

Population Parameters of Planktonic Shrimp, *Lucifer intermedius* (Decapoda: Sergestidae) from Sungai Pulai Seagrass Area Johor, Peninsular Malaysia

(Parameter Populasi Udang Plankton, *Lucifer intermedius* (Decapoda: Sergestidae) dari Kawasan Rumput Laut Sungai Pulai, Johor, Semenanjung Malaysia)

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ABSTRACT

Growth, mortality and recruitment of the sergestid shrimps *Lucifer intermedius*, collected from the Sungai Pulai seagrass area in Johor, Peninsular Malaysia was investigated between April 2007 and December 2007 using monthly length-frequency data. The shrimps were collected during the day by subsurface towing of a Bongo net with a mesh size of 500 μm for 30 minutes. Total length was measured monthly for 50 individuals and the estimated extreme length was 10.42 mm. The von Bertalanffy growth parameters, K and L_{∞} were estimated as 1.40 yr^{-1} and 11.10 mm, respectively. The growth performance index (ϕ') was 2.237 while total mortality (Z) was calculated at 5.32 yr^{-1} . The natural and fishing mortality was 2.99 yr^{-1} and 2.33 yr^{-1} , respectively. The recruitment pattern of *L. intermedius* was continuous throughout the year with two major peaks. The exploitation rate (E) was estimated at 0.44. This indicates that fishery status of *L. intermedius* in the Sungai Pulai sea grass area of Johor Strait is below the optimum level of exploitation ($E < 0.50$).

Keywords: Growth parameters; *Lucifer intermedius*; Malaysia; mortality

ABSTRAK

Tumbuhan, mortaliti dan pengrekrutan udang sergestid, *Lucifer intermedius* yang dikumpul dari kawasan rumput laut di Johor, Semenanjung Malaysia telah dikaji antara April 2007 hingga Disember 2007 dengan menggunakan data panjang-frekuensi bulanan. Udang ditangkap pada siang hari secara menarik jaring Bongo dengan saiz matjaring 500 μm di bawah permukaan air selama 30 minit. Jumlah panjang badan diukur daripada 50 individu dan anggaran panjang ekstrem adalah 10.42 mm. Parameter tumbesaran von Bertalanffy, K and L_{∞} masing-masing dianggarkan bernilai 1.40 dan 11.10 mm tahun⁻¹. Indeks prestasi tumbesaran (ϕ') adalah 2.237 manakala jumlah mortaliti (Z) pula telah dikira pada nilai 5.32 tahun⁻¹. Mortaliti secara semula jadi dan tangkapan adalah masing-masing berada pada tahap 0.44 dan 2.33 tahun⁻¹. Corak pengrekrutan bagi *L. intermedius* adalah berterusan sepanjang tahun dengan dua puncak. Kadar pengeksploitasian telah dianggar pada nilai 0.48. Ini menunjukkan yang status perikanan *L. intermedius* di kawasan rumput laut Sungai Pulai Selat Johor berada di bawah daripada paras optimum eksploitasi ($E < 0.50$).

Kata kunci: *Lucifer intermedius*; Malaysia; mortaliti; parameter tumbesaran

INTRODUCTION

The family Sergestidae of class Crustacea is divided into two subfamilies, Sergestinae and Luciferinae. The subfamily Sergestinae comprises of six genera, viz. *Acetes* H. Milne Edwards, *Peisos* Burkenroad, *Petalidium* Bate, *Sergestes* H. Milne Edwards, *Sergia* Stimpson and *Sicyonella* Borradaile while the subfamily Luciferinae is represented by a single genus, *Lucifer* Thomson (Omori 1975). In members of the Luciferinae, the body is strongly compressed and gills are absent. As for Sergestinae, gills are present and the body is moderately compressed.

Lucifer spp. are found commonly in the surface layers of tropical and subtropical waters, and they sometimes become a major component of surface-dwelling planktonic organisms (Omori 1992). The genus has been examined by several taxonomists and it currently contains seven recognised species (Bowman 1967; Kensley 1971; Petit

1973). These decapods are known to play a vital role in the food web of the tropical neritic waters and estuaries, particularly in the dynamics of the seagrass and mangrove ecosystems. There has been no published report on *Lucifer* from the coastal waters of Malaysia for the last few decades with the exception of Omori (1977).

In the field of research of fish population dynamics, there are many tools for assessing the exploitation level and stock status. Of these, FiSAT (FAO-ICLARM Stock Assessment Tools) has been widely used for estimating population parameters of shrimps (Enin et al. 1996; Etim & Sankare 1998; Jayawardane et al. 2003; Papaconstantinou & Kapiris 2001), primarily because it requires only length-frequency data. Knowledge of various population parameters is necessary for the planning and management of *Lucifer* resources such as asymptotic length (L_{∞}) and growth coefficient (K), mortality (natural and fishing) rate

and exploitation level (E). Realising the importance of the genus *Lucifer* as an intermediary link in the marine food web of the coastal waters and its possible utilization as a source of feed in culture system, studies were conducted on the population parameters of *L. intermedius* from the Sungai Pulai sea grass beds in Johor, Peninsular Malaysia.

MATERIALS AND METHODS

STUDY AREA AND SAMPLING

Monthly sampling was carried out during full moon and new moon period in Merambong seagrass beds (N 01°19.414"; E 103° 35.628") of the coastal waters of Gelang Patah, Johor (Figure 1) between April 2007 and December 2007. Samples of sergestid shrimps were collected using Bongo net (mouth diameter 0.3 m, length 1.3 m, mesh size 500 μ m). After each tow, samples were immediately fixed in 5% formalin and transported to the laboratory for further examination.

IDENTIFICATION OF *LUCIFER*

In the laboratory, all sergestid shrimps were sorted out from the rest of the zooplanktons. Then *L. intermedius* was identified using Nikon dissecting microscope with the guide from literatures (Bowman 1967; Kensley 1971; Lovett 1981; Omori 1977; Petit 1973). A total of 50 individuals were measured for their total length for each month of the sampling period.

DATA ANALYSIS

Total length frequencies data of *L. intermedius* were analysed using the MINITAB version 14 and monthly length-frequency data (Table 1) were analysed using the FiSAT computer programme (Gayanilo et al. 1996). The parameters of the von Bertalanffy growth function (VBGF), asymptotic length (L_{∞}) and growth coefficient (K) were estimated using ELEFAN-I routine (Pauly & David 1981)

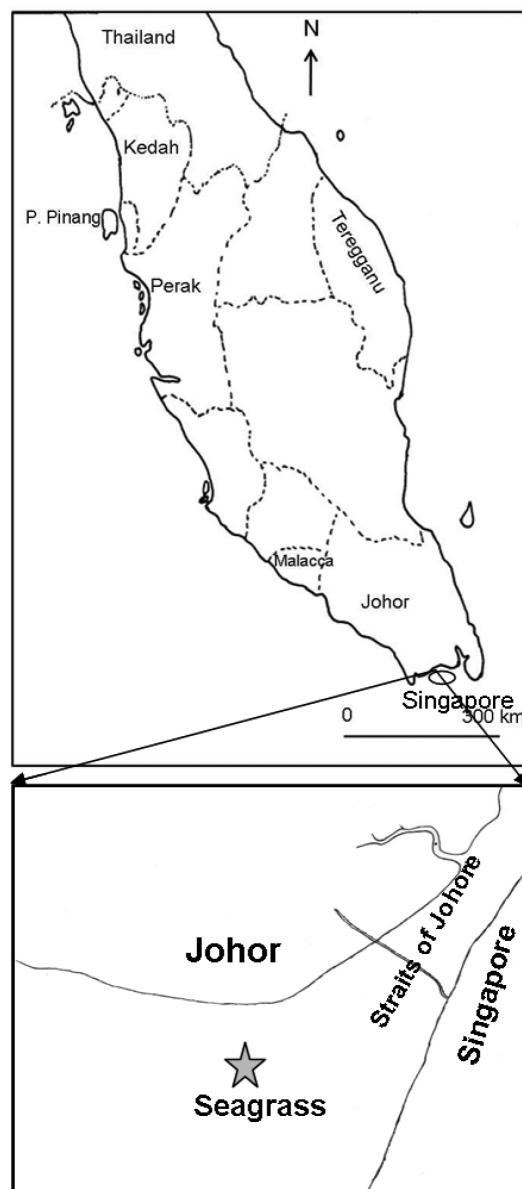


FIGURE 1. Geographical location of the sampling station in Sungai Pulai seagrass beds, Johor, Peninsular Malaysia

TABLE 1. Length-frequency data of *Lucifer intermedius* inhabiting seagrass beds of Sungai Pulai estuary, Johor, Peninsular Malaysia (April-December, 2007)

Mid Length	April	May	June	Oct	Nov	Dec
3.0	-	2	12	7	6	3
4.0	1	10	9	5	8	7
5.0	15	13	11	11	9	8
6.0	21	6	12	7	11	10
7.0	5	9	3	9	13	6
8.0	5	5	-	7	8	-
9.0	1	3	-	1	-	-
10.0	0	-	-	1	-	-
SUM	48	48	47	48	55	34

incorporated in the FiSAT software. The K scan routine was conducted to assess a reliable estimate of the K value. The estimated L_{∞} and K were used to calculate the growth performance index (ϕ') (Pauly & Munro 1984) of *L. intermedius* using the equation:

$$\phi' = 2 \log_{10} L_{\infty} + \log_{10} K \quad (1)$$

Total mortality (Z) was estimated using the length converted catch curve (Pauly 1984) and the natural mortality rate (M) was estimated using empirical relationship of Pauly (1980):

$$\log_{10} M = -0.0066 - 0.279 \log_{10} L_{\infty} + 0.6543.$$

$$\log_{10} K + 0.4634 \log_{10} T \quad (2)$$

where M is the natural mortality, L_{∞} the asymptotic length, K the growth coefficient of the VBGF and T is the mean annual habitat water temperature. Once Z and M were obtained, fishing mortality (F) was estimated using the relationship:

$$F = Z - M \quad (3)$$

where Z is the total mortality, F fishing mortality and M , the natural mortality. The exploitation level (E) was obtained by the relationship of Gulland (1971):

$$E = F/Z = F/(F+M) \quad (4)$$

The recruitment pattern of the stock was determined by backward projection on the length axis of the set of available length frequency data as described in FiSAT. This routine reconstructs the recruitment pulse from a time series of length-frequency data to determine the number of pulses year⁻¹ and the relative strength of each pulse. Input parameters were L_{∞} , K and t_0 ($t_0=0$). Normal distribution of the recruitment pattern was determined by NORMSEP (Pauly & Caddy 1985) in FiSAT.

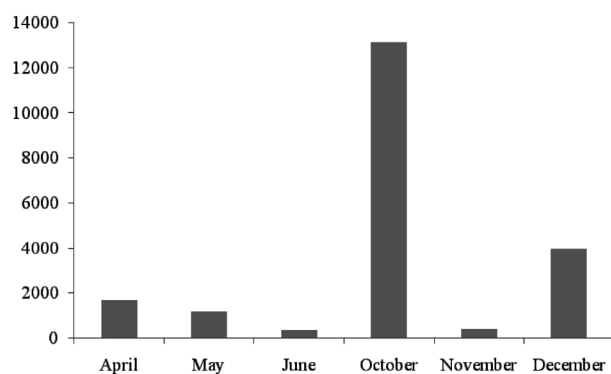


FIGURE 2. Monthly abundance of *Lucifer intermedius* (No./unit effort) in the seagrass beds of Sungai Pulai estuary, Johor, Peninsular Malaysia

RESULTS AND DISCUSSION

POPULATION STRUCTURE

The genus *Lucifer* has a long neck, a short and acute rostrum and very distinctive stalked eyes. Carapace is laterally compressed, anteriorly elongated, with mandibles widely separated between antennae and eyes. The length of the eye stalk is significant in *Lucifer* species; some has long eye stalks, where the eye and stalk are as long as the neck, while others has short eye stalks and are about half the length of the neck. A total of 20,673 *Lucifer* samples were collected from the sea grass beds of Sungai Pulai in this study. The most abundant *L. intermedius* was recorded in October with 13137 individuals per unit effort, and the lowest was in June 2007 with 367 individuals per unit effort (Figure 2). The mean total length was 5.077 ± 1.613 mm with the range between 2.15 and 9.54 mm (Figure 3).

Lucifer intermedius has been reported from the Gulf of Oman and from the Straits of Malacca to Japan (Lovett 1981; Omori 1977). The abundance of *L. intermedius* in the area of seagrass bed can be influenced by many factors such as the spawning season of the shrimps, high productivity and favourable water parameters within the area. Evidence indicates that climate variability influences the state and functioning of marine ecosystems (Willmer et al. 2000). At the same time increasing pressure from exploitation and other human activities has been shown to impact exploited and non-exploited species and this has potentially modified the ecosystem structure. As an important habitat, seagrass offers food, shelter and essential nursery areas to commercial and recreational fishery species, and to the numerous marine invertebrates that are residing within, or migrate to seagrasses. Among all ambient parameters, salinity is one of the major factors controlling species

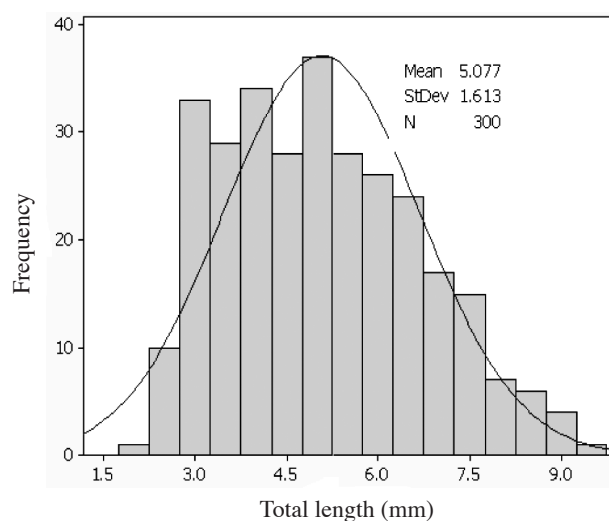


FIGURE 3. Length frequency distribution of *Lucifer intermedius* collected from the seagrass beds of Sungai Pulai estuary, Johor, Peninsular Malaysia

distribution, abundance and sex ratio for many marine organisms including shrimp (Willmer et al. 2000).

GROWTH PARAMETERS

The observed and the predicted extreme length (L_{max}) were found to be 10.00 and 10.42 mm respectively (Figure 4). The range at 95% confidence interval for extreme length was calculated as 9.04 – 11.81 mm. This initial extreme length value was used into ELEFAN-I, incorporated in FiSAT package producing the optimum growth curve. The best value of VBGF growth constant (K) was estimated as 1.40 yr⁻¹ by ELEFAN-I (Figure 5). The response surface (Rn) was calculated as 0.168 which selected the best combination of growth parameters $L_{\infty} = 11.10$ mm and $K = 1.40$ yr⁻¹. The optimized growth curve was superimposed on the restructured length-frequency histograms (Figure 6). The calculated value for the growth performance index (ϕ') of *Lucifer intermedius* during the present investigation was 2.237.

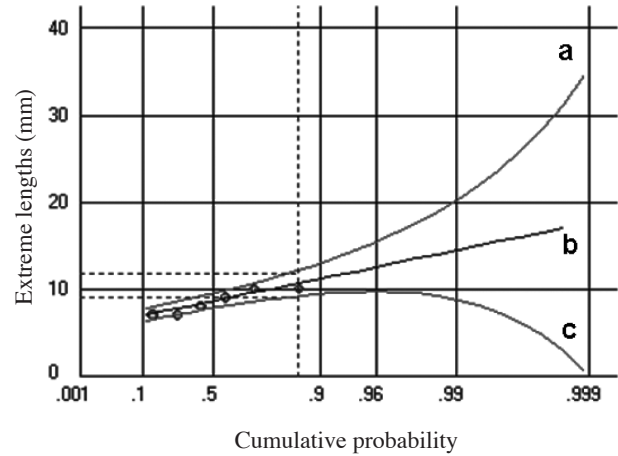


FIGURE 4. Predicted maximum length of *Lucifer intermedius*, predicted maximum length value and 95% confidence interval is obtained from the intersection of overall maximum length with the line a, b and c, respectively

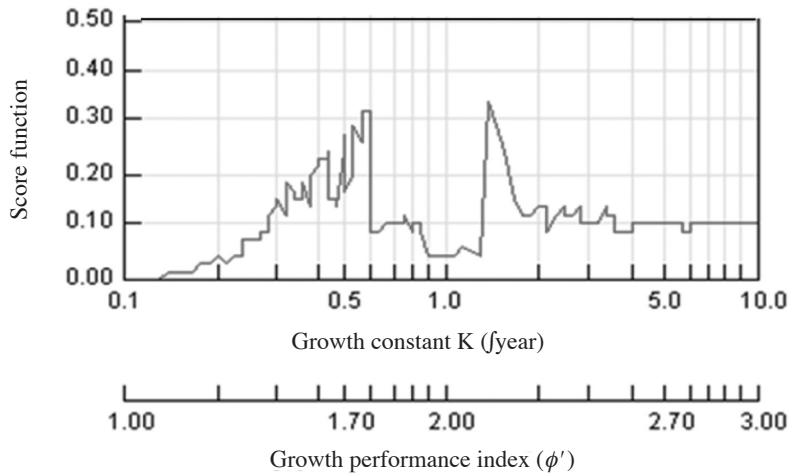


FIGURE 5. Estimation of growth constant K value of *Lucifer intermedius*

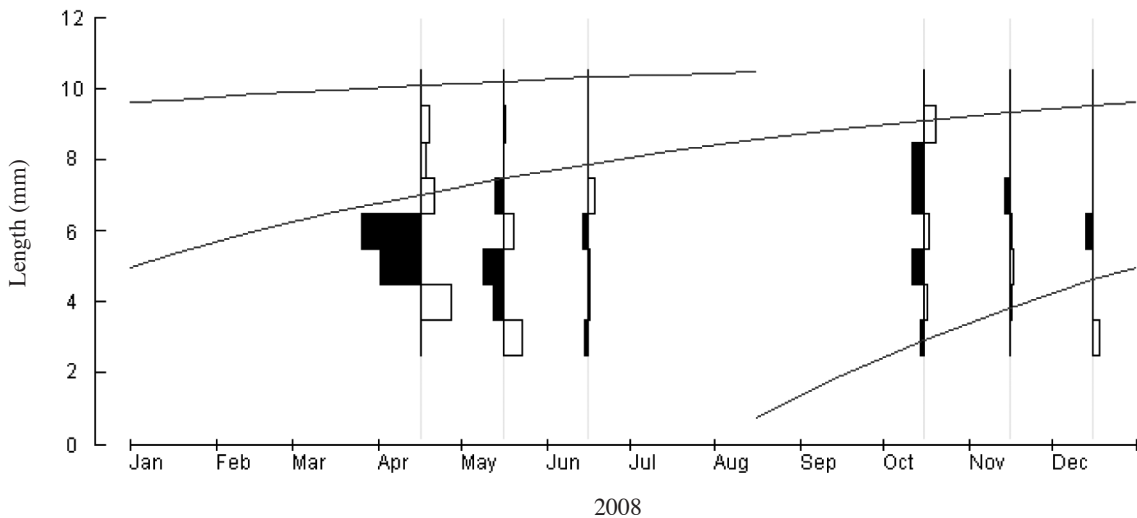


FIGURE 6. von Bertalanffy growth curves of *Lucifer intermedius* superimposed on the restructured length-frequency histograms. The black and white bars are positive and negative deviation from the “weighted” moving average of three length classes and they represent pseudo-cohorts

MORTALITY

The mortality rates M , F and Z were estimated at 2.99 yr^{-1} , 2.33 yr^{-1} and 5.32 yr^{-1} , respectively using length converted catch curve (Figure 7). The darkened quadrilaterals represent the points used in calculating Z through least squares lines regression. The blank circles represent points either not fully recruited or nearing to L_{∞} and hence discarded from the calculation. Good fit to the descending right hand limits of the catch curve was considered. The fishing mortality rate (F) obtained by subtracting M and Z was found to be 2.33 yr^{-1} (Table 2). From these figures, an exploitation rate (E) of 0.44 was obtained for *L. intermedius* in the seagrass beds of Sungai Pulai estuary, Johore which was below the optimum level of exploitation ($E = 0.50$). This is based on the assumption that a stock is optimally exploited when fishing mortality (F) equals natural mortality (M), or $E = (F/F + M) = 0.50$ (Gulland 1971).

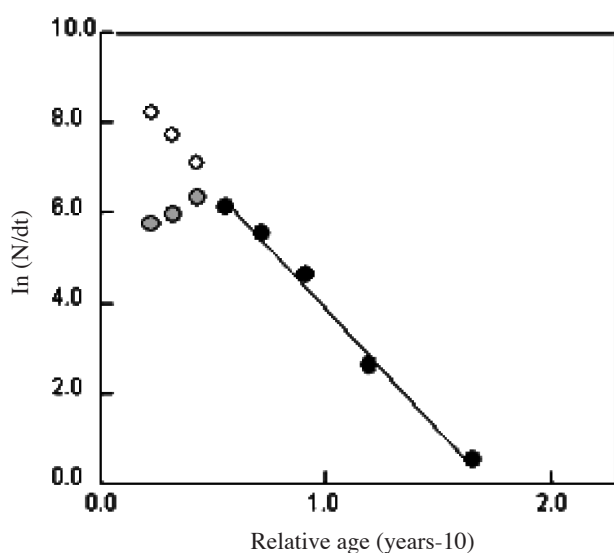


FIGURE 7. Length converted catch curve of *Lucifer intermedius*; the darkened full dots represent the points used in calculation using least square linear regression and the open dots represent the point either not fully recruited or nearing to L_{∞} .

TABLE 2. Estimated population parameters of *Lucifer intermedius* in the seagrass beds of Sungai Pulai estuary, Johore, Peninsular Malaysia

Parameter	Unit
Asymptotic length (L_{∞})	11.10 mm
Growth coefficient (K)	1.40 yr^{-1}
Growth performance index (ϕ)	2.237
Total mortality (Z)	5.32 yr^{-1}
Fishing mortality (F)	2.33 yr^{-1}
Natural mortality (M)	2.99 yr^{-1}
Exploitation level	0.44
95% confidence interval	9.04-11.81 mm

Mortality rates can be partitioned into two components, fishing and natural mortality. Higher fishing mortality versus the natural mortality observed from the present study (Table 2) indicate the unbalanced position in the stock. Fishing mortality is the result of harvest and natural predation of this shrimp. *Lucifer intermedius* is a planktonic shrimp that becomes a major component in the diets of shore fish and larger shrimps (Omori 1974).

RECRUITMENT PATTERN

The recruitment pattern of *L. intermedius* was continuous throughout the year with two major peaks (Figure 8). The recruitment varied from 1.08 to 16.86% during the study period. The highest recruitment occurred in the month of September when the lowest (1.08%) recruitment was observed in the month of June (Figure 8). This study showed two major recruitment events per year indicating two cohorts were produced in a year. This is in good agreement with other sergestid shrimps (Amin et al. 2008; Oh & Jeong 2003; Zafar et al. 1997).

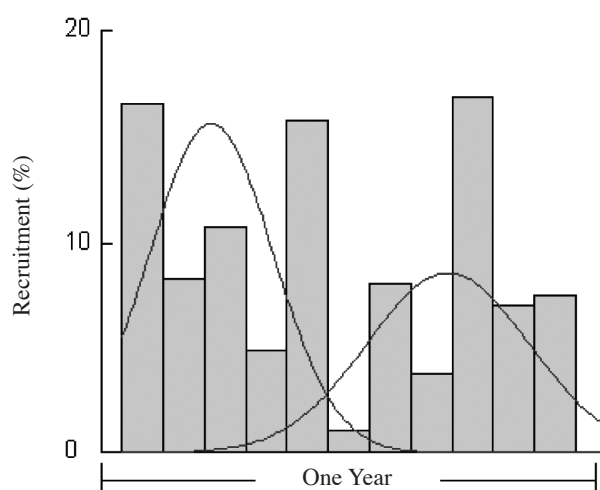


FIGURE 8. Estimated recruitment pattern of *Lucifer intermedius*

CONCLUSIONS

Lucifer intermedius was recorded from the seagrass beds of Sungai Pulai, Johore. The observed and predicted extreme lengths (L_{max}) of *L. intermedius* were 10.00 and 10.40 mm respectively with range 9.04 – 11.81 mm at 95% confidence interval during the study period. The asymptotic length (L_{∞}) estimated for *L. intermedius* was 11.10 mm and the growth coefficient (K) was estimated as 1.40 yr^{-1} . The growth performance index (ϕ) was 2.237. The fishing mortality (F) was 2.33 yr^{-1} . The value of natural mortality (M) was 2.99 yr^{-1} . The exploitation level (E) of *L. intermedius* in the Sungai Pulai seagrass bed, Johore was lower than the optimum level of exploitation.

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