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Population and feeding ecology of *Parapenaeopsis sculptilis* (Heller, 1862) in Klang Strait, Peninsular Malaysia

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ABSTRACT A study of the population and feeding ecology of the marine prawn *Parapenaeopsis sculptilis* was conducted at the mudflat off Sungai Buloh and on an offshore shoal (Angsa Bank) in the Klang Strait. The female:male sex ratio varied with the month of sampling with a range of 0.80-18.00. *P. sculptilis* showed negative allometric growth. Size at sexual maturity for *P. sculptilis* occurs at 16 mm for male and 25 mm for female. Mating and spawning could have occurred in shallow inshore water. Population densities were high at Angsa Bank and on the mudflat with mean densities of 2,246 and 1,137 individuals per hectare, respectively. Fifty-three to 68% of the prawns sampled were juveniles of 10-25 mm carapace length, indicating that the study sites function as important nursery areas. Stomach-content analysis revealed no significant diet difference between juvenile and adult prawns which fed on a variety of food comprising mainly mangrove detritus, crustaceans and molluscs.

ABSTRAK Kajian ekologi populasi dan pemakanan udang *Parapenaeopsis sculptilis* telah dijalankan di dataran lumpur Sungai Buloh dan sekitar Angsa Bank. Nisbah jantina (betina kepada jantan) *P. sculptilis* berbeza mengikut bulan penyampelan iaitu dalam julat 0.80-18.00. *P. sculptilis* menunjukan tumbesaran allometri negatif. Saiz awal matang udang jantan dan betina adalah 16 mm dan 25 mm panjang karapas masing-masing. Proses pengawanan dan peneluran *P. sculptilis* boleh berlaku di kawasan perairan cetek. Kepadatan populasi udang adalah tinggi di Angsa Bank dan dataran lumpur dengan purata kepadatan udang masing-masing, 2,246 dan 1,137 udang per hektar. Lima puluh tiga hingga 68% udang disampel merupakan peringkat juvenil dengan panjang karapas 10-25 mm, mengimplikasikan fungsi penting tapak kajian sebagai kawasan nurseri. Analisis kandungan perut menunjukan tiada perbezaan bererti dari segi diet diantara udang juvenil dan dewasa iaitu *P. sculptilis* memakan pelbagai jenis bahan makanan terutamanya detritus bakau, Crustacea dan Mollusca.

(population dynamics, feeding, *Parapenaeopsis sculptilis*, mudflat, Klang Strait)

INTRODUCTION

Twenty-eight species of penaeid prawns belonging to six genera are landed commercially in West Malaysia [1]. The three most important genera are *Metapenaeus, Parapenaeopsis* and *Penaeus. Parapenaeopsis sculptilis* contributed approximately 6% of the total of 72,727 tonnes of marine prawns landed in Malaysia for 1998 [2]. This species locally known as "udang kulit keras" is widely distributed in Malaysian waters. In Selangor, *P. sculptilis* are largely caught in shallow waters along the coast between the major estuaries of the Klang River, Langat River and Selangor River, and in Angsa Bank, an extensive sand-mud shoal situated 5-30km offshore [3].

This paper reports on some aspects of the population and feeding ecology of *P. sculptilis* in Klang Strait waters.

MATERIAL AND METHODS

Prawns were collected at a mudflat off Sungai Buloh and at Angsa Bank from July to October 1994, using an otter trawl net having a cod-end mesh size of 2 cm. Two to three 45-min trawls were made at each site. Catches were taken either whole or subsampled depending on the quantity. All specimens collected were kept in ice before analysis. Water parameters, such as temperature, salinity, pH and dissolved oxygen, were measured at sites.

In the laboratory, the prawns were measured (carapace length in mm) and weighed (in g). Sex and reproductive maturity of the prawn were determined following Chong *et. al* [3]. Maturity was classified into four stages for male and female prawns, namely, immature (stage 1), maturing (stage 2), mature (stage 3) and spent (stage 4).

For diet analysis, only the food content of the anterior proventriculus of the prawn were examined. The proventriculus was firstly classified according to its fullness, then slit open and its entire content was washed onto a rafter cell, or onto a microscope slide if the content was little. Food items were identified under a compound microscope fitted with an eyepiece (10x10 square grid) micrometer. Their percentange volumetric compositions were estimated using the eye estimated method [4]. Between 10 to 18 prawns from each site were examined for each month.

RESULTS

Water parameters

Monthly instantaneous readings of water temperature, salinity, pH and dissolved oxygen at the mudflat and Angsa Bank ranged from 28.2-30.0°C, 29.5-31.0 ppt, 8.1-8.2 and 7.3-7.5 ppm, and 29-31°C, 28.0-30.5 ppt, 8.2-8.3 and 6.7-8.2 ppm, respectively.

Length-weight relationship

The length-weight relationship of *P. sculptilis* followed the allometric function, $W = aL^b$, where a and b are constants, W is the prawn weight (g) and L is the carapace length (mm). The functional power equation obtained were:

female $W = 1.9962 \times 10^{-3} L^{2.5664}$ ($r^2 = 0.95$)
male $W = 2.3993 \times 10^{-3} L^{2.5254}$ ($r^2 = 0.84$)
combined $W = 2.3605 \times 10^{-3} L^{2.5214}$ ($r^2 = 0.93$).

The constants (b) were significantly different from the isometric constant, b = 3, when tested using the Student's t-test ($P<0.05$). Therefore, both male and female *P. sculptilis* show negative allometric growth indicating that as the prawn grows its weight increment decreases relative to its length increment. The female and male allometric constants were not significantly different ($P<0.05$), hence an (pooled) allometric constant of 2.5214 represents the species (see Fig. 1 for length-weight relationship).

Sex ratio

The female: male sex ratio varied according to the sampling site and month (Table 1). The ratio varied between 0.80-18.00 at Angsa Bank and 1.18-2.62 at the mudflat.

Size at first maturity

All prawns at stages 3 and 4 were considered as mature. For each sex, the percentange of matured prawn at every carapace length was determined, then a plot of percentange mature prawns versus carapace length was produced. The underlying sigmoid curve followed a logistic equation of the form:

$$P = 1 / (1 + e^{-(a+bL)}) \quad \text{..... (1)}$$

where P is the proportion of mature fish at carapace length L, and a and b are constants[5]. The logit equation, given by

$$\text{logit } P = \ln [P/(1-P)] = a + bL \quad \text{..... (2)}$$

was then fitted. P = 0.5 which defines the size at first maturity (L_m) was then estimated from a/b.

The size at first maturity was estimated at 16mm and 25mm carapace length for male and female, respectively (Fig. 2). However, the smallest mature male was observed at 14 mm and all males were mature at 22 mm carapace length. The smallest mature female prawn was found to be 16 mm and all females were mature at 36 mm carapace length.

Stock abundance

The density of prawn stock (D) at each study site was estimated using the swept area method [6].

The population density was higher at Angsa Bank with a mean density of 2,246 prawns per hectare. At the mudflat off Sungai Buloh the mean density was 1,137 prawns per hectare (Table 2). The prawn population was dense in July and August but low in September and October at Angsa Bank, and vice versa at the mudflat.

The prawn biomass reflected the population density, where Angsa Bank had a slightly higher mean biomass of 12.24 kg per hectare, compared to the mudflat which had 12.00 kg per hectare.

Population structure

All developmental stages were caught at the study site (Table 3). From the total of 918 prawns

(male and female) examined, 40% were of stage 1, 23% of stage 2, 36% of stage 3 and 1% of stage 4. In Angsa Bank juvenile prawns (stages 1 and 2) contributed 68% and adults (stages 3 and 4) contributed 32%. In the coastal mudflat juvenile and adult prawns contributed 53% and 47%, respectively. The monthly proportions of mature males found were high, both in Angsa Bank and in the mudlat.

Pooled length-frequency distributions were constructed separately for each study site (Fig. 3). Two major cohorts could be discerned; one with a mode at 18 mm carapace length, comprising largely immature or juvenile prawns, and another with a mode at 35 mm carapace length, comprising largely mature and spent individuals. The larger-size cohort was particularly prominent at the Sungai Buloh mudflat.

Diet analysis

Of the total of 90 prawn proventricula or stomachs (juvenile and adult) examined, only 4.4% were empty, and fullness ranged from 1/4-filled to full.

Organic detritus comprised flocs of decaying organic material, either of mangrove plant origin or unidentifiable. Large crustacean food comprised of cuticular fragments and the appendages of penaeid and sergestid shrimps. Plant parts that could be seen clearly, green or brown in color, were classified as macrophyte. Miscellaneous refers to parts of fish bones and gills, and the antennae of ants. Sand and silt particles were classified as inorganic particles.

P. sculptilis fed on a variety of food. The types of food taken at the study sites were similar, which showed the importance of organic detritus, crustaceans and molluscs (Bivalvia and Gastropoda) (Table 4).

Diatoms and small crustaceans (copepods, mysids and naupliar larvae) were usually found inside the prawn proventricula but their percentage volumetric compositions were small. Other foods (nematodes, polychaetes, foraminiferans and tintinnids) were also present but occurred infrequently.

Overall, the food of juvenile and adult *P. sculptilis* in Klang Strait comprised 50% animal matter, 30% organic detritus, 10% macrophyte and 10% inorganic particles. Juvenile prawns took in more (5% more) macrophyte matter than adult prawns.

Table 1. Number of Parapenaeopsis sculptilis sampled (male and female), sex ratio and χ^2 value for testing the null hypothesis of 1:1 sex ratio, at each sampling site and month. **, significant at 1% level, *, significant at 5% level; n.s., not significant at 5% level.

Place	Month	Female		Male		Total	Sex	
		Number	%	Number	%		Ratio	χ^2 value
Angsa Bank	July	161	43.8	207	56.2	368	0.78	5.75*
	August	62	46.6	71	53.4	133	0.87	0.609n.s
	September	38	55.1	31	44.9	69	1.22	0.7101n.s
	October	18	94.7	1	5.3	19	18	15.2015**
	Subtotal	**279**		**310**		**589**		
Sungai Buloh	July	34	72.3	13	27.7	47	2.61	9.3882**
	August	30	66.7	15	33.3	45	2	5*
	September	42	72.4	16	27.6	58	2.62	11.65**52
	October	95	53.1	84	46.9	179	1.13	0.675n.s
	Subtotal	**201**		**128**		**329**		
Combined	July	195	47	220	53	415	0.89	1.506n.s
	August	92	51.7	86	48.3	178	1.07	0.2022n.s
	September	80	63	47	37	127	1.7	8.5748**
	October	113	57.1	85	42.9	198	1.33	3.9596
	Total	**480**		**438**		**918**		

Table 2. Population density and standing stock biomass of Parapenaeopsis sculptilis at Angsa Bank and Sungai Buloh. Mean density in number per hectare (D) and biomass in wet weight (g) hectare (D′).

Site/Month	Angsa Bank		Sungai Buloh	
	D	(D′).	D	(D′).
July	6198.33	31.99	514.09	6.45
August	1723.41	8.62	639.66	8.78
September	754.69	3.25	749.85	9.09
October	308.09	5.11	2643.27	23.70
Mean	2246.13	12.24	1136.72	12.00

Table 3. Maturity-frequency distribution of female and male Parapenaeopsis sculptilis by site and month. * Stage 1 (immature), stage 2 (maturing), Stage 3 (mature) and Stage 4 (spent).

Study site/ Month	Number								Total	Percentage Combined male and female			
	Female				Male								
	*1	2	3	4	*1	2	3	4		*1	2	3	4
a) Angsa Bank													
July	116	34	9	2	45	55	107	0	368	43.75	24.18	31.52	0.54
August	40	9	13	0	22	18	31	0	133	46.62	20.3	33.08	0
September	26	4	8	0	12	15	4	0	69	55.07	27.54	17.39	0
October	1	0	17	0	0	0	1	0	19	5.26	0	94.74	0
Total	**183**	**47**	**47**	**2**	**79**	**88**	**143**	**0**	**589**	**44.82**	**22.92**	**32.26**	**0.34**
b) Sungai Buloh													
July	15	12	3	4	0	8	5	0	47	31.91	42.55	17.02	8.51
August	12	12	5	1	2	8	5	0	45	31.11	44.44	22.22	2.22
September	13	8	21	0	1	5	10	0	58	24.14	20.69	53.45	0
October	39	8	47	1	18	14	51	1	179	31.84	12.29	54.75	1.12
Total	**79**	**40**	**76**	**6**	**21**	**35**	**71**	**1**	**329**	**30.39**	**22.8**	**44.68**	**2.13**

Table 4. Mean percentage volumetric composition of proventriculus contents of juvenile and adult Parapenaeopsis sculptilis

Food items	Angsa Bank		Sungai Buloh	
	Juvenile	Adult	Juvenile	Adult
Plant matter				
Algae & diatoms	0.9	0.73	2.18	0.92
Mangorove	5.33	2.66	8.87	3.99
Organic detritus	38.1	31.4	35.94	43.13
Crustaceans				
Large Crustacea	16.39	16.38	20.94	18.79
Copepoda	0.26	1	0.57	0
Mysidacea	0	0.22	0.92	0
Nauplius larvae	0	0.47	2.48	0.03
Eggs	4.7	9.42	0.21	0.4
Mollusca				
Bivalvia larvae/juveniles	14.98	18.17	11.58	12.86
Gastropoda larvae/juveniles	12.19	2.21	2.28	6.19
Protozoa				
Foraminifera	0.58	0	4.23	0.24
Tintinnida	0	1.2	3.75	0.43
Nematoda	0	1.9	0.03	0.16
Polychaeta	0.56	6.4	0.27	1.93
Inorganic particles	5.2	3.87	4.82	4.14
Miscellaneous items	0.71	3.97	0.93	6.79

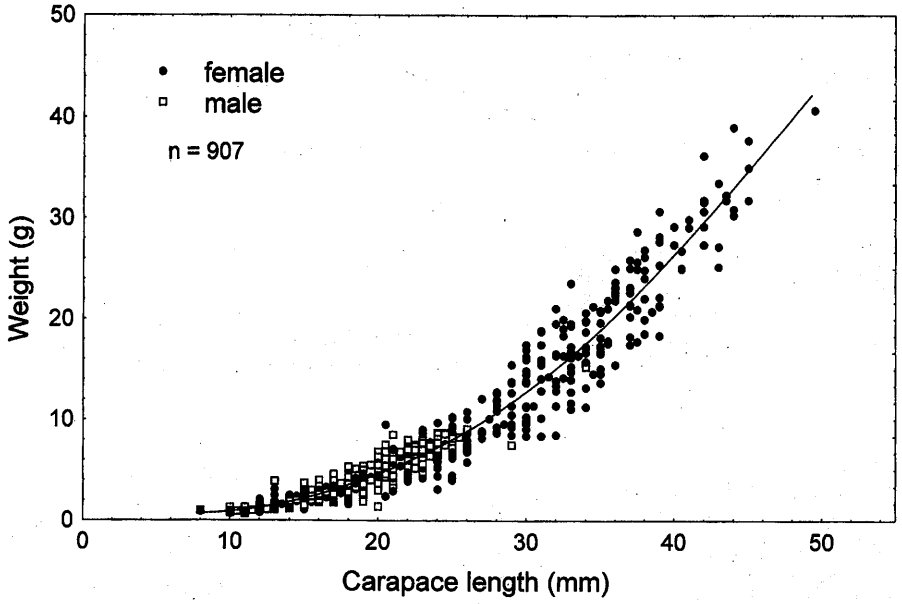

Figure 1. The length-weight relationship of *Parapenaeopsis sculptilis* (pooled male and female prawns).

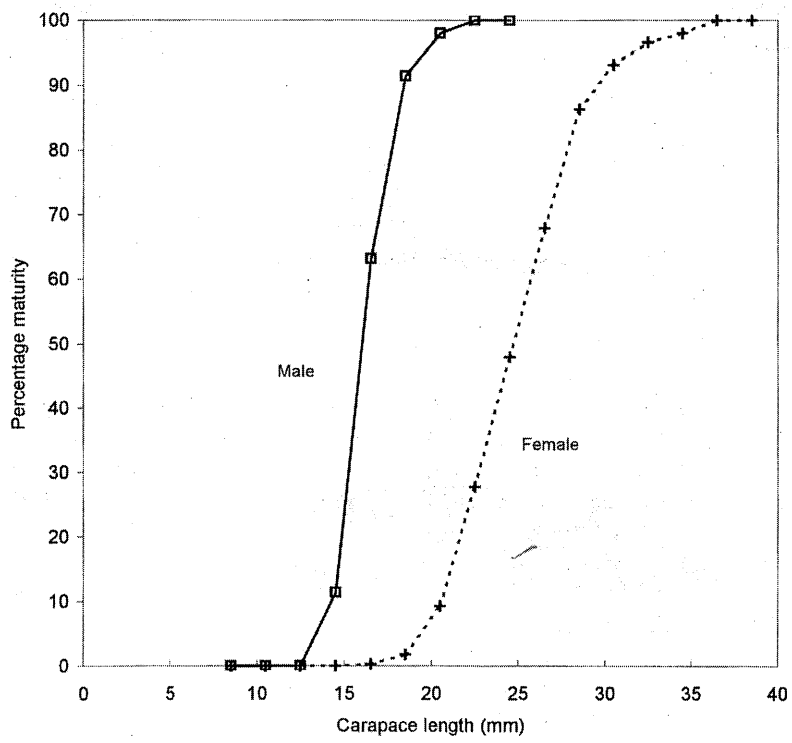

Figure 2. Size at sexual maturity of male and female *Parapenaeopsis sculptilis.*

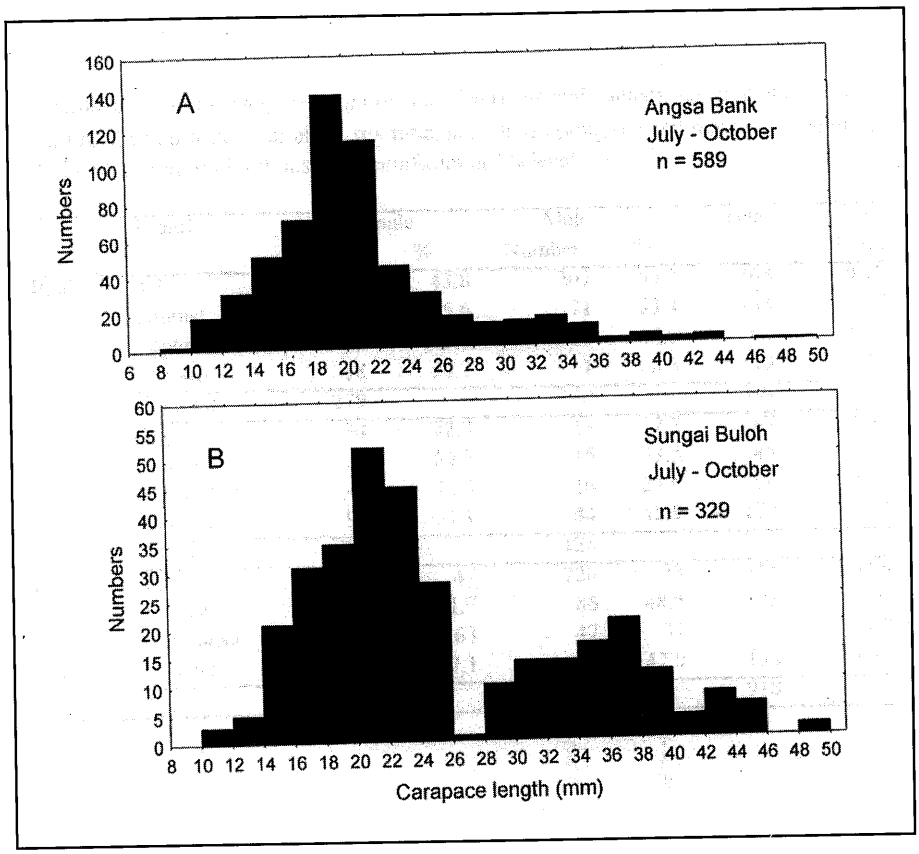

Figure 3. Length-frequency distribution of *Parapenaeopsis sculptilis* sampled at (A) Angsa Bank and (B) the mudflat off Sungai Buloh (pooled data from July to October 1994).

DISCUSSION

Hall [7] reported that a large specimen of *P. sculptilis* tend to have less weight from the expected. Hall's computed allometric constant (b = 2.994) is however larger than our computed b values. This may be attributed to differences in geographical location and the samples examined. While Hall's work was based on mostly large prawns caught in Penang waters, the present study is based on prawns of various stages of development caught in Selangor waters.

The high percentage of juvenile prawns caught at the mudflat and Angsa Bank suggests that these are nursery areas for *P. sculptilis*. This study also indicates that subadult and adult *P. sculptilis* feed off the coastal mudflat, and use its subtidal vicinity as breeding ground. The sex ratio in favour of female indicates that male prawns (which mature earlier) migrate offshore earlier than female prawns. The presence of very mature and spent stages indicates that maturation, copulation and spawning of this species occur in shallow coastal waters, thereby supporting earlier observations [3]. Therefore, it appears that this species unlike *Penaeus* spp., does not necessarily depend on deep water for gonadal maturation and breeding. The present study also suggests that the shallow subtidal vicinity just off Sungai Buloh's coastal mudflat is more favoured as a breeding area for *P. sculptilis* than the offshore Angsa Bank.

The high densities of *P. sculptilis* at the mudflat and Angsa Bank are not unexpected. It is known that juvenile *P. sculptilis* dominate the coastal mudflats of Selangor and Perak [3,8], and also the importance of Angsa Bank (as nursery ground) for the prawn fisheries has been shown

from previous studies [3]. Chong and Ooi [9] using canonical correspondence analysis of prawn species abundance with three major Malaysian coastal biotopes (mangrove, coral and seagrass) were able to show strong connectivity between *P. sculptilis* abundance with coastal mudflat area and tidal amplitude. Apparently extensive mudflats in macrotidal regions are the favoured nursery areas of this species.

Apart from the life cycles reason, it is postulated that the high density of *P. sculptilis* at the study site is due to food abundance and substrate suitability. Many marine animals living in the mangrove-fringed mudflat, such as protozoans, crustaceans, molluscs and polychaetes, serve as abundant food supply for juvenile and adult prawns. In Angsa Bank, the benthos plays an important role in the food web as it contributes 50% of the food of fishes, and is sustained by benthic microflora, dead phyto- and zooplankton, faecal deposits and allochthonous mangrove detritus [10]. Although it has been suggested that *P. sculptilis* is generally carnivorous [11], it also consumes macrophyte detritus and algae in substantial amounts. Therefore, this species should be considered a detritivorous carnivore.

The utilisation of mangrove detritus as a nutritional source has been alluded to, however based on stable (C,N,S) isotope study, Newell *et al.* [12] found that *P. sculptilis* derived nutrition more from benthic microalgal or phytoplankton production. Interestingly, their stable isotope study [12] of the tissues of juvenile and adult *P. sculptilis* has indicated the close similarity in food items as is found in the present study.

Mudflats prawns are dominated by *Parapenaeopsis* species which burrow in surface sediments [3,8], a behaviour that is favoured in sandy mud subtrates which are less likely to foul gills. Fine sand (53-250 μm diameter) constituted 90% and 25-65% of the top 3-cm sediment layer at Angsa Bank and Sungai Buloh mudflat, respectively (per. obs., second author). In contrast, the mangrove inlets of Sungai Sementa Besar and Sungai Sementa Kecil near Port Klang contained 65-75% mud (<53 μm), and are dominated by non-burrowing banana prawns, *Penaeus merguiensis* [3].

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REFERENCES

1. Lee, S.S (1972). Cormercial species of prawns (Crustacean: Decapoda) in West Malaysia. *Malays. Agric. J.* **48**: 264-277
2. Annual Fisheries Statistic Malaysia (1998). Fisheries Division, Ministry of Agriculture, Malaysia.
3. Chong, V.C, Sasekumar A., M.U.C Leh and D'cruz, R. (1990). The fish and prawns communities of a Malaysian coastal mangrove system, with comparisons to adjacent mudflats and inshore waters. *Est. Coast. Shelf Sci.* **31**: 703-722
4. Chong, V.C (1981). Food and feeding habits of the white prawns *Penaeus merguensis. Mar. Ecol. Progr. Ser.* **5**: 185-191.
5. Koranteng, K.A (1993). Size at first maturity of the Anchovy (*Engraulis encrasicolos*) in Ghanaian waters and suggestion for appropriate mesh size in its fishery. *Naga-ICLARM Quarterly* (Jan.) pp. 123-130.
6. Pauly, D. (1983). Some simple method for the assesment of tropical fish stocks. *FAO Fisheries Technical Paper* **234**: 52.
7. Hall, D.N.F (1962). Observation on taxonomy and biology of some Indo-West Penaeidea (Custacea:Decapoda). *Colonial Office Fishery Publication* **No.17** H.M.S.O London.
8. Chong, V.C., Sasekumar, A. and Lim, K.H (1994). Distribution and abundance of prawns and a Malaysian mangrove system. In: *Proc. Third ASEAN-Australian Symposium on Living Resources*, (eds. Sudara et. al), Dept. of Marine Sciences, Chularlongkorn University, Bangkok. **2**: 437-445.
9. Chong, V.C. and Ooi, A.L. (2001). Prawn abundance and mangroves: Quantitified relationships and new perspectives. Paper presented in "International Workshop on Mangrove Systems of South East Asia", 6-8 November 2001, ICLARM, Penang, Malaysia, pp. 12
10. Thong, K.L (1980). The community structure of the Angsa Bank and the trophic relationship as the fish community. B.Sc thesis, Dept. of Zoology, University of Malaya, Malaysia.

11. Leh, Charles, M.U.C and Sasekumar, A. (1981). Feeding ecology of prawns in shallow waters adjoining mangrove shores. In: *Proc. Asian. Symp. on Mangrove Environmental Researh and Management* (eds. Soepadmo et. al), University of Malaya, Kuala Lumpur, Malaysia. Pp. 331-353.

12. Newell, R.I.E., Marshall, N., Sasekumar A. and Chong, V.C (1995). Relative importants of benthic microalgae, phytoplankton and mangroves as sources of nutrition for penaeid prawns from Malaysia. *Marine Biol.* **123**: 595-606.