada individu-individu yang kecil dengan panjang keseluruhan dari 6 sm hingga 40 sm dan muda dengan kebanyakannya berumur 4 tahun. Penemuan dari kajian ini boleh digunakan sebagai rujukan untuk pembangunan langkah-langkah pengurusan perikanan negara pada masa hadapan.

### Introduction

The total area of Malaysia Exclusive Economic Zone (EEZ) is estimated at 548 800 km<sup>2</sup> and 54% of it comprised of the Peninsular Malaysia Exclusive Economic Zone (Jamil and Hadil, 2012). Meanwhile, East Coast of Peninsular Malaysia (ECPM) EEZ alone is about 130 300 km<sup>2</sup> (Pauly, 2016) with high fish diversity (approximately 1 500 fish species) and 358 species is commercially important (Ghaffar *et al.*, 2005). The EEZ has been explored by fishing gears particularly trawls, gill nets and others. Pauly (2016) also stated that the resources at the ECPM EEZ is more exploited by fishermen from Thailand. However, there is limited information available on the status of fish resources in the area.

In 2016, the Department of Fishery Malaysia has conducted an extensive survey to assess the status of demersal fishes in the EEZ of Malaysia including in the East Coast of Peninsular Malaysia. During this survey, three species of groupers; the Sixbar grouper, *Epinephelus sexfasciatus*, Bridled grouper, *Epinephelus heniochus* and Areolate grouper, *Epinephelus areolatus* were found to be the most dominant. This study aims to determine the length frequency distribution and age composition of groupers collected from the ECPM in order to investigate the biological status of this commercially important species.

Determination of age composition is one of the most important parameters in population dynamic study (Ono *et al.*, 2015), where the information is vital for further analyses on the growth parameters, mortality rate and estimation of stock population (Pope *et al.*, 2010) and to determine the health of a population. A reliable and accurate information about the age structure of a fish population, is one of the basic criteria's, which is important to manage fishery or a population of a species (Anderson *et al.*, 1992). Isomaa *et al.*, (2014) recommended that the data to create a fisheries management strategy should include the reliable information on the age structure of the stock.

The purpose of this study was to describe the length frequency distribution and age composition of the Sixbar grouper, *Epinephelus sexfasciatus*, Bridled grouper, *Epinephelus heniochus* and Areolate grouper, *Epinephelus areolatus* collected from the EEZ East Coast of Peninsular Malaysia. As proposed by Reuter (2016) this knowledge is necessary for stock assessment and to develop management or conservation plans of fish population.

## **Materials and methods**

### *Fish sampling and sample analysis*

Fish samples were obtained during the National Demersal Trawl Survey within the ECPM EEZ by the Department of Fishery, Malaysia from May to July 2016. A total of 155 sampling stations were included in this survey. Each station was trawled for one hour by using the trawl net. The samples obtained were stored in lab freezer until further experiment. The samples were thawed a day before analysis. The total length and standard length of each sample was measured with measuring board to the nearest 0.01 centimeter (cm) and the weight was recorded to the nearest 0.01 gram (g).

### *Otolith extraction, preparation and sectioning*

Open the hatch method was used to extract a pair of otoliths from groupers following the procedures described by Secor *et al.*, (1991). One otolith from each pair was embedded in BUEHLER epoxy resin (20-8128-032) and BUEHLER epoxy hardener with the mix ratio of 5:1. Otolith sectioning was performed using BUEHLER Isomet 1000 precision saw equipped with diamond watering blade 15.2cm in diameter. Three thin transverse sections (0.3 mm) that covered the widest range near the otolith centre were used. The otolith section was mounted on a glass slide and examined under stereomicroscopes with reflected light or transmitted light to enhance the detail.

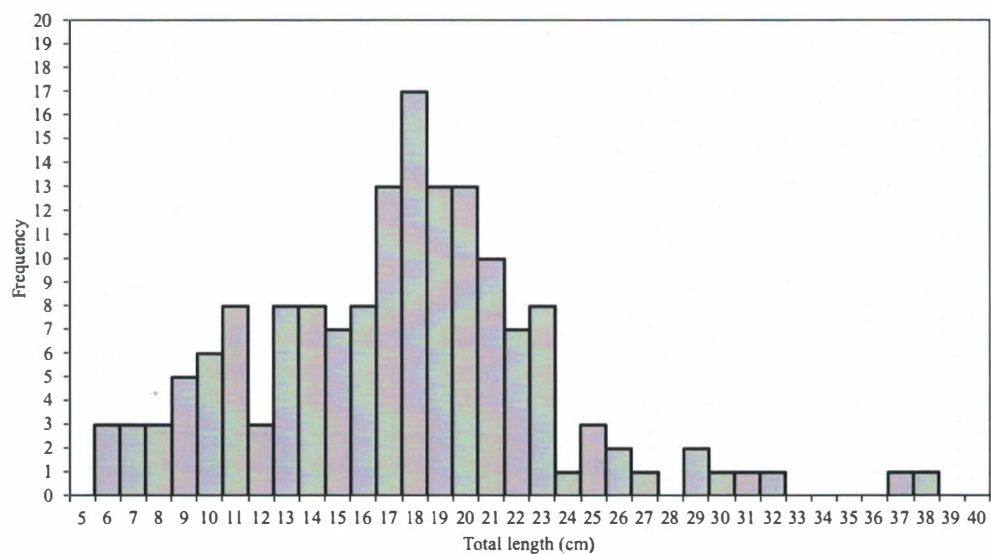
### *Age determination*

Age of fish was estimated by counting the opaque zones in each otolith section. To verify the age estimates, each otolith section was viewed and read twice without prior knowledge of the fish length or the sampling date. If the two counts differed by more than one, the otoliths were excluded from the analysis.

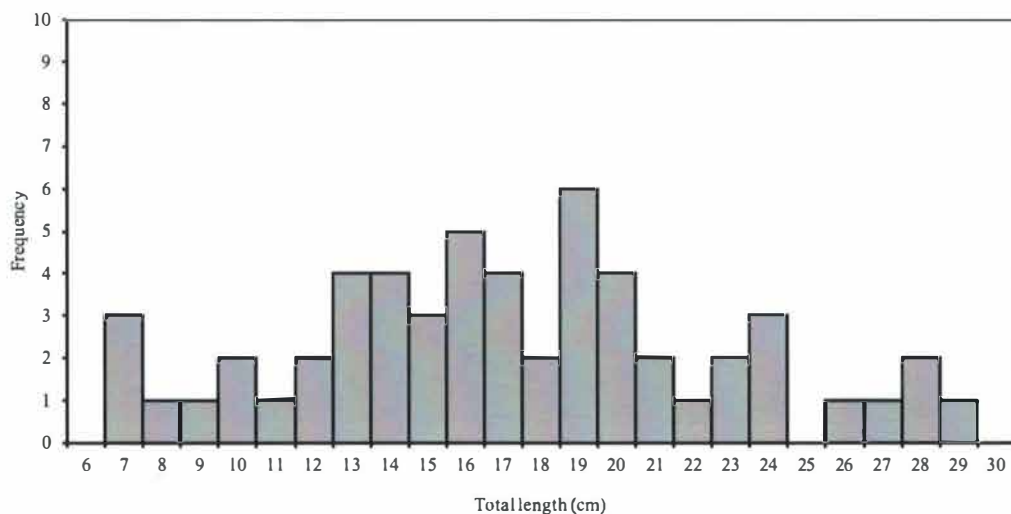
## Results

### Length-frequency distribution

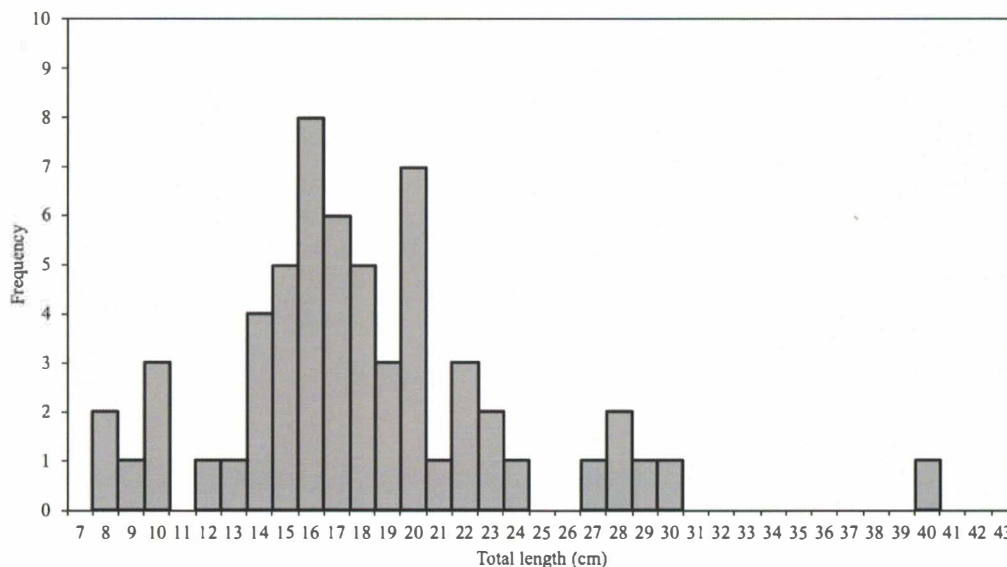
A total of 156 Areolate grouper, *E. areolatus*, 55 Six-bar grouper, *E. sexfasciatus* and 61 Bridle grouper, *E. heniochus* were sampled during this survey. Fig.1-3 showed the length frequency distribution of all three grouper species. The size of *E. areolatus* ranged between 6.0 and 38.0 cm with mostly in 17.5-18.5 cm length class. For *E. sexfasciatus*, the size ranged between 7.0 cm to 29.0 cm with the dominant size was in 18.5-19.5 cm length class. The size of *E. heniochus* ranged from 8.0 cm until 40.0 cm with most fish was in between 15.5-16.5 cm length classes.



**Figure 1:** Length-frequency distribution of *E. areolatus* collected from the Exclusive Economic Zone of the East Coast of Peninsular Malaysia (n =156)



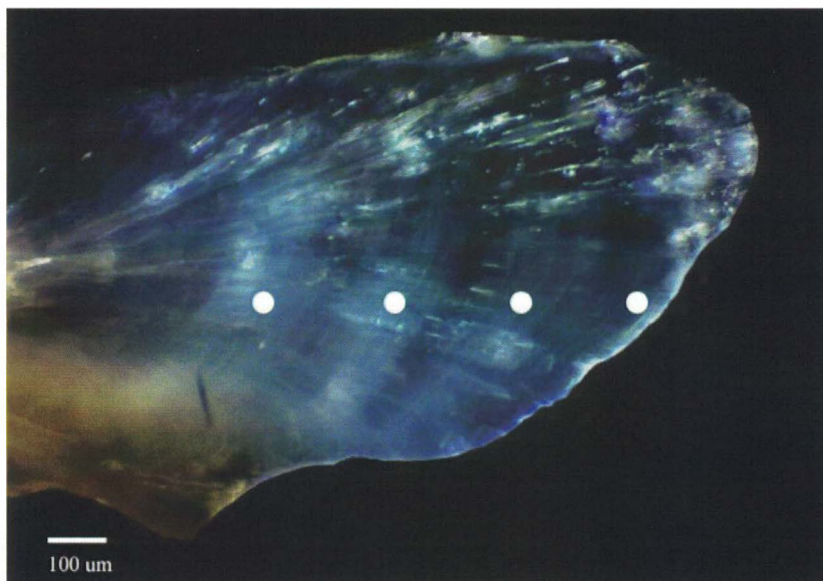
**Figure 2:** Length-frequency distribution of *E. sexfasciatus* collected from the Exclusive Economic Zone of the East Coast of Peninsular Malaysia (n =55)



**Figure 3:** Length-frequency distribution of *E. heniochus* collected from the Exclusive Economic Zone of the East Coast of Peninsular Malaysia (n = 61)

*Age composition of groupers*

In this study, 140 otoliths of *E. areolatus*, 42 otoliths of *E. sexfasciatus* and 54 otoliths of *E. heniochus* were successfully analysed for age composition by counting the number of opaque zones as shown in Fig.4.



**Figure 4:** The example of sectioned otolith of grouper, where the opaque zones were marked with white circles.

The age-length key for *E. areolatus* was shown in Table 1. The analysis of age composition showed that the age of this species collected from ECPM EEZ was between 0 to 12 years old with the most dominant age at three years old.

The age-length key analysis for *E. sexfasciatus* as shown in Table 2 revealed the smallest fish was one year old, the largest fish was six years old and the dominant age was three and four years old. The age of *E. heniochus* ranged from one to seven years old with the dominant age was four years old (Table 3).

**Table 1:** The age-length key of *E. areolatus* from the Exclusive Economic Zone of Peninsular Malaysia, Malaysia (n = 140)

Total Length (cm)	Age Classes (Year)												Total number (n)	
	0	I	II	III	IV	V	VI	VII	VIII	IX	X	XI		XII
6	1	2												3
7	1	3	1											5
8	1	1												2
9		3												3
10		2	3											5
11		4		1										5
12			1	2										3
13		1	2	5										8
14			6	2										8
15				6										6
16			1	4	3	3								11
17			1	8	2	1	1							13
18			2	4	3	3	2							14
19				3	2	2	1							8
20					6		3	1	1					11
21				1	5	1		1	2					10
22					1	4	2	1	1					9
23							1			1				2
24					1			1						2
25					1	1								2
26									2		1			3
27														0
28										1				1
29										1	1			2
30														0
31												1		1
32											1			1
33														0
34														0
35														0
36														0
37												1		1
38													1	1
<b>Total number (n)</b>	<b>3</b>	<b>16</b>	<b>17</b>	<b>36</b>	<b>24</b>	<b>15</b>	<b>10</b>	<b>4</b>	<b>6</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>2</b>	<b>140</b>

**Table 2:** Age-length key of *E. sexfasciatus* from the Exclusive Economic Zone of Peninsular Malaysia, Malaysia (n = 42)

Total Length (cm)	Age Classes (Year)						Total number (n)
	I	II	III	IV	V	VI	
6	2						2
7	1	1					2
8							0
9	1						1
10							0
11							0
12		1					1
13	3	2	1				6
14		2					2
15			1	1			2
16			3				3
17			1	1			2
18				2			2
19			1	2			3
20			3	2			5
21					2		2
22							0
23				2	1		3
24					1		1
25					1		1
26					1		1
27							0
28						3	3
<b>Total number (n)</b>	<b>7</b>	<b>6</b>	<b>10</b>	<b>10</b>	<b>6</b>	<b>3</b>	<b>42</b>

**Table 3:** Age-length key of *E. heniochus* from the Exclusive Economic Zone of Peninsular Malaysia, Malaysia (n= 54)

Total Length (cm)	Age Classes (Year)							Total number (n)
	I	II	III	IV	V	VI	VII	
6								0
7	1							1
8		2						2
9		2						2
10		1						1
11								0
12		1						1
13		1	1					2
14		2	3	2				7
15			2	2				4

16		3	2				5
17		2	2				4
18		1	4	1			6
19			2				2
20			5	2			7
21				1			1
22				3			3
23				1			1
24							0
25							0
26							0
27					1		1
28				2	1		3
29							0
30						1	1
<b>Total number (n)</b>	<b>1</b>	<b>9</b>	<b>12</b>	<b>19</b>	<b>10</b>	<b>2</b>	<b>54</b>

### Discussion

The length-frequency distribution is widely used and important in biological parameter and assessment such as length-weight relationship, reproduction of fish and length selectivity of commercial fish gears. In this study, the maximum total length of *E. areolatus* was 38 cm, however 99% of the samples collected was less than 33 cm. Previous study by Abdul-Kadir *et al.* (2016) on the reproductive aspects of the same species from Terengganu waters revealed that the total length at maturity ( $L_m$ ) of *E. areolatus* ranged between 32.6 cm to 35.7 cm. Hence, it was deemed that majority of the particular fish species obtained during the survey at ECPM EEZ was small in size and immature. Abdul Kadir *et al.*, (2016) also reported that the length at first maturity of *E. sexfasciatus* in Terengganu waters was between 22.80 to 24 cm. Comparing to the length frequency distribution of the similar species observed in this study, a high frequency of fish was below this size though not as high as *E. areolatus*. Kuitert and Tonozuka (2001) also reported that the maximum size of *E. sexfasciatus* in Indonesian water was 40.0 cm, far bigger than the largest fish found in this study at only 29 cm.

The length-frequency distribution of *E. heniochus* ranged from 8.0 until 40.0 cm with the largest size at 39.8 cm. Based on previous study by Yagishita *et al.* (2003), the length of this species sampled in Korea was 17.6 cm of standard length. However, it was reported that this species is able to attain for at least 35 cm in standard length (Haemstra & Randall, 1991) and 43 cm of total length (Froese & Pauly, 2016). No data on reproductive aspects of *E. heniochus* in the similar environment or water bodies was reported hence the IUCN red list listed this species as Data Deficient but need continuous monitoring.

The data on age composition also may reveal the status of the population. The stock age structure can contribute to the abundance of fish stock through reproductive potential of older individuals (Cardinale and Arrhenius, 2000). Most of *E. areolatus* in this area is younger fish, where the higher frequency of fish was below 5 years old. Similar trend was observed for the other two grouper species collected in this study. Many tropical fish including groupers can live for more than 30 years old (Choat and Robertson, 2002) so the fish obtained in this study comprised of smaller and younger individuals which would affect the rate of fecundity and recruitment to the stocks which will have direct impact to the species abundance and stability.

In conclusion, *E. areolatus*, *E. sexfasciatus* and *E. heniochus* collected by trawl net during the National Demersal Trawl Survey in the ECPM EEZ by the Department of Fishery, Malaysia from May to July 2016 comprised of small, immature and young individuals so management measures should be taken to increase the number of mature and older individual in the stock for its future sustainability. Stewart (2011) proposed some of the management action that can be taken such as reducing rates of exploitation, regulated maximum length to protect older fish, changes of gear selectivity and introducing of the no take marine protected areas. Long-term monitoring of the resources in the Exclusive Economic Zone should be implemented more regularly to observe the status of these commercially importance species.

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