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Velvet Shrimps (*Metapenaeopsis* spp.) of Torres Strait, Queensland, Australia

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Abstract

The velvet shrimps, *Metapenaeopsis rosea* (Racek and Dall 1965) and *M. palmensis* (Haswell 1879), form a large part of penaeid shrimp catches from Torres Strait, Queensland, Australia, and are caught from 5 to 30 mm carapace length. Recruitment to the fishery occurs annually in January to March and abundance is greatest during May to October. Females are first found mature at 12 mm carapace length and spawning occurs year-round with peaks in April, July and October. Males begin to mature at 5 mm carapace length and all have joined petasmas by 9 mm carapace length. *M. rosea* males are heavier than their female counterparts at any given carapace length and no difference was found between male and female *M. palmensis*. Male and female *M. rosea* were heavier than those of *M. palmensis* at the same length. Until recently catches of these species were discarded but increasingly those of larger sizes are retained and marketed.

Introduction

Velvet shrimp is the FAO common name (Holthius 1980) given to a group of small penaeid species caught in tropical-temperate waters. *Metapenaeopsis rosea* (Racek and Dall 1965) (pink velvet shrimp or rosy shrimp) and *M. palmensis* (Haswell 1879) (southern velvet shrimp) are the two most abundant of five *Metapenaeopsis* species taken by trawlers operating in Torres Strait, Queensland, Australia.

M. rosea is an Indo-Pacific shrimp of minor commercial importance. Distribution of *M. rosea* is restricted to northern Australia (particularly in the vicinity of the Great Barrier Reef)

(Racek and Dall 1965), from Mackay (Queensland) through the Gulf of Carpentaria to Darwin (Northern Territory), and the northeastern Arafura Sea (Irian Jaya) (Grey et al. 1983).

The distribution of *M. palmensis* is more extensive and they are of commercial importance in some areas. They form over 15% of the shrimp catch in small trawl operations in some areas of central Japan (Hayashi and Sakamoto 1978). This species is found in waters of eastern Borneo, Indonesia and Papua New Guinea (Racek and Dall 1965) and is the most dominant species of *Metapenaeopsis* in the Batan Bay and Tigbauan-Gimbal waters in the Philippines (Motoh et al. 1977). In the Gulf of Thailand small *M. palmensis* are taken as by-catch and are sold as a dried product (Yoo-Sook-Swat and Thubthimsang 1988). Within Australia, *M. palmensis* is found in warm temperate and tropical northern waters from Shark Bay (Western Australia), through to Sydney (New South Wales) in the east, but is more common in waters along the northeastern coast (Racek and Dall 1965).

Over twenty *Metapenaeopsis* species are distributed widely throughout the world. Approximately nine species are found in Australian waters (Racek and Dall 1965). Other species of *Metapenaeopsis* caught in trawls in Torres Strait are *M. novaguineae* (Haswell 1879), *M. lamellata* (de Haan 1850) and *M. mogiensis* (Rathbun 1902). *Metapenaeopsis* species are also found in waters of southeastern Africa (Racek and Dall 1965; Racek and Yaldwyn 1970; Champion 1973), Gulf of Mexico, Caribbean (Huff and Cobb 1979), South America (Huff and Cobb 1979; Bauer 1985), Borneo, Sumatra and Indonesia (Racek and Dall 1965; Racek and Yaldwyn 1970), India (Suseelan et al. 1982; Dutt and Ramaseshaiah 1986), Thailand (Johnson 1976; Tseng and Cheng 1980), Singapore (Hall 1962; Johnson 1976), Sarawak and Brunei (Johnson 1976), Japan and Malaysia (Kubo 1949; Hall 1962; Tham 1968; Tseng and Cheng 1980), Vietnam (Johnson 1976), Papua New Guinea (Hall 1962; Racek and Dall 1965; Racek and Yaldwyn 1970; Johnson 1976), Solomon Islands (Racek and Dall 1965), China, Taiwan and Hong Kong (Tseng and Cheng 1980), Arabian-Persian Gulf and Red Sea (Miquel 1984).

Despite their wide occurrence, few details are known of the biology of the *Metapenaeopsis* species in Australia, perhaps because *M. rosea* and *M. palmensis* are not specific targets of trawl fisheries in Australia. They are taken as by-products in fisheries for other penaeid species (Grey et al. 1983). Catches of these species are not usually recorded by fishermen and are discarded. However, in recent years it has become common for larger sizes to be retained and marketed. As their exploitation increases, information on distribution, abundance, and maturation is necessary if management of the fishery is to succeed. This paper addresses these needs and represents the first detailed life history study of these species from Australia.

Methods and Materials

From January 1986 to December 1987 extensive surveys of commercial shrimps were made at monthly intervals, on or around the time of the new moon, at 28 sites throughout Torres Strait (Fig. 1). Each site was trawled once for 1 hour during the evening between 1900 and 0300 hours using a single 6-m, polyethylene 47-mm mesh net based on the Florida Flyer' design. Swept area based on vessel speed and gear spread was recorded.

All penaeid shrimps were removed from the catch, frozen on board and later separated by species and sex. All shrimps were measured (carapace length to nearest 0.1 mm), and ovary condition was noted for females, based on Tuma's (1967) ovary development stages.

Records from trawl shots were not considered quantitative if large sharks, turtles or sponges obstructed the net or reduced efficiency. Records from these shots were used for length-frequency analysis of shrimps and species composition only.

Parameters for the weight-length relationship were obtained by simple regression analysis (Table 1), and fitted to a power function (equation 1) and a linear function (equation 2). Linear regression analysis and analysis of covariance (ANCOVA) were performed on weight and carapace length data, transformed to the natural log, to

Table 1. The regression parameters for the weight-length relationships of *M. rosea* and *M. palmensis*.

Species	Sex	N	Regression parameters				r^2
			$W = a \cdot CL^b$		$\ln(W) = a + b \cdot \ln(CL)$		
			a	b	a	b	
M. rosea	F	498	1.4E-03	2.79	- 6.56	2.79	.91
	M	501	7.7E-04	3.05	- 7.17	3.05	.92
M. palmensis	F	315	8.9E-04	2.94	- 7.02	2.94	.85
	M	148	5.1E-04	3.17	- 7.58	3.17	.89

determine the significance of difference in the weight-length relationship between species and sex.

$$W = a \cdot CL^b \qquad \ldots 1)$$
$$\ln(W) = a + b \cdot \ln(CL) \qquad \ldots 2)$$

where W represents weight (g); CL represents carapace length (mm); a is the intercept; and b is the slope.

In the following sections shrimp length measurements given are for carapace lengths (CL). Number of shrimps per hectare of bottom swept is referred to as abundance. For purposes of analysis, the region was divided into two areas: (1) east of the Warrior Reefs (East) which is commercially trawled, and (2) west of the Warrior Reefs (West) which has been closed to trawling since 1981.

Following Tuma (1967), ovary stages are referred to as quiescent (stage I), developing (stage II), early maturity (stage III), ripe (stage IV) and spent (stage V). Stages I and V could not be differentiated and were combined. Males were determined mature when the first pair of pleonic endopodites fuse to form the petasma.

Results

Spatial Distribution

By number, *M. rosea* and *M. palmensis* formed a large part of the penaeid shrimp catch from all areas surveyed in Torres Strait (Fig. 2). Of the two velvet shrimps, *M. rosea* was usually the more numerous except in the northeastern sector between Warrior Reefs and the Yorke Islands (Fig. 1) where numbers of *M. rosea* and *M. palmensis* were similar.

Size Distribution

Each year the size of both species ranged from 5 to 30 mm CL (Fig. 3). Juvenile shrimps of both species recruited into the fishery once annually, at around 5 mm CL, in January to March of both years studied.

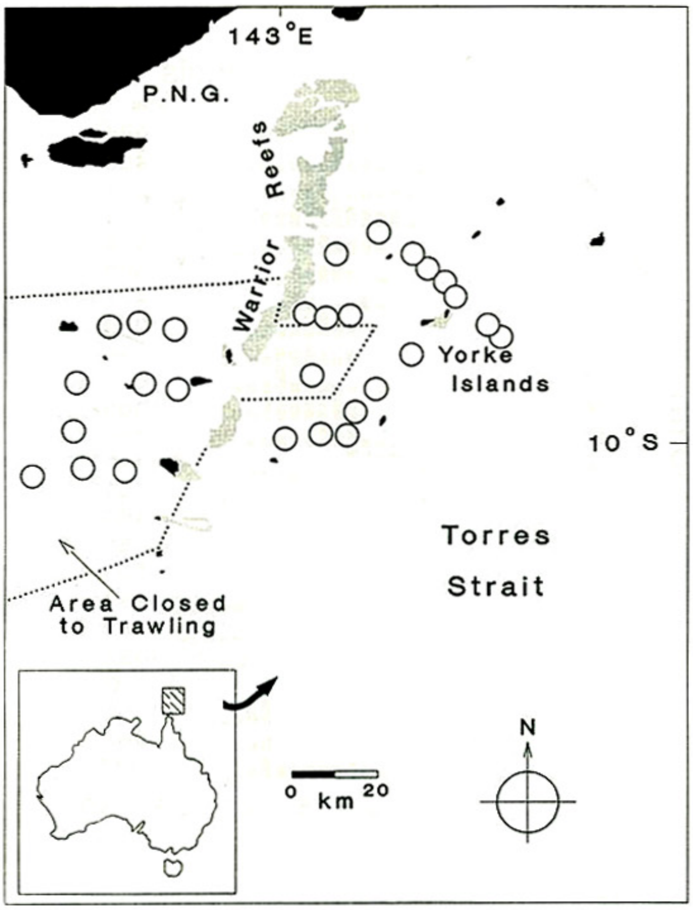

Fig. 1. Map of Torres Strait showing study area and trawling sites represented by open circles (area closed to commercial fishery is indicated).

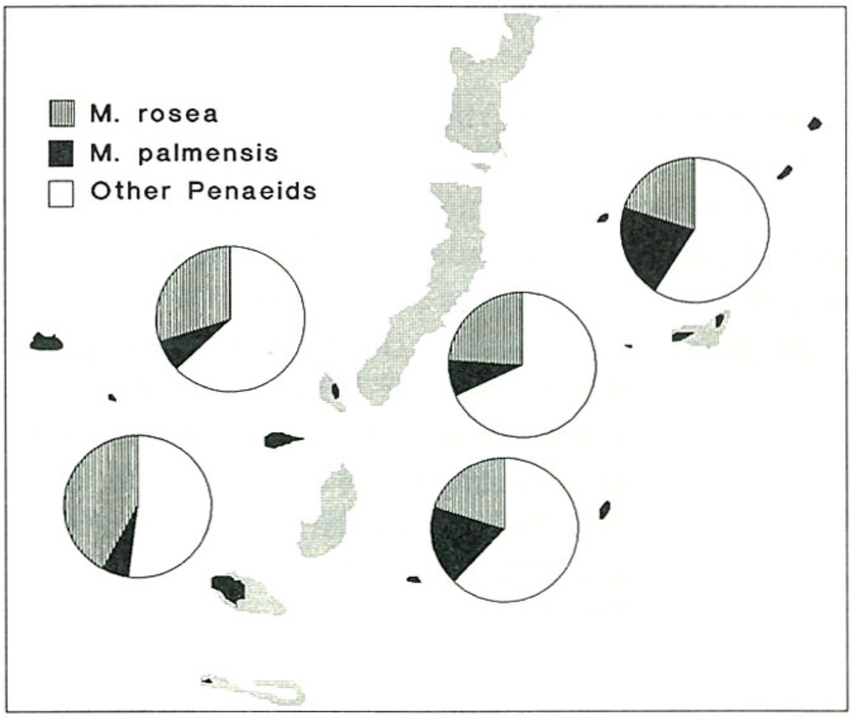

Fig. 2. Map of Torres Strait showing the proportion of catches formed by *M. rosea* and *M. palmensis* on a numerical basis at five areas representing pooled trawling site data.

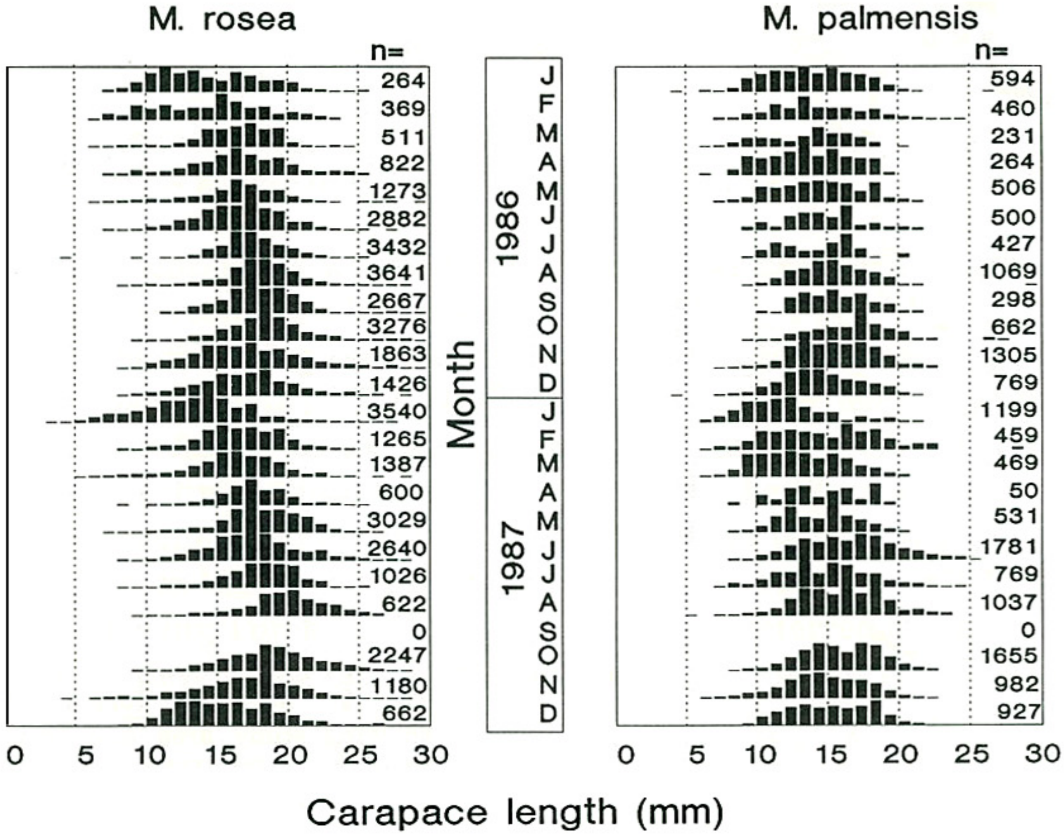

Fig. 3. Monthly size distribution of *M. rosea* and *M. palmensis*. Length class abundances are expressed as a percentage on a monthly basis.

Seasonal Abundance

Abundance of *M. rosea* was variable and area dependent but generally peaked during May to October (Fig. 4). Although this species was twice as numerous to the West as it was to the East, the seasonal pattern of abundance in both areas was similar. Abundance was higher in 1986 than in 1987 for both areas.

M. palmensis caught to the East, exhibited a seasonal pattern of abundance similar to that of *M. rosea* caught in the East (Fig. 4). Those caught to the East displayed a major peak in abundance in September to January and those caught to the West displayed a peak in abundance from May to October. *M. palmensis* abundance from the East and West was 25% that of *M. rosea*.

Weight-Length Relationship

Analysis of covariance on the weight-length relationships showed a significant difference between *M. rosea* males and females (P <

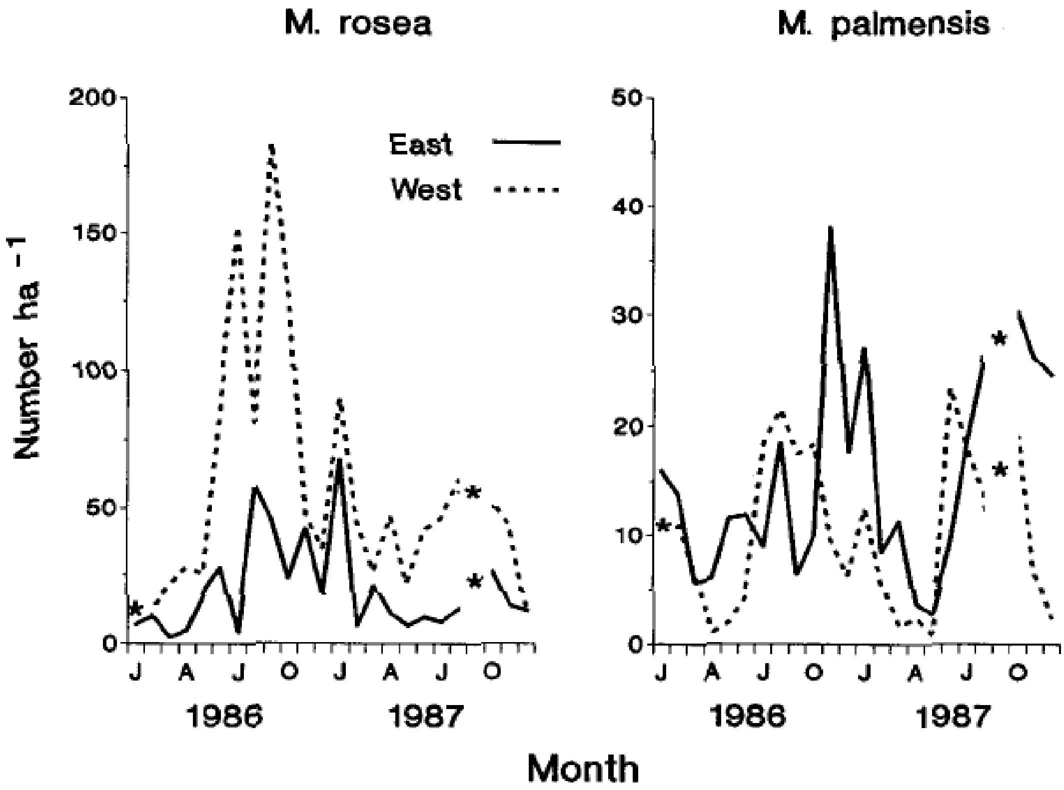

Fig. 4. Monthly abundance of *M. rosea* and *M. palmensis* from the east and west of the Warrior Reef complex. (Asterisk denotes missing samples.)

0.001), although no significant difference was found between sexes of *M. palmensis* ($P > 0.2$). A significant difference was found between female *M. rosea* and *M. palmensis* ($P < 0.001$) and between males of the two species ($P < 0.001$).

Seasonal Ovary Development

The proportion of *M. rosea* or *M. palmensis* females with developing-ripe ovaries (stages II-IV) was usually less than 20% of those sampled, except when peaks of up to 50% of females with developing-ripe ovaries were present, indicating major breeding periods (Fig. 5).

For *M. rosea,* spawning periods (stages III-IV) occurred in April and July in 1986, and in April, July and October in 1987. Peak spawning periods for *M. palmensis* occurred in April, July and October in 1986 and 1987 (Fig. 5). For both species, the October spawning peak appears to correspond to the January to March recruitment periods (Fig. 3).

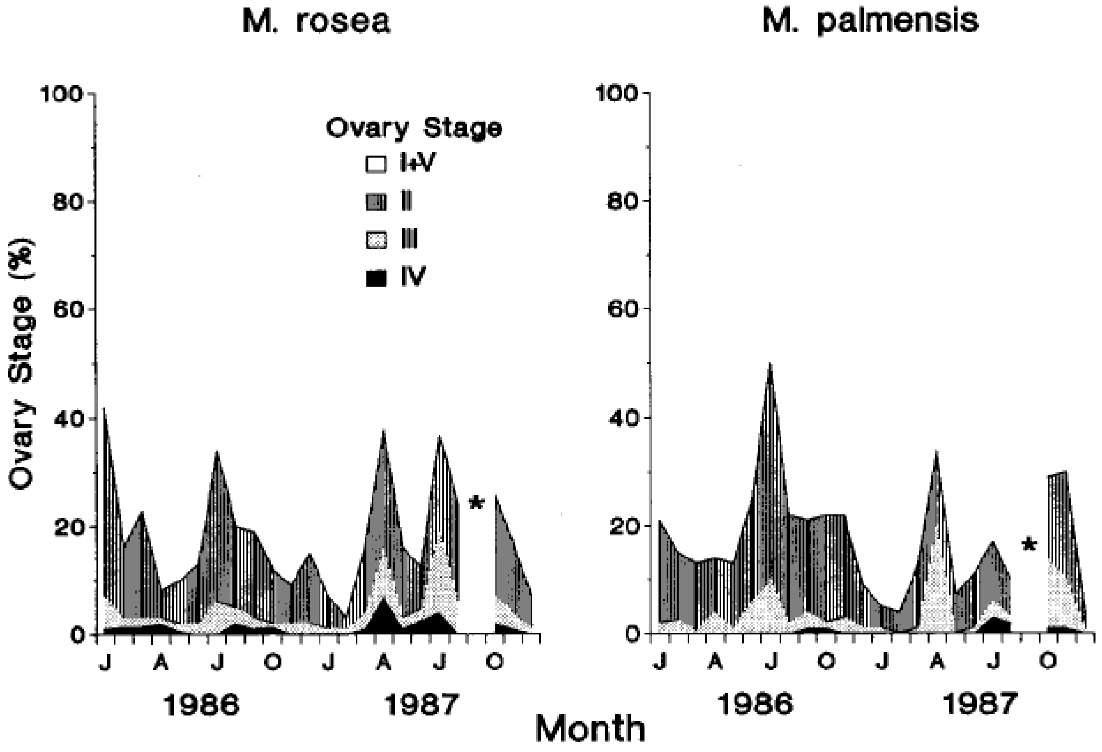

Fig. 5. Monthly changes in the abundance of ovary stages (after Tuma 1967) of *M. rosea* and *M. palmensis* (I = quiescent, II = developing, III = early maturity, IV = ripe, and V = spent). (Asterisk denotes missing samples.)

Maturation

Gravid females of both species first appeared at 12 mm CL (Fig. 6). Regardless of size, the percentage of ripe females (stages III and IV) never exceeded 20% (Fig. 6).

Fusion of the petasma of male *M. rosea* and *M. palmensis* was evident in some individuals as small as 5 mm CL. All males were mature by 9 mm CL.

Discussion

The distribution of velvet shrimps is related to sediment types or water depth. In Torres Strait, *M. rosea* prefer the finer sediments (Harris 1988) and shallow waters (10 to 14 m) southwest of the Warrior Reef complex, while *M. palmensis* prefer the coarser sediments (Harris 1988) and deeper waters (24 to 40 m) north of the Yorke Islands. Other studies report that sediment preferences for *M.*

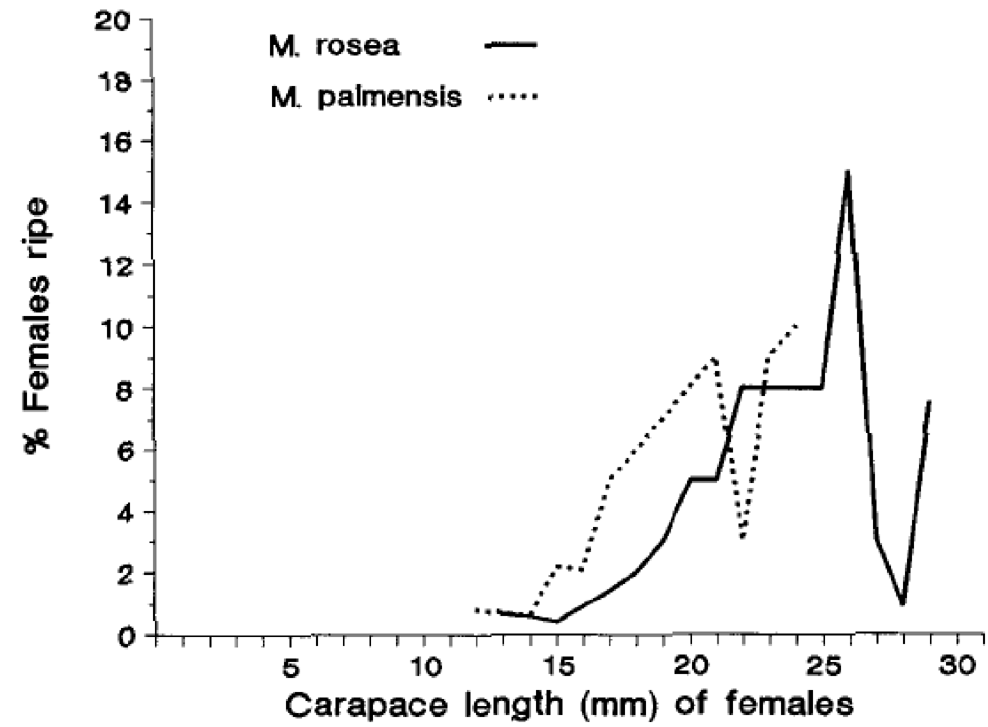

Fig. 6. Relationship between the percentage of females with early mature-ripe ovaries (stages III-IV) and carapace length for *M. rosea* and *M. palmensis*.

rosea range from mud to mud-sand to 30 m depth (Racek and Dall 1965; Grey et al. 1983), while *M. palmensis* occurs over mud or sand bottoms at 5 to 30 m depth (Grey et al. 1983). Similarly, *M. goodei* in Florida is commonly found on coarse sand and shell substrates in 37 m of depth (Huff and Cobb 1979).

Recruitment of velvet shrimps in Torres Strait occurs during the mid to late summer months of January to March. Some northern hemisphere *Metapenaeopsis* species also recruit during the summer. Small *M. palmensis* enter the central Japanese fishery from July to November (Hayashi and Sakamoto 1978), and *M. barbata* from August to October (Sakamoto and Hayashi 1977). However, settlement of juvenile *Metapenaeopsis* species onto seagrass beds showed increases in numbers from August and September or October in Dorado on the north coast of Puerto Rico (Bauer 1985), implying a possible winter recruitment from seagrass beds.

Velvet shrimp abundance in Torres Strait was greatest during May to October and less so from December to March. Huff and Cobb (1979) reported peaks of abundance of *M. goodei* during summer and autumn in the Caribbean and the number of individuals of *M. barbata* was highest during autumn in Japan (Sakamoto and

Hayashi 1977). Bauer (1985) reported little seasonal variation in *Metapenaeopsis* adult numbers on the north coast of Puerto Rico.

Abundance is related to recruitment but also to survival. In Torres Strait, fishing effort is most intense in the East during the period of March to April, which reduces the numbers of all species substantially (Channells et al. 1988).

In Torres Strait, the peak periods of female velvet shrimp breeding, based on ovary condition, are April, July and October. *M. palmensis* spawn from June to September in central Japan (Hayashi and Sakamoto 1978). They believed that each individual female spawned only once but there is no evidence for this in *M. palmensis* from Torres Strait. Hall (1962) reported that *M. barbata* bred twice yearly in Singapore waters. Spawning in the Caribbean species, *M. goodei,* coincided with increased summer and autumn abundance and may have been associated with spawning aggregations (Huff and Cobb 1979).

The smallest Torres Strait velvet shrimps found with developed ovaries were 12 mm CL. No literature could be found relating shrimp age or size with ovary development. Huff and Cobb (1979) found impregnated females of *M. goodei* were from 8 to 16 mm CL in size but did not report on ovary development.

Maturation of male velvet shrimps occurred between 5 mm and 9 mm CL. This is similar to *M. goodei* which begin to mature at 4 mm CL and are completely mature by 6 mm CL (Huff and Cobb 1979).

Weight-length relationships are important in relating shrimp carapace length to commercial gradings. Analysis of the weight-length relationship for *M. rosea* showed that males of any given carapace length were significantly heavier than their female counterparts, though males do not reach the same maximum size as females. This difference has also been reported for larger penaeid species such as *Penaeus longistylus* (Penn 1980), *P. latisulcatus* and *P. esculentus* (Penn and Hall 1974). Male and female *M. palmensis* were of similar weight and carapace length, although males did not attain the same maximum carapace length as females. Yoo-Sook-Swat and Thubthimsang (1988) found female *M. palmensis* slightly heavier than males in the Gulf of Thailand. For a given carapace length, *M. rosea* of either sex are heavier than their *M. palmensis* counterpart. Hall (1962) published weight-length relationships for *M. stridulans* and *M. barbata*. He reported that although the weight-length relationship between congeneric species appears similar, the relationship does differ significantly.

Quantities of *M. rosea* from the northeastern coast of Australia are now sold commercially (R. Watson, unpublished data). They have a reputation for flavor that exceeds that of the larger commercial penaeid species (Poole 1987). As acceptance in the market place increases, a knowledge of velvet shrimp biology is essential for the effective management of these species as a fisheries resource.

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