*Asian Fisheries Science* **31** (2018):276–283

ISSN 0116-6514
E-ISSN 2073-3720
https://doi.org/10.33997/j.afs.2018.31.04.003

Asian Fisheries Science
The Journal of the Asian Fisheries Society

# Population Characteristics of Areolate Grouper *Epinephelus areolatus* (Forsskål 1775) from Terengganu Waters, Malaysia

**NOR HAZILA ABDUL KADIR*, RUMEAIDA MAT PIAH and MOHD AZMI AMBAK**

School of Fisheries Science and Aquaculture, Universiti Malaysia Terengganu, Kuala Terengganu, Terengganu, Malaysia

## Abstract

Growth parameters of areolate grouper, *Epinephelus areolatus* (Forsskål 1775) in Terengganu waters were determined by using length frequency analysis. A total of 606 samples from two main fish landing ports in Terengganu were collected monthly between February 2014 and January 2015. Growth parameters were estimated by using FISAT II (FAO-ICLARM stock assessment tools) computer software package, which includes a direct fit of length frequency data by ELEFAN I method. The von Bertalanffy growth parameters for *E. areolatus* from Pulau Kambing fish landing port were $L_\infty$ = 50.40 cm and K = 0.36 $y^{-1}$ meanwhile samples from Kuala Dungun were $L_\infty$ = 48.30 cm and K = 0.32 $y^{-1}$. The length weight relationship for *E. areolatus* from Pulau Kambing was y = 2.9546x – 4.1931, and from Kuala Dungun fish landing port was y = 2.9438x – 4.1492. The present research findings are important for future studies and relevant for the stock assessment and fishery management of *E. areolatus* in Terengganu waters.

**Keywords:** asymptotic length, fisheries management, fish population dynamics, length weight relationship

## Introduction

Areolate grouper, *Epinephelus areolatus* (Forsskål 1775) is one of the Serranidae species that is found worldwide (Ambak et al. 2012) and reportedly the most landed grouper species in Terengganu waters (Mat Piah et al. 2018). Russell et al. (2008) considered *E. areolatus* in the Least Concern category in the IUCN Red List of Threatened Species with the justification that this species is not one of the major target species, with the addition to the restrictions on trawling within many areas of its range. They, however also reported that the details of its current abundance and parameters are unknown and likely declining due to intensive fishing efforts over soft bottom.

*Corresponding author. E-mail: zilakadir@gmail.com

*Epinephelus areolatus* is the most sought-after grouper species in Malaysia due to its taste and can be found in the most major fish markets. In Terengganu waters, they are not only landed by trawl nets, but also by fish traps and hooks and lines (DOF 2013). Currently, the study on the population parameters of this species in Malaysia is limited to the reproductive aspects (Abdul Kadir et al. 2016), so this study aimed to investigate the basic population parameters of the species such as growth parameters, length frequency distribution and length-weight relationship.

Growth parameters, length frequency distribution and length-weight relationship provide essential information for grouper management purposes (Mehanna et al. 2013). Length frequency distribution gives information on specific fish size and their corresponding frequency within a given population (Adebiyi 2013). The length-weight relationship is a useful tool for understanding the biological changes in fish stocks, predicting the condition, reproductive history of fish and in morphological comparison of species and population (Badhul Haq et al. 2011).

## Materials and Methods

A total of 606 samples were collected monthly from February 2014 until January 2015 from Pulau Kambing and Kuala Dungun fish landing ports (Fig. 1). These were the two major fish landing ports in Terengganu where most of the fish captured by fish traps were landed (Mat Piah et al. 2018). The fish samples used in this study were from the catches of portable trap fisheries. The study aimed to characterise the population characteristics of grouper from Terengganu waters and to ensure this, samples were obtained from the fisherman who operated within 12 nautical miles (nm) from the shoreline. These fishermen will go to the sea early in the morning and land their catch in the afternoon.

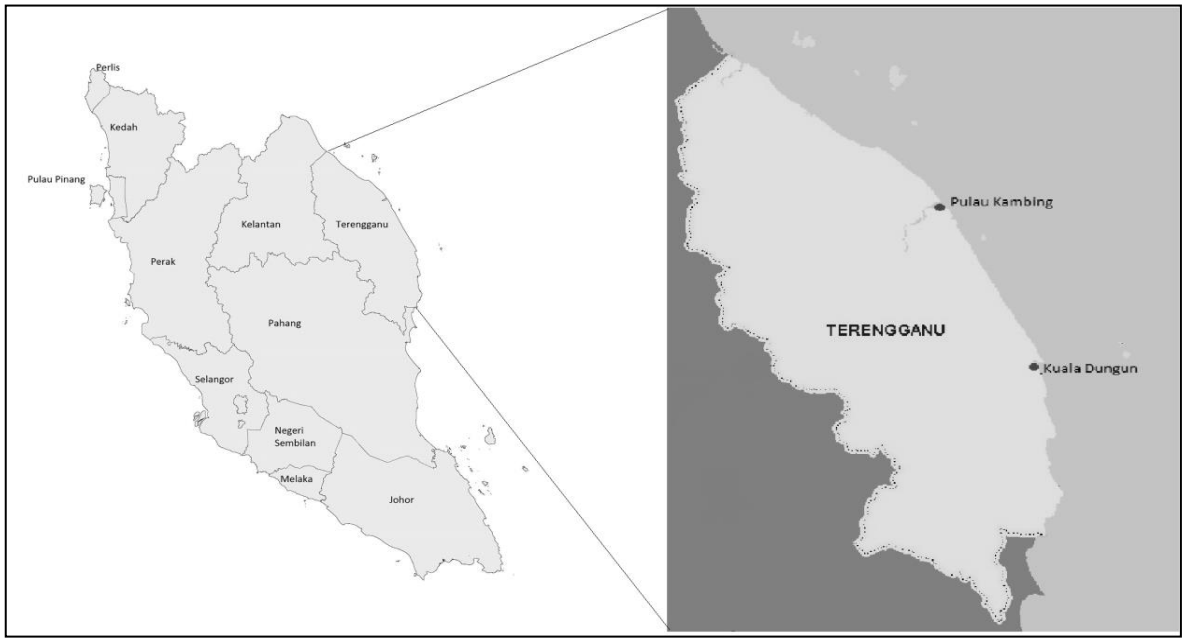


**Fig. 1.** Map of Peninsular Malaysia showing the location of sampling sites at Pulau Kambing fish landing port and Kuala Dungun fish landing port in the state of Terengganu.

The total length (TL) of all samples were measured to the nearest 0.01 cm and weighted to the nearest 0.01 g. All samples were sorted and grouped into 2 cm class interval. Growth parameters were estimated by analysing the data using FISAT II (FAO-ICLARM stock assessment tools) computer software package, which includes direct fit of length frequency data by ELEFAN I (Electronic length frequency analysis) method (Pakhmode et al. 2013).

The growth was described by using the von Bertalanffy equation:

$$Lt = L\infty\ (1 - \exp[-K(t - to)])$$

Where $L_t$ is the length at age $t$, $L_\infty$ is the asymptotic length that the species would reach, $K$ is growth coefficient, and $t_o$ is the theoretical age at length zero. The value of $t_o$ was calculated by using the equation:

$$to = t + (\frac{1}{K})(\ln\left(L\infty - \frac{Lt}{L\infty}\right))$$

The length-weight relationship was calculated by using the formula, $W = aL^b$ and was logarithmic transformed into log W = log a + b log L and fitted into straight lines, where W is weight of the fish in grams, L is the length of the fish measured in centimetres, parameter a is the intercept and b is slope of the regression.

## Results

The length frequency distribution shows that the smallest length class observed for *E. areolatus* sampled from Pulau Kambing (Fig. 2) and Kuala Dungun (Fig. 3) landing ports were 14.0–15.9 cm and 12.0–13.9 cm respectively. *Epinephelus areolatus* from Pulau Kambing fish landing port was in the range of 14 cm to 46 cm, while in Kuala Dungun, fish landed was in the range size of 12 cm to 44 cm.

The length frequency analysis showed that *E. areolatus* sampled from Pulau Kambing fish landing port consist of more than one size group as observed from the poly-modal size distribution. Most of the groupers landed at these two landing ports were in the size range of 26.0–29.9cm. There was a higher percentage (16.43 %) of large fish of above 34 cm obtained from Pulau Kambing compared to 11.53 % from Kuala Dungun landing port.

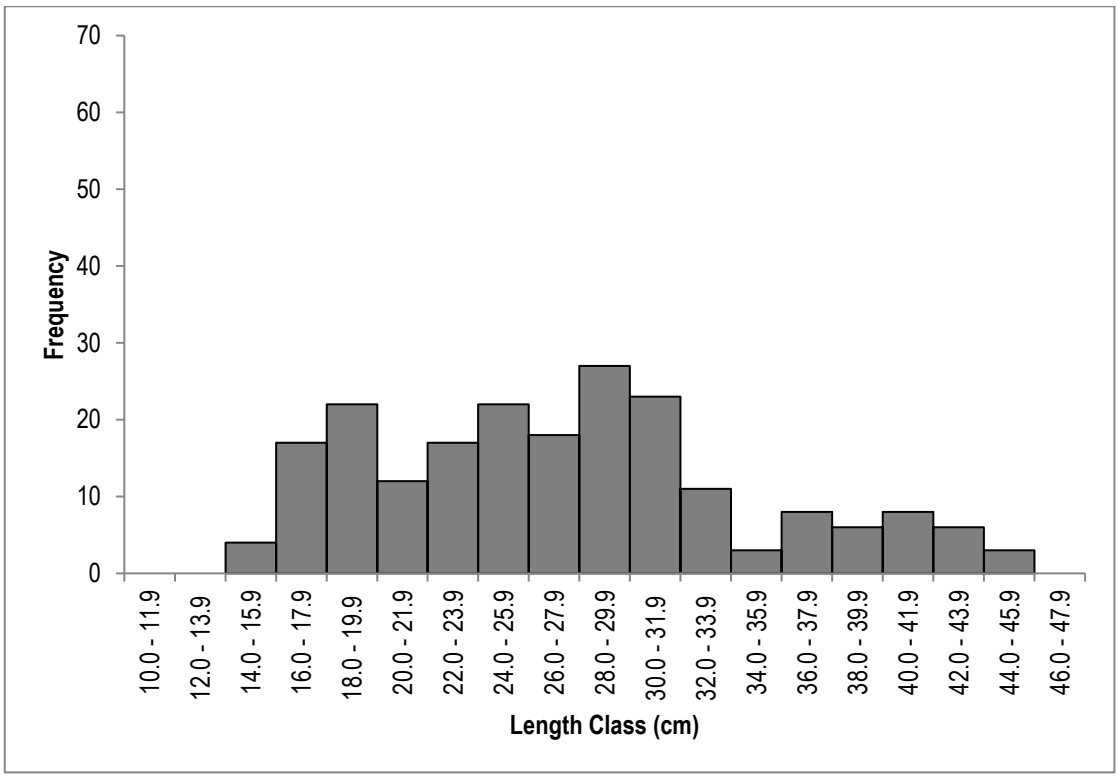


**Fig. 2.** Length frequency distribution of areolate grouper *Epinephelus areolatus* sampled from Pulau Kambing fish landing port.

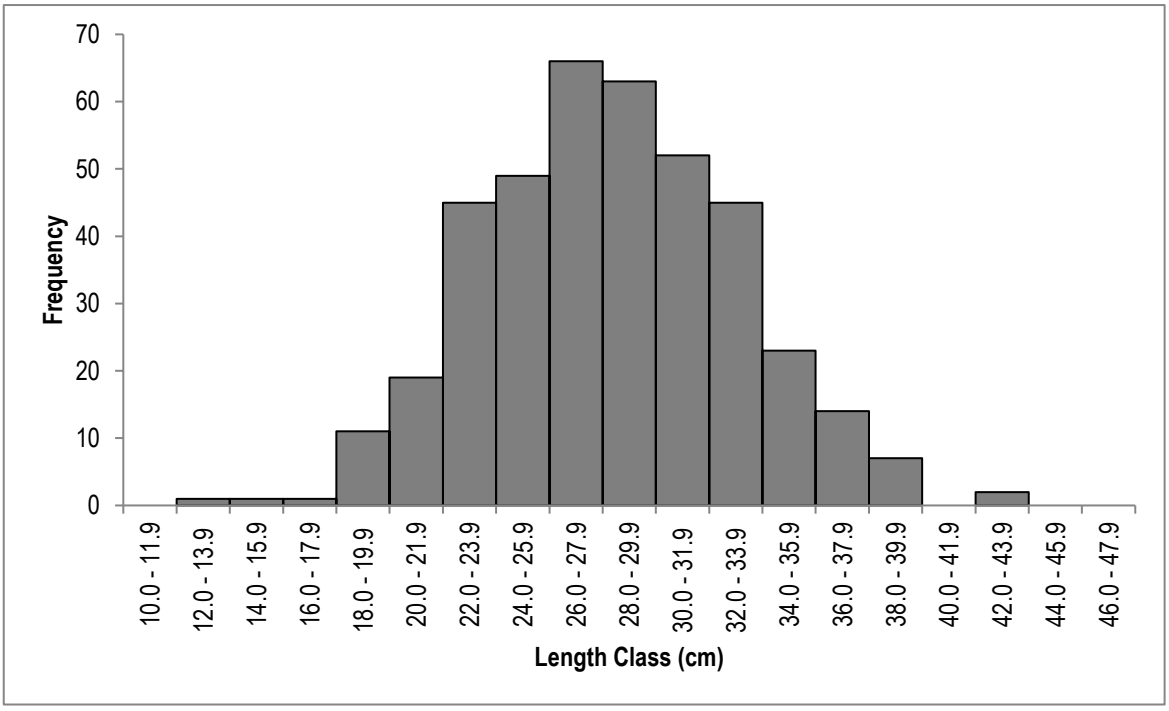


**Fig. 3.** Length frequency distribution of areolate grouper *Epinephelus areolatus* sampled from Kuala Dungun fish landing port.

The von Bertalanffy growth parameters calculated for samples from Pulau Kambing landing port were; $L_\infty = 50.40$ and $K = 0.36$ year$^{-1}$, meanwhile $L_\infty$ of those from Kuala Dungun fish landing port was slightly lower at 48.30 and the value of $K$ at 0.32 year$^{-1}$ (Table 1).

**Table 1.** Growth parameters of *Epinephelus areolatus* from Pulau Kambing and Kuala Dungun fish landing ports.

| | Pulau Kambing landing port | Kuala Dungun landing port |
|---|---|---|
| Number of samples, N | 207 | 399 |
| Growth coefficient, $K$ | 0.36 year$^{-1}$ | 0.32 year$^{-1}$ |
| Asymptotic length, $L_\infty$ (cm) | 50.40 | 48.30 |

The parameters of the length-weight relationship showed that value of b of *E. areolatus* from Pulau Kambing was 2.9546 and 2.9438 from Kuala Dungun landing port (Table 2).

**Table 2.** Summary of parameters from length-weight relationship analysis of *Epinephelus areolatus* from Pulau Kambing and Kuala Dungun fish landing ports.

| | Pulau Kambing landing port | Kuala Dungun landing port |
|---|---|---|
| Number of samples, N | 207 | 399 |
| Range length, cm | 14.70–45.20 | 13.70–43.80 |
| Range weight, g | 41.51–1423.24 | 58.22–1126.72 |
| b value | 2.9546 | 2.9438 |
| R square | 0.9871 | 0.9384 |

## Discussion

The population characteristics of *E. areolatus* is important for better understanding of this commercially exploited species, and hence the findings can be used for its management. The length frequency distribution observed in this study showed that *E. areolatus* at Pulau Kambing are comprised of several size groups in the fish population. However, only one size group fish was observed in Kuala Dungun. Normally the size of fish is related to age, thus areolate groupers landed at Pulau Kambing were comprised of several age groups. Although only one size group was recorded in Dungun, it may comprise several age groups. Areolate grouper is a sex-changing species, starting their life as females and changing to males as they grow older. According to Abd-Allah et al. (2015), the maximum age of areolate grouper estimated from otolith of 597 specimens (with length ranging from 11.2–50.5 cm) collected from the Gulf of Suez was 8 years. The mean length at age was 16.9, 24, 29.9, 35.7, 39.7, 43.4, 46.6 and 49.7 cm for the age groups from one to eight years.

A study on the reproduction aspects of *E. areolatus* by Abdul Kadir et al. (2016) reported that the length at maturity, $L_m$ of *E. areolatus* from Pulau Kambing and Kuala Dungun fish landing ports was 32.60 cm and 35.70 cm, respectively. In Vanuatu, areolate groupers mature at 22 cm, reaching a maximum of 44 cm (Pakoa 1998). When compared with the length frequency

distribution obtained in this study, it was estimated that more than 60 % of fish from Pulau Kambing and Kuala Dungun fish landing ports were below the size of length at maturity, which will affect the future sustainability of this species.

The infinite length of this species in Terengganu waters was slightly lower compared to the same species from the Gulf of Suez with was reported to be 66.55 cm (Abd-Allah et al. 2015). The von Bertalanffy growth function (VBGF) analysis of length frequency data showed that the growth rates of groupers in Terengganu were at 0.36 $year^{-1}$ and 0.32 $year^{-1}$, higher compared to the *K* value of the same species from the Gulf of Suez and Egypt at only 0.154 $year^{-1}$ (Abd-Allah et al. 2015). Other species of groupers also showed much lower K value such as *E. marginatus* (Lowe 1834) (dusky grouper) from the western Mediterranean Sea with 0.087 $year^{-1}$ (Renones et al. 2007) and *E. malabaricus* (Bloch & Schneider 1801) (Malabar grouper) from the Andaman Islands at 0.080 $year^{-1}$ (Kirubansakar et al. 2013). It can be concluded that *E. areolatus* from Terengganu waters is a slow-growing species, similar with other studies on growth rates as reported by Pauly and Ingles (1981), Bouchereau et al. (1999), Condini et al. (2014), Abd-Allah et al. (2015) and Burton et al. (2015), where the K value for slow growing species ranges between 0.08 to 0.50 $year^{-1}$.

The length-weight relationship is reflected by the expected increase in weight with increasing length irrespective of age or sex (Adebiyi 2013). In the present study, b value of *E. areolatus* at Pulau Kambing and Kuala Dungun was estimated to be 2.9546 and 2.9438, respectively. Alkahem et al. (2003) reported the b value of *E. areolatus* from Arabian Gulf was 2.950, meanwhile, Kulbicki et al. (2005) reported b value of the same species from New Caledonia was 3.048. The difference may be attributed to the physical, chemical and biological condition of the environment such as depth, dissolved oxygen, salinity and nutrient that are conducive for better growth of fish (Alkahem et al. 2003; Thomas et al. 2003).

## Conclusion

This present study found a low estimate of *K* and high $L\infty$ indicated that *E. areolatus* sampled from Terengganu waters is a slow growing and long-lived species. It is recommended that further estimation of growth parameters of the species should be done by using otolith structure of the fish. Otolith growth ring reading is a more reliable tool for age estimation in long-lived fishes due to difficulty in identification of the modal or age groups in length frequency distribution. It is also recommended that a specific management plan should be developed for the conservation of this species due to its slow growth rate and the high number of small fish observed in the samples. To reduce exploiting small fishes, the traps can be redesign to allow individuals smaller than 20 cm or 1 year old to escape. The use of hooks and line is preferable than the use of non-selective traps for the future sustainability of the grouper population.

## Acknowledgements

The authors would like to thank everyone involved in the completion of this study especially staff from the Fisheries Science Laboratory, School of Fisheries and Aquaculture Sciences, Universiti Malaysia Terengganu. The authors also want to thank Universiti Malaysia Terengganu

for providing logistic support to carry out this study. This study was conducted under Research Acculturation Grant Scheme provided by the Ministry of Higher Education, Malaysia (RAGS/2013/UMT/57098).

## References

Abd-Allah, E., A. El-Ganainy and A. Osman. 2015. Age and growth of areolate grouper *Epinephelus areolatus* from the Gulf of Suez. American Journal of Life Sciences 3:7–12.

Abdul Kadir, N.H., R.M. Piah, M.A. Ambak and N. Musa. 2016. Reproductive aspects of areolate grouper, *Epinephelus areolatus* and six-barred grouper, *E. sexfasciatus* from Terengganu waters, Malaysia. AACL Bioflux 9:1372–1379.

Adebiyi, F.A. 2013. Length-frequency distribution, length-weight relationship and condition factor of Sompat grunt *Pomadasys jubelini* (Cuvier, 1830) off Lagos Coast, Nigeria. Pertanika Journal Tropical Agriculture Science 36:337–344.

Alkahem, H.F., Z. Ahmad and A.A.A.R. Al-Dhahi. 2003. Length weight studies of *Epinephelus chlorostigma* and *Epinephelus areolatus* from Arabian Gulf. Journal of the Indian Fisheries Association 30:65–71.

Ambak, M.A., M.I. Mansor, M.Z. Zakaria and A.G. Mazlan. 2012. Fishes of Malaysia, 2nd ed. Penerbit UMT, Kuala Terengganu, Malaysia. 301 pp.

Badhul Haq, M.A., R. Vignesh, M. Srinivasan and K.H. Brajamani Meetei. 2011. A report on the length and weight relationship of Grouper *Epinephelus malabaricus* (Bloch and Scheneider, 1801) from Mandapan coastal waters (Southeast Coast of India). Archives of Applied Science Research 3:166–172.

Bouchereau, J.L., P. Body and C. Chauvet. 1999. Growth of the dusky grouper *Epinephelus marginatus* (Linnaeus, 1758) (Teleostei, Serranidae), in the Natural Marine Reserve of Lavezzi Islands, Corsica, France. Scientia Marina 63:71–77.

Burton M.L., J.C. Potts and D.R. Carr. 2015. Age, growth, and natural mortality of yellowfin grouper (*Mycteroperca venenosa*) from the southeastern United States. PeerJ 3:e1099.

Condini, M.V., C.Q. Albuquerque and A.M. Garcia. 2014. Age and growth of dusky grouper (*Epinephelus marginatus*) (Perciformes: Epinephelidae) in the Southwestern Atlantic, with a size comparison of offshore and littoral habitat. Fishery Bulletin 112:311–321.

DOF (Department of Fisheries, Malaysia). 2013. Annual Fisheries Statistics. http://www.dof.gov.my/en/fishery-statistics. Accessed 21 January 2016.

Kirubansakar, R., S. Dam Roy, Grinson George, Kamal Sarma, P. Krishnan, S. Ram Kumar, M. Kaliyamoorthy and M.P Goutham-Barathi. 2013. Fishery and exploitation of Malabar Grouper, *Epinephelus malabaricus* (Bloch & Schneider 1801) from Andaman Islands. Asian Fisheries Science 26:167–175.

Kulbicki, M., N. Guillemot and M. Amand. 2005. A general approach to length weight relationships for New Caledonian lagoon fishes. International Journal of Ichthyology 29:235–252.

Mat Piah, R., N.H. Abdul Kadir, S.A. Kamaruddin, M.N. Azaman and M.A. Ambak. 2018. Analysis of historical landing data to understand the status of grouper population in Malaysia. Malaysian Applied Biology 47:49–58.

Mehanna, S.F., A. Al-Marzouqi and B. El-Siabi. 2013. Stocks characteristics and population dynamics of the spiny cheek grouper *Epinephelus diacanthus* (Valenciennes, 1828) from Arabian Sea, Oman. Turkish Journal of Fisheries and Aquatic Sciences 13:127–132.

Pakhmode P.K., S.A. Mohite, S.D. Naik and A.S. Mohite. 2013. Length frequency analysis and length weight relationship of ribbonfish, *Lepturacanthus savala* (Cuvier, 1829) off Ratnagiri coast, Maharashtra. International Journal of Fisheries and Aquatic Studies 1:25–30.

Pakoa, K. 1998. Vital statistics of marine fishes in Vanuatu. NAGA 21(3):27–29.

Pauly, D., and J. Ingles. 1981. Aspects of the growth and natural mortality of exploited coral reef fishes. In 4th International Coral Reef Symposium, Manila, Philippines, Vol 1. pp. 89–98. Marine Science Center, University of the Philippines, Quezon City, Philippines.

Renones, O., C. Pineiro, X. Mas and R. Goni. 2007. Age and growth of the dusky grouper *Epinephelus marginatus* (Lowe 1834) in the exploited population of the western Mediterranean Sea. Journal of Fish Biology 71:346–362.

Russell, B., D. Pollard, A. Cornish, M. Kulbicki, B. Yeeting and S. Fennessy. 2008. *Epinephelus areolatus*. The IUCN Red List of Threatened Species 2008:e.T132774A3447992. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T132774A3447992.en. Accessed 4 February 2016.

Thomas, J., S. Venu and B.M. Kurup. 2003. Length weight relationship of some deep-sea fish inhabiting the continental slope beyond 250m depth along the West Coast of India. NAGA, WorldFish Center Quarterly 26(2):17–21.

*Received: 29/12/2017; Accepted: 17/12/2018; (AFSJ-2017-0143)*