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Selection of Broodstock of Tiger Prawn, *Penaeus monodon* Fabricius, on the Basis of Morphometric Traits

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ABSTRAK

Penaeus monodon *matang dipungut dari perairan Kedah, Perak, Terengganu, Johor dan Sabah. Ciri morfometrik terpilih dan berat badan bagi setiap ekor udang disukat. Udang betina didapati lebih besar (P<0.05) berbanding dengan udang jantan bagi semua lokasi. Analisis regresi langkah demi langkah menunjukkan bahawa panjang karapas sahaja mencukupi untuk menerangkan varians dalam berat badan bagi udang jantan dan betina. Panjang karapas boleh memberikan anggaran yang lebih tepat bagi berat badan dan oleh itu ia boleh dijadikan sebagai satu kriteria dalam pemilihan induk. Hubungan logaritma antara berat badan dan panjang penuh, berat badan dan panjang karapas, dan antara panjang karapas dan panjang penuh bagi kedua-dua seks juga dikira.*

ABSTRACT

Mature Penaeus monodon *were collected from Kedah, Perak, Terengganu, Johore and Sabah waters in Malaysia. Selected morphometric characters and body weight were measured individually. The results showed that the females were significantly larger (P<0.05) than the males in all locations. Stepwise regression analysis indicated that carapace length alone is sufficient to explain the variance in body weight for male and female prawns and can thus be used as a criterion for the selection of broodstock. The logarithmic relationships between body weight and total length, body weight and carapace length, and between carapace length and total length for both sexes were also calculated.*

INTRODUCTION

Penaeus monodon Fabricius, commonly known as tiger prawn, is the main cultured prawn species in Malaysia. Despite the establishment of hatchery and rearing techniques for this species, prawn broodstocks used for seed production and selective breeding are still being collected from natural populations.

Morphometric traits can easily be used as a criterion for the selection of prawn broodstock (Lester 1983; Huang *et al.* 1990) without killing or damaging them. Total length and carapace length are commonly used to estimate the size composition of prawn species (Ramamurthy and Manickaraja 1978). In addition, some morphometric characters can give a more accurate estimate of body weight and can be used for selecting broodstock on the basis of weight. Relationships between total length and carapace length, and total length and weight have been described for *P. monodon* and other prawn species (Hall 1962; Kirkegaard *et al.* 1970; Ramamurthy and Manickaraja 1978; Horton and Lester 1982; Lester 1983; Goswami *et al.* 1986; Huner *et al.* 1988).

The objectives of this study were to estimate the variability of selected morphometric traits and to determine the relationships among the characters in tiger prawns from different localities.

MATERIALS AND METHODS

Samples of wild and mature *Penaeus monodon* were purchased alive from fishermen in five

different areas, Kedah, Perak, Terengganu, Johore and Sabah waters.

Individual prawns were weighed in the laboratory to the nearest 0.001 g. Total length and carapace length were measured using vernier calipers to the nearest 0.01 cm. All parameters were based on Chua (1978), Grey *et al.* (1983), and Ahmad and Mahyam (1986). The proportion of carapace length to total length or carapace length index (%) was calculated by (carapace length/total length) x 100. Differences in carapace length indices among localities and between sexes were tested by one-way analysis of variance. Tukey test analysis was used to measure differences in carapace length index mean values among locations. The characters were log transformed to reduce the correlation of means and variances (Sokal and Rohlf 1981).

The morphometric characters were analysed by stepwise variable selection regression method using Statgraphics statistical graphics system (STSC, Inc. and Statistical Graphics Corporation, USA). Body weight was used as a dependent variable while total length and carapace length were independent variables. The relationships between total length and weight, and between carapace length and weight are described by the allometric equation, i.e. $Y = aX^b$, where X and Y are independent and dependent variables, respectively, and a and b are two constants. Non-linear regression analysis (Sokal and Rohlf 1981) was performed to determine these relationships for both sexes from different locations. Linear regression analysis was also used to describe the relationship between carapace length and total length. Data were pooled for males and females to provide a common regression equation describing the relationships between the two variables.

RESULTS AND DISCUSSION

The range, mean and coefficient of variation values for adult male and adult female shrimps collected from the five locations are presented in Table 1. Females were significantly larger ($P<0.05$) than the males, with average body weights of 113.54 g and 74.88 g, respectively. This characteristic was also noted in *Penaeus longistylus* (Penn 1980), *P. latisulcatus* and *P. esculentus* Haswell (Penn and Hall 1974). Male shrimps, however, had less variable and greater carapace length indices than the females, indicating that carapace length increases more rapidly than the total length in males but less rapidly in females. The coefficient of variation of the carapace length indices ranged between 5 and 18% in males and 5 to 21% in females. Among the various locations, males from Sabah had the highest average carapace length index (36.46%) and males from Kedah the lowest (22.65%). Similarly to males, the carapace length index (%) of females from Sabah was the largest (36.43%) and females from Kedah were also the smallest (23.17%). The Tukey test shows that the carapace length indices of females were significantly different ($P<0.05$) among locations, except between those from Johore and Perak. The prawns from Johore and Perak could be derived from the same population. The difference in size of carapace within sexes among different locations may be due to different stocks and different environments (Goswami *et al.* 1986; Huang *et al.* 1990).

The results of stepwise variable selection regression analysis for male and female prawns from five locations are shown in Table 2. In males, the carapace length was the first variable in stepwise regression analysis in Perak and Kedah populations, accounting for 79.4% and 72.4%, respectively, of the variation in body weight. Total length became the first entered variable in the regression analysis in Sabah, Terengganu and Johore male shrimp populations, explaining 77.8%, 61.8% and 61.0% of the variation in body weight, respectively. Conversely, among females, carapace length was the first variable to enter the regression step in Perak and Johore populations, explaining 95.6% and 79.7% of the variations in body weight, respectively. The total length was the first entered variable in stepwise regressions of Sabah, Kedah and Terengganu female populations that explained 82.88%, 80.6% and 74.7%, respectively, of the variance in body weight.

This study indicates that carapace length alone is sufficient to explain the variance in body weight for male (65.4%) and female (73.8%) prawns although a combination of two or three variables at a time gives a more accurate estimation of body weight.

From the analysis of variance, there were significant differences ($P<0.05$) in length between sexes for all locations. Therefore, the regression analyses for males and females were done separately.

Table 3 describes the logarithmic relationships between body weight (W) and total length

TABLE 1

Range, mean and coefficient of variation (CV) of total length (TL), carapace length (CL), body weight (WT) and carapace length index (CL. I.) for male (M) and female (F) *Penaeus monodon* collected from different regions in Malaysia

Variable	Sex	Kedah			Perak			Terengganu			Johore			Sabah		
		Range M (N=46) F (N=33)	Mean	CV	Range M (N=95) F (N=6)	Mean	CV	Range M (N=89) F (N=65)	Mean	CV	Range M (N=85) F (N=10)	Mean	CV	Range M (N=68) F (N=33)	Mean	CV
TL.	Male	16.2-25.8	20.73	0.12	18.2-28.9	23.34	0.10	15.3-36.0	24.42	0.12	18.8-26.2	22.84	0.07	18.1-26.3	22.48	0.07
(cm)	Female	15.6-27.7	23.20	0.13	23.5-27.5	20.73	0.06	17.3-36.8	28.37	0.14	22.3-26.1	23.89	0.05	20.5-27.0	23.63	0.07
CL.	Male	3.5-5.6	4.68	0.10	6.7-10.1	8.09	0.08	4.0-9.5	7.02	0.20	6.1-8.8	7.41	0.07	6.6-10.0	8.18	0.09
(cm)	Female	4.0-6.8	5.36	0.12	7.3-8..7	8.27	0.07	3.7-10.9	7.41	0.18	6.7-8.5	7.67	0.07	6.3-10.3	8.59	0.09
WT	Male	29.5-104.1	57.01	0.28	47.9-130.4	72.70	0.23	37.5-261.2	79.80	0.40	41.7-90.7	62.12	0.17	52.6-137.8	8648	0.23
(g)	Female	41.5-132.4	81.92	0.26	55.2-101.4	85.05	0.40	49.1-265.1	133.74	0.40	52.9-83.8	65.94	0.15	62.2-143.5	99.57	0.21
CL. I.	Male	19.2-27.9	22.57	0.09	27.8-40.1	34.65	0.06	20.1-39.2	28.76	0.18	29.0-37.0	32.43	0.05	32.1-41.1	36.40	0.06
(5)	Female	19.9-27.9	23.10	0.08	27.0-34.0	31.64	0.08	12.2-35.9	26.13	0.21	28.6-35.0	32.11	0.05	30.7-40.7	36.38	0.05

TABLE 2

Range, mean and coefficient of variation (CV) of total length (TL), carapace length (CL), body weight (WT) and carapace length index (CL. I.) for male (M) and female (F) *Penaeus monodon* collected from different regions in Malaysia

		Kedah		Perak		Terengganu		Johore		Sabah	
Variable	Sex	b	R	b	R^2	b	R^2	b	R^2	b	R^2
log CL.	Male	2.422	0.724	2.511	0.794	1.575	0.501	1.748	0.584	1.941	0.584
	Female	1.833	0.771	3.356	0.956	2.028	0.660	1.756	0.797	1.775	0.673
	Combined	2.260	0.798	2.568	0.794	1.931	0.628	1.748	0.604	1.937	0.632
log TL.	Male	1.948	0.691	1.643	0.573	1.986	0.618	1.849	0.610	2.987	0.778
	Female	1.781	0.806	0.409	0.011	2.799	0.747	1.139	0.623	2.738	0.828
	Combined	2.090	0.768	1.604	0.547	2.434	0.689	1.846	0.613	2.891	0.809

TABLE 3
Relations of log body weight (W) to log total length (L) in male and female of *Penaeus monodon* from different locations

Location	Sex	log W = log a + b log L	Correlation coefficient (r)
Kedah	Male	log W = -0.809 + 1.948 log L	0.83
	Female	log W = -0.518 + 1.781 log L	0.90
Perak	Male	log W = -0.418 + 2.511 log L	0.89
	Female	log W = -1.149 + 3.356 log L	0.98
Terengganu	Male	log W = -0.869 + 1.986 log L	0.79
	Female	log W = -1.959 + 2.799 log L	0.86
Johore	Male	log W = -0.719 + 1.849 log L	0.78
	Female	log W = -1.128 + 2.139 log L	0.79
Sabah	Male	log W = -2.101 + 2.987 log L	0.90
	Female	log W = -1.763 + 2.738 log L	0.91
Combined	Male	log W = -0.671 + 1.899 log L	0.62
	Female	log W = -0.513 + 1.741 log L	0.64

(L) in male and female prawns. Non-linear regression equations of log W = log a + b log L are shown for each location (Table 3). The relationships between body weight and total length for males and females in all locations were estimated as log W = -0.513 + 1.741 log L and log W = -0.671 + 1.899 log L, respectively. The values of coefficient "b" of the weight-total length relationships show considerable variation, ranging from 1.899 to 2.987 in males and from 1.741 to 3.356 in females. The "b" value was significantly smaller ($P<0.05$) than 3.0 for males. In contrast, "b" value in *P. duorarum* was significantly greater than 3.0 for both sexes as reported by Kutkuhn (1962). However, Fontaine and Neal (1971) found that the "b" value for *P. duorarum* males was not different from 3.0 ($P>0.05$).

The logarithmic relationships between body weight (W) and carapace length (L_{car}) for both males and females from each location are also described by the non-linear regression equation of log W = log a + b log L_{car} (Table 4). For all locations, the relationships between body weight and carapace length for males and females were estimated as log W = -0.019 + 2.10 log L_{car} and log W = -0.083 + 2.213 log Lcar, respectively.

Table 5 shows the logarithmic relationships between carapace length (L_{car}) and total length (L) for male and female prawns from each location as log L_{car} = log a + b log L. For all locations, the linear relationships between carapace length and total length for males and females were described as L_{car} = -0.561 + 1.042 log L, respectively.

The results show that carapace length increased linearly with the total length although carapace length does not grow allometrically with body weight. However, body weight is correlated more with carapace length for both male and female prawns, r = 0.81 and r = 0.86, respectively (Table 4) compared with total length with r = 0.64 and r = 0.62 for males and females, respectively (Table 3). Carapace length is a considerably more stable size reference dimension (Rhodes and Holdich 1984) and this may contribute to its good correlation with body weight. Total length measurement is rather varied according to the length of the rostrum, which is easily damaged, thus affecting the accuracy of this measurement.

This study indicates that carapace length can be used as a single variable to explain a large proportion of the variance in body weight. This is in accordance with the measurement used by Hall (1962). Thus this variable can be regarded as an important criterion for choosing

TABLE 4
Relationship of log body weight (W) to log carapace length (L_{car}) in male and female of *Penaeus monodon* from different locations

Location	Sex	log W = log a + b log L	Correlation coefficient (r)
Kedah	Male	log W = 0.133 + 2.422 log L_{car}	0.85
	Female	log W = 0.577 + 1.833 log L_{car}	0.88
Perak	Male	log W = 0.418 + 2.511 log L_{car}	0.89
	Female	log W = 1.149 + 3.356 log L_{car}	0.98
Terengganu	Male	log W = 0.471 + 1.575 log L_{car}	0.71
	Female	log W = 0.101 + 2.028 log L_{car}	0.81
Johore	Male	log W = 0.273 + 1.748 log L_{car}	0.76
	Female	log W = 0.265 + 1.756 log L_{car}	0.89
Sabah	Male	log W = 0.165 + 1.941 log L_{car}	0.76
	Female	log W = 0.340 + 1.775 log L_{car}	0.82
Combined	Male	log W = 0.083 + 2.213 log L_{car}	0.86
	Female	log W = 0.019 + 2.100 log L_{car}	0.81

TABLE 5
Relationship of log carapace length (L_{car}) to log total length (L) in male and female of *Penaeus monodon* from different lacations

Location	Sex	log L_{car} = log a + b log L	Correlation coefficient (r)
Kedah	Male	log L_{car} = -0.110 + 0.593 log L	0.72
	Female	log L_{car} = -0.329 + 0.775 log L	0.82
Perak	Male	log L_{car} = 0.111 + 0.583 log L	0.76
	Female	log L_{car} = 0.741 + 0.124 log L	0.11
Terengganu	Male	log L_{car} = -0.476 + 0.953 log L	0.51
	Female	log L_{car} = 0.101 + 2.029 log L	0.81
Johore	Male	log L_{car} = -0.164 + 0.761 log L	0.74
	Female	log L_{car} = -0.388 + 0.924 log L	0.67
Sabah	Male	log L_{car} = 0.486 + 1.035 log L	0.78
	Female	log L_{car} = -0.700 + 1.190 log L	0.86
Combined	Male	log L_{car} = 0.084 + 0.548 log L	0.37
	Female	log L_{car} = -0.561 + 1.042 log L	0.53

broodstock in selective breeding programmes of *P. monodon*.

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