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Sex ratio, spawning season and the size at maturity of *Parapenaeopsis sculptilis* (Heller 1862) in the coastal waters of Perak, Peninsular Malaysia

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Abstract

Parapenaeopsis sculptilis (Heller, 1862) locally referred to as "udang kulit keras" in Malaysia has profound biological, ecological, aquacultural and conservational significance. The reproductive biology of this important penaeid from the coastal waters of Perak, Peninsular Malaysia, was studied during the period between February 2012 to January 2013. Females outnumbered males with a sex ratio of M: F= 1:3 ($P < 0.05$). Four maturity stages of female gonads *viz*., immature, maturing, mature and spent stages were distinguished. The first stage of sexual maturity was attained at a length of 9.3 cm, and female *P. sculptilis* showed a peak gonadosomatic index during the month of April, August and October, indicating that *P. sculptilis* potentially breeds throughout the year. The findings of this study would greatly contribute towards the understanding of gonadal maturation, spawning season and breeding biology, which could be important for the effective population management of this prawn species.

Key words

Gonadal maturation, *Parapenaeopsis sculptilis*, Sex ratio, Spawning season

Introduction

Understanding the reproductive biology of genus *Parapenaeopsis* (Malacostraca: Decapoda: Penaeidae) such as their sexual cycle, spawning, maturity, breeding pattern and fecundity, is essential for the development of the aquaculture industry, as well as for the formation of management policies of fishery of this species. In tropical marine waters, where there is little seasonal fluctuation of sea temperature, many invertebrates including prawns are known to reproduce throughout the year. The maturation and spawning period of some penaeid prawns have been investigated by Menon (1953), Rajyalakshmi (1961), George (1962) and Subrahmanyam (1963). The spawning seasons of penaeid prawns are most commonly determined by the percentage of mature females present in the catch or from changes in gonadal indices (Dall *et al.*, 1990). The spawning season is identified as periods with comparatively high mean gonadosomatic indices (GSI) for both the sexes of prawns, and the occurrence of higher proportions of mature and spent shrimps among the catches (Jayawardane *et al.,* 2002). GSI has been widely used as a measure of the average reproductive status for many marine invertebrate groups (Giese and Pearse, 1974). Meanwhile, *P. sculptilis* is a commercially important species in the Malaysian and Singaporean prawn fisheries (Dall *et al*., 1990). In view of the above, the objective of the present study were to determine the maturation and spawning seasons, sex ratio and size at

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sexual maturity of *P. sculptilis* in the coastal waters of Terong, Perak.

Materials and Methods

Sampling procedure : Monthly samples of *P. sculptilis* were collected from Terong, Perak between February 2012 to January 2013. The prawns were caught using a push net locally known as 'pukat sorong'. The fishing gear consisted of synthetic or natural fiber materials attached to a triangularly-framed bamboo pole or wooden post or logs.

Sample analysis : Sex was determined by the presence of a petasma on the first pair of pleopods in males and by the absence of this in female penaeid prawns (Pérez and Kensley, 1997). The works of Dall (1957) and Hall (1962) were followed for identification of these sexual characters. Difference in sex ratio were analyzed and tested for any significant divergence from the expected 1:1 ratio by Chi-square (χ^2) goodness-of-fit test (Zar, 1999).

Ovary examinations : For each female sample, additional observations were made. Maturity states were determined using four categories based on morphological characteristics of the ovaries, according to Ayub and Ahmed (1992, 2002): Stage I (immature ovaries), Stage II (maturing ovaries), Stage III (mature ovaries) and Stage IV (spent ovaries)

In order to obtain the ovaries, the female prawns were dissected. Before dissection, the total length and body weight were measured to the nearest 0.01 cm and 0.1 g. Dissection was performed using very fine forceps, and the entire ovary was taken out and preserved in 5% formalin. The ovarian weight was determined by weighing this to the nearest 0.01 g by an electronic digital balance. The gonadosomatic index (GSI) was determined the following formula of Pillay and Nair (1971),

$$GSI \frac{\text{Ovary weight}}{\text{Female body weight}} X100$$

Results and Discussion

Sex ratio : In total, 3110 specimens of *P. sculptilis* were examined during this one-year study, out of which 710 were males and 2400 were females comprising a sex ratio of 1:3. The χ^2 test revealed that the sex ratio between males to females was significantly different ($p<0.05$).

Ovarian developmental stages : Four stages of maturity were identified in female *P. sculptilis*. The mean GSI from immature (0.46) to mature stage (6.36) was accompanied by distinct changes in color shape, size and GSI. In the present study, significant differences ($p<0.05$) in GSI were observed among different gonadal developmental stages of *P. sculptilis*. Descriptions of these various stages are as follows:

Stage I (immature) : The ovary was very thin, white, translucent and difficult to distinguish and indistinct. It was not fully developed and appeared reduced to the posterodorsal part of the stomach. The GSI values were in a range of 0.07 to 0.99 with a mean value of 0.46±0.25SD.

Stage II (maturing) : The ovary increased in size from the lobes that were developed. The ovary covered a part of the stomach, which could be observed through the carapace and the color ranged from yellowish green to light green. The GSI value ranged from 1 to 3.97, with a mean value of 2.34±0.85SD.

Stage III (mature) : The ovary was dark green in color and clearly visible through exoskeleton. The entire stomach was covered with fully developed lobes. The GSI values ranged from 4.01 to 12.95, with a mean value of 6.36±1.88 SD.

Stage IV (spent) : This stage was usually similar to the immature stage; the ovary was greatly reduced in size and was flaccid. The color was dirty yellow or white. The mean GSI values ranged from 0.01 to 0.07, with a mean value of 0.03±0.02SD.

Spawning season : About 50 females of *P. sculptilis* were examined monthly for estimation of ovarian and gonadosomatic index (GSI) from February 2012 to January 2013. The mean GSI values of females increased from February and reached a peak in April, August and October, with lowest peak in May, September and November, respectively. The highest GSI value (5.89) was observed in April, where females were at a mature stage. The lowest GSI (0.63) was obtained in November, where females were at an early active and immature phase (Fig. 1). The monthly distribution percentage of different stages of ovarian maturation is shown in Fig. 2. Stage I (immature), which occurred during February-March, June-July and September-January, was less than 50%. Stages II and III (maturing and mature) were more than 50% throughout the year and reached 100% during the month of April, August and October. Spent ovaries were observed during March, July, September and November-January.

Length at first maturity : To estimate the length at first

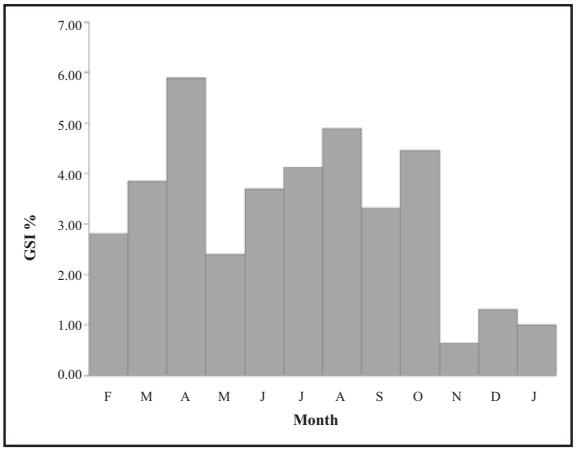

Fig. 1 : Monthly changes in gonadosomatic index (GSI) of female *P. sculptilis* in the coastal waters of Perak

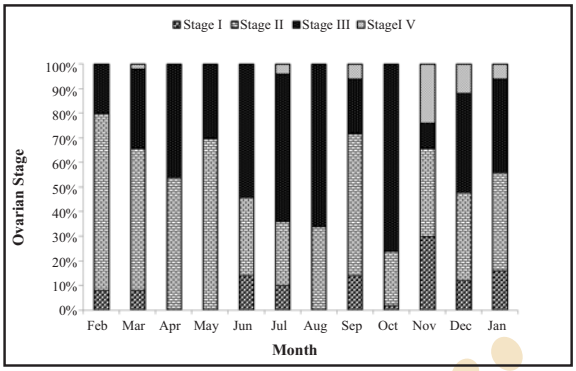

Fig. 2 : Monthly changes in percentage occurrences of each ovarian maturity stage for *P. sculptilis* collected in the coastal waters of Perak

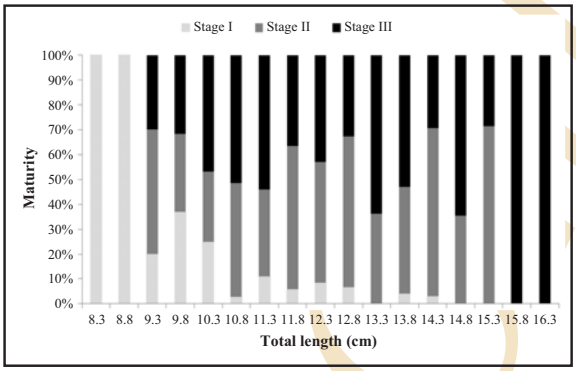

Fig. 3 : Monthly changes in percentage occurrence of each ovarian maturity stage against standard length class for *P. sculptilis* collected in the coastal waters of Perak

maturity, the percentage composition of females at each ovarian maturity stage, according to total length (TL) classes, was examined using the year round samples (Fig. 3). Stage I appeared for each TL class with the highest proportion (100%) between 8.3-8.8 cm TL class. The minimum size of mature-phase ovaries (Stage II and III) was within 9.3-9.8 cm TL class, while the maximum size was in the 16.3 cm TL class. Stages II and III first appeared (> 50%) at 9.3 cm in total length. This indicated that *P. sculptilis* females attained sexual maturity at a size of 9.3 cm in total length.

This study is significant in providing information on the reproductive biology and life history of *P. sculptilis* in the coastal waters of Terong, Perak, Peninsular Malaysia. The ratios of males to females during this one-year study were significantly different ($P<0.05$) in favor of females for most months out of the year, and this difference might be due to the migration of females to deeper waters for spawning. This is in agreement with Rao (1969) who studied the sex ratio of *P. sculptilis* in the fishery of Hooghly estuarine system, and found that the sex ratio of males to females was 1:3.24.

The method used to determine GSI has been stated to successfully predict the breeding season of prawns (Subrahmanyam, 1963). High GSI indicated a good gonad condition indicative of maturity, while low GSI indicates immature or spent gonads (Pillay and Nair, 1971). The population of *P. sculptilis* in the coastal waters of Terong, Perak had a peak GSI during April, August and October (Amani *et al*., 2015) due to increase in egg mass in preparation for spawning. Meanwhile, high GSI values for female *P. sculptilis* was observed in August, September, October and March-April from the Gulf of Khambhat (Patel and Ibrahim, 1982). Bhimachar (1963) and Rajyalakshmi (1966) reported that the spawning of *P. sculptilis* took place during December-January and April-May in Indian coastal waters. This is different with the findings of Sukumaran and Rajan (1986) who reported two GSI peaks, one in February-March and the other in July-November for *P. sculptilis* sampled from Bombay. In addition, Sunil and Suryanarayanan (2002) reported from the Kerala coast of India. The highest GSI value of *P. stylifera* in a mature stage was in February, May, July, August, September and October. However, female *P. hardwickii* showed high breeding and spawning activities during January-May (Nagabhushanam and Kulkarni, 1982). Guo (1993) reported two peaks of spawning season for *P. hardwickii* between February and April, and between October and November in the Taiwan Strait. In Bombay fishing area, the peak period was observed

from December to May (Shaikhmahmud and Tembe, 1961; Mohamed, 1967); along the Malabar Coast from November to December (Menon, 1953) and at Cochin from November to January and April (George and Rao, 1967), respectiwely. Sukumaran and Rajan (1981) reported the spawning season of *P. hardwickii* during October and April-May at Versova and during November-December at Sassoons Docks. Mohamed (1967) observed that the spawning season is protracted for *P. hardwickii* from October to February with peaks in December and January in the waters of Bombay. Ayub and Ahmed (2002) studied *P. stylifera* from Pakistan's inshore waters and observed that the spawning was more frequent from November to February.

In the present study, the size at first sexual maturity of *P. sculptilis* was found to be 9.3 cm in total length, based on the presence of mature ovaries. However, majority of the specimens attained maturity at about 9.3 to 16.3 cm size, which was slightly larger estimate than the sizes first sexual maturity from different regions of the world (Amani *et al*., 2015). This is different with finding of Menon (1953) and Rao (1968) for females of *P. stylifera* at 75 mm and 70 mm, as well as those reported by Patel and Ibrahim (1982) who found the length at first maturity for female *P. sculptilis* to be 70 mm. Meanwhile, Sukumaran and Rajan (1986) found females *P. hardwickii* matured at 73 mm in Bombay area, while Bhimachar (1963) and Rajyalakshmi (1966) showed that the size at sexual maturity for female *P. sculptilis* was 75 mm.

Based on the results obtained from the present study, the sex ratio of *P. sculptilis* was 1:3 (male: female) and the peak GSI of female *P. sculptilis* was observed during April, August and October in the study area. Sexual maturity in females was initially attained at a total length of 9.3 cm. The findings of this study would enhance the understanding of gonadal maturation, spawning season and breeding biology of *P. sculptilis*, which would ultimately contribute to the development of induced breeding, seed production and aquaculture of this commercially important prawn species.

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