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Juvenile prawn biology and the distribution of seagrass prawn nursery grounds in the southeastern Gulf of Carpentaria

Abstract: Fifteen consecutive monthly samples of juvenile prawns were collected in beam trawls from estuarine and inshore coastal waters around the Wellesley Islands. On seagrass beds, juvenile brown tiger prawns, *Penaeus esculentus,* and endeavour prawns, *Metapenaeus endeavouri,* formed 46.1% and 27.7% of the catch respectively. Where seagrass was absent *M. endeavouri* was more abundant (23.9% of the catch) than *P. esculentus* (0.1%). Other commercial species were caught in small numbers during the study. The non-commercial *M. dalli* was common on both bottom types. Immigration to nursery grounds of postlarval *P. esculentus* peaked in July with little recruitment between December and June. Larger prawns moved to the offshore fishery between October and January. Immigration of *M. endeavouri* and *P. latisulcatus* occurred in October and November and larger prawns of both species moved offshore between November and February. *M. dalli* postlarvae appeared earlier with a peak in April and another in September and emigrated between May and October. Of nine species of seagrass collected around the Wellesley Islands, four were common in tiger and endeavour prawn nursery grounds.

Introduction

The Gulf of Carpentaria on Australia's northern coast is a large shallow embayment approximately 900 km by 500 km with a maximum depth of only 70 m. Its waters and surrounding estuaries contain habitats important to a number of penaeid prawn species which are commercially important.

There are two identifiable commercial prawn fisheries in the Gulf. One is a daytime fishery that targets on schools of the banana prawn, *Penaeus merguiensis.* The other is a night trawl fishery whose catch is mainly the two tiger prawns, the brown tiger, *P. esculentus,* and the grooved tiger, *P. semisulcatus.* Other important commercial penaeids caught with these include the two endeavour prawns, *Metapenaeus ensis* and *M. endeavouri,* and two species of king prawn, the western king prawn, *P. latisulcatus,* and the red spot king prawn, *P. longistylus.*

Up until the late 1970s the banana prawn fishery was the most important in the Gulf. Northern prawn fishery logbooks show that since 1978, however, landings of tiger prawns have exceeded landings of banana prawns (Data supplied by Commonwealth Department of Primary Industry, Canberra). By 1982, tiger prawns alone made up 47% of the commercial catch compared with only 33% for banana prawns. In the 10 years up to 1982 fishing effort expended in the tiger prawn fishery increased from 8000 to 19000 boat days (Australian Fisheries Council 1982).

The area in the southeastern Gulf centred around the Wellesley Islands is the major fishing area for tiger prawns in Queensland state waters. From 1982 fishing logbooks, an estimated catch of 600000 kg of tiger prawns was taken from fishing grounds adjacent to these islands.

In response to concern over the lack of biological information with which to assess the likely effects of increasing effort in this fishery, a project was initiated by the Fisheries Research Branch of the Queensland Department of Primary Industries to study the biology of the commercial penaeid prawns in the Wellesley Islands region.

This study was designed to provide the information required for the long-term management of the tiger prawn fishery. Two field sampling programs were implemented to run concurrently. Adult prawns in the commercial fishery were studied during an offshore sampling program and the biology of juvenile prawns was investigated in inshore nursery habitats.

This paper describes the overall juvenile prawn sampling program. It presents the life cycle timing for four prawn species based on data from the Dugong River, Mornington Island, the species composition of juvenile penaeid prawns in inshore waters, and the distribution of seagrass prawn nursery grounds around the Wellesley Islands.

Materials and methods

The sampling method consisted of trawling for juvenile prawns during the night hours at selected inshore sites. Two 1.5 m wide by 0.5 m high beam trawls fitted with 2.0 mm mesh net were towed at a speed of 0.5 m s^{-1} for 50 m over the bottom. The towing vessel was a 7.3 m launch rigged to enable both nets to be towed simultaneously, giving two samples at each site.

Prior to each trawl, water temperature and salinity were measured with a Hamon temperature and salinity meter at 200 mm above the substrate.

An initial survey of island waters was conducted to choose sampling sites representative of the range of inshore habitats found around several islands of the Wellesley group. Sixteen sites were selected in sheltered areas with depths of 5 m or less. Eight additional sites were located in deeper waters (Fig. 1).

Samples were taken on consecutive new moons commencing in October 1982 and continuing for 15 months. At a site in the Dugong River with dense seagrass and an abundance of juvenile prawns, samples were taken every 2 h for 24 h each month. Data from this site were used in the analysis of life cycles.

Carapace length measurements (CL) were taken of all prawns caught, and those with a carapace length greater than 3 mm were identified to species (Dall 1957).

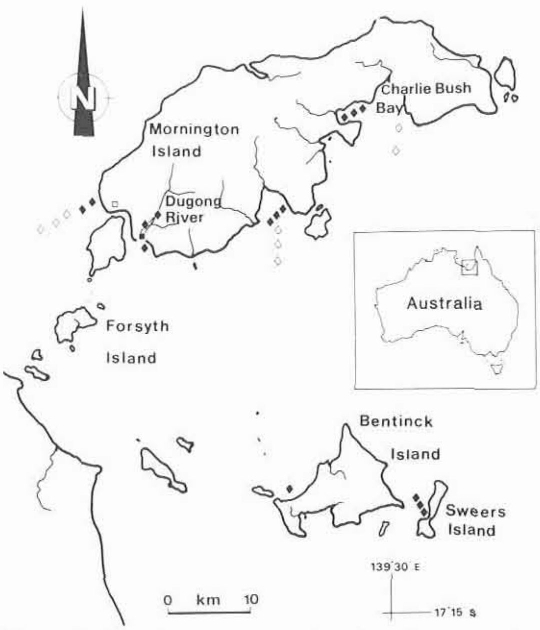

Figure 1. Juvenile prawn sampling sites ◇ around the Wellesley Islands in the southeastern Gulf of Carpentaria. Sites marked ◆ were in less than 5 m of water and 24-hour samples were taken at the site marked ■ in the Dugong River. Aboriginal mission is marked □ .

Studies of the seagrass beds around the Wellesley Islands were made in March and September of 1984. The total area of seagrass beds was determined using divers to check presence and absence of bottom vegetation along transects from deep water into the coast at approximately 0.5 n mile intervals, with spot checks for continuity at intervals between transects. Where seagrass was found, a representative 1 m^2 sample of the bottom was taken. In the laboratory analysis seagrass samples were separated into component species and for each species the wet weights of both root and leaves were recorded.

Results

Temperature and salinity

Water temperatures at the 24 h sampling site in the Dugong River on Mornington Island exceeded 30° C during the summer months (December, January and February) with a maximum recorded temperature of 33.2° C (Fig. 2a). The lowest temperatures occurred in June and July 1982, with a minimum of 14.5° C in June. The winter drop in temperature, which

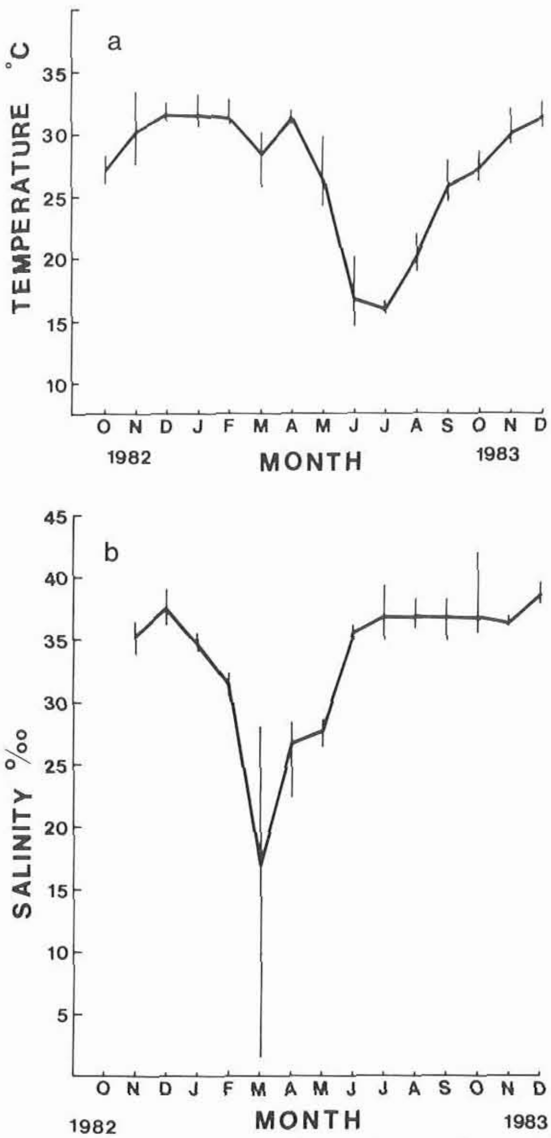

Figure 2. Mean and range of **a.** water temperature and **b.** salinity in the Dugong river from October 1982 to December 1983.

was of short duration, probably resulted from the cool southerly winds that blew from the mainland during these months.

With the exception of the February to May period when most rainfall occurred, salinities in the Dugong River remained relatively constant. The normal timing of monsoon rains in the southeastern Gulf is January-February.

Water salinity reached a minimum of 1.6‰ in March 1982 as a result of late monsoon rains and exceeded 40‰ at times in October (Fig. 2b).

Life cycle timing

The presence of prawns with CL$\leq$ 5.0mm on sampling sites in the Dugong River entrance was used as an indication of recently settled postlarvae. As postlarvae and juveniles were found in inshore waters, a mixed life cycle was assumed with eggs fertilised offshore and postlarvae developing and appearing in inshore areas in three to four weeks. These would develop into juvenile prawns, move offshore to mature and spawn completing the life cycle (Kirkegaard 1975).

Penaeus esculentus

In the waters surrounding the Wellesley Islands there was evidence (Fig. 3a) of spawning by *P. esculentus* throughout the year, although at an extremely low level between October and May, 1982. We assume that a peak in spawning in June would result in the appearance of prawns with CL$\leq$ 5.0mm on inshore grounds in July. Larger juveniles, CL$\geq$ 5.1mm, peaked in abundance in September-October and then decreased to very small numbers on the inshore nursery grounds by January.

Metapenaeus endeavouri

Metapenaeus endeavouri prawns with CL$\leq$ 5.0mm appeared on inshore grounds in November 1982 and again in January and October, 1983, suggesting offshore spawning between September and December (Fig. 3b). Numbers of larger juveniles peaked around October and November, decreasing to small numbers by March.

Penaeus latisulcatus

The number of *P. latisulcatus* prawns with CL$\leq$ 5.0mm was very low throughout the year (Fig. 3c). Those caught in November, 1982, and October, 1983, suggest a September and October spring spawning with postlarvae settling in October and November. The numbers of larger juveniles peaked at the same time and after January were found in only small numbers on inshore prawn nursery grounds.

Metapenaeus dalli

The peaks in the curve for *M. dalli* prawns CL$\leq$ 5.0mm in April and September suggest a March spawning followed by a smaller August spawning (Fig. 3d). Larger juveniles peaked in abundance in April, May and again in

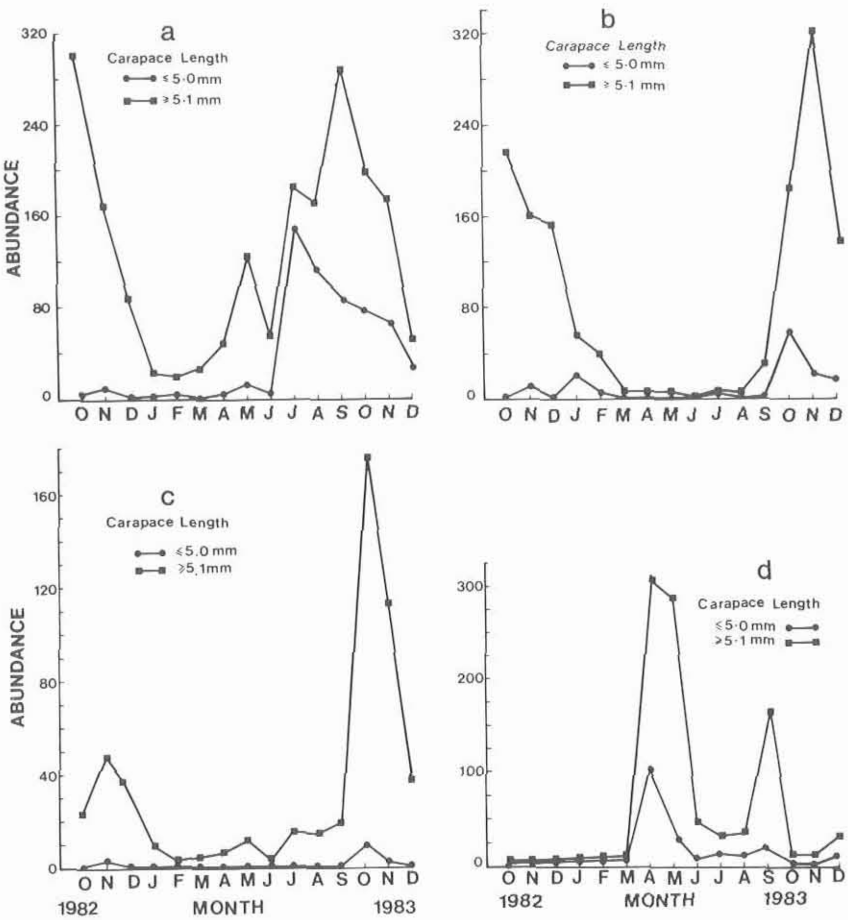

Figure 3. The number of **a.** *Penaeus esculentus*, **b.** *Metapenaeus endeavouri*, **c.** *Penaeus latisulcatus* and **d.** *Metapenaeus dalli* in the Dugong River each month from October 1982 to December 1983. The timing of the immigration of postlarvae and small juveniles to the nursery ground is given by the numbers of prawns with a carapace length of $\leq$ 5.0 mm. The numbers of larger juveniles are given by the graph of $\geq$ 5.1 mm CL prawns.

September and had moved offshore from the nursery ground by October.

Species composition

Studies in southern Queensland (Young 1978; Young and Carpenter 1977) and preliminary investigations by Staples (1984) have shown that the density of some species of juvenile prawns in inshore areas is enhanced where seagrasses occur. As a preliminary analysis of species composition on prawn nursery grounds around the Wellesley Islands, data were compiled for two sites on Mornington Island: one at the entrance of the Dugong river where trawls were made through extensive beds of seagrass, and the other in Charlie Bush Bay where the bottom was free of seagrass cover.

Data for both sites are presented from samples taken each month during the 15-month sampling period. The density of commercially important prawns was far greater on the seagrass bed (Fig. 4a) where juvenile *P. esculentus* and *M. endeavouri* formed 46.1% and 27.7% of the catch respectively. In Charlie Bush Bay, *P. esculentus* represented only 0.1% of the total number of juvenile prawns and *M. endeavouri* 23.9% (Fig. 4b).

The non-commercial *M. dalli* was slightly more abundant on the bare substrate but relatively numerous at both sites. *Penaeus latisulcatus* and *P. semisulcatus* were few in number at both sites, mostly caught where seagrass occurred.

Only a few juvenile *P. merguiensis* were recorded from the samples. Such a low incidence is expected as juvenile *P. merguiensis* are most likely to be found within 2 m of the shore (Staples and Vance 1979). Both Mornington Island sampling sites were more than 50 m from the shoreline.

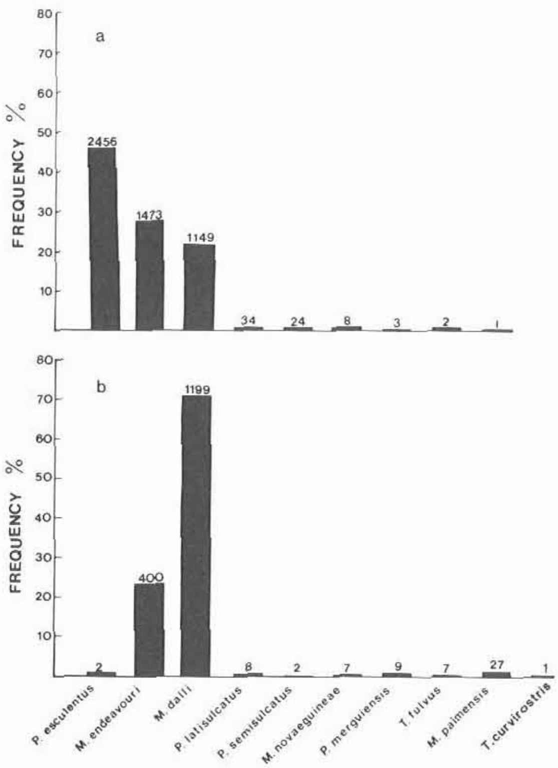

Figure 4. The species composition of juvenile prawns on **a.** seagrass beds in the Dugong River entrance and **b.** bare substrate in Charlie Bush Bay.

Table 1. Occurrence of seagrass species (+) around the Wellesley Islands and the adjacent mainland.

Sampling area	Cymodocea serrulata	Halodule uninervis/pinifolia	Halophila ovalis	Halophila spinulosa	Halophila decipiens	Syringodium isoetifolium	Enhalus acoroides	Thalassia hemprichii
Mornington Island	+	+	+	+	+	+	+	+
Denham Island	+	+	+	+		+		+
Sweers Island	+		+	+				
Bentinck Island	+	+	+	+	+	+		
Forsyth Island	+	+	+	+	+	+	+	
Allen Island	+	+	+	+		+		
Pains Island	+	+						
Adjacent mainland	+	+	+					

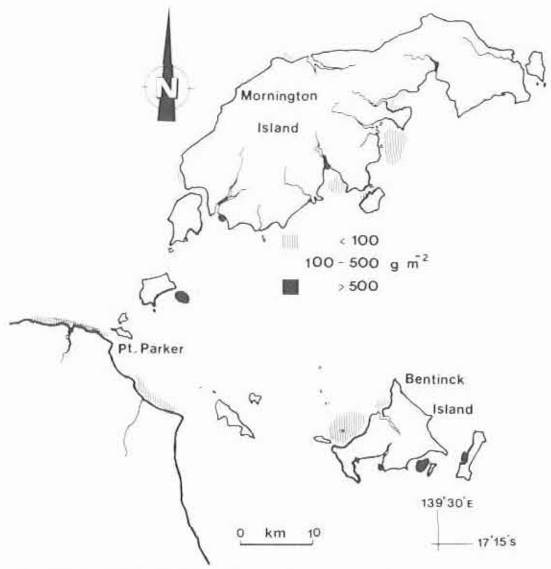

Figure 5. The distribution of seagrass beds around the Wellesley Islands and the adjacent mainland. Shaded areas represent the wet weight of all plant material collected from 1 m^2 of bottom.

Distribution of seagrass

Large areas of dense seagrass are restricted to the southwestern coast of Mornington Island, Government Bay on Forsyth Island, and the southeastern and northeastern coasts of Bentinck Island (Fig. 5). Seagrasses were sparsely distributed in depths greater than 5 m, possibly due to the generally high turbidity of the shallow Gulf waters.

Nine species of seagrass were identified from collections. The distribution of these species around the Wellesley Islands and the adjacent mainland coast is presented in Table. 1.

Discussion

Of the prawn species important to the southeastern Gulf of Carpentaria fishery, only two, *P. esculentus* and *M. endeavouri*, were common on the inshore nursery grounds of the Wellesley Islands. The small number of *P. merguiensis* in the two sites presented in this paper probably reflected the bias in sampling sites chosen with the intention of studying tiger prawn populations. During the sampling period, large numbers of *P. merguiensis* were present on shallow tidal banks near the aboriginal community (Fig. 1). *Penaeus semisulcatus* was present in the offshore fishery only in small numbers during 1983. Juveniles of this species were uncommon in Wellesley Island waters despite their presence around northern Gulf islands such as Groote Eylandt (Staples[1], pers. comm.).

Closures to fishing in the southeastern Gulf of Carpentaria have been implemented to prevent trawling of juvenile prawns. For such management to be successful an accurate estimation of the timing of the life cycle of the important commercial prawn species is needed.

There is evidence that the timing of the life cycle for *P. esculentus* may vary with latitude. In Moreton Bay, southern Queensland, recruitment to nursery grounds of *P. esculentus* postlarvae takes place in January and February (Young 1978), some five months later than in the southeastern Gulf of Carpentaria. Preliminary results from Weipa (Staples 1984), suggest a double recruitment to nursery grounds, one in September-October and one in March-April. Around the Wellesley Islands juvenile *P. esculentus* migrate to the fishery between September and January. A closure preventing trawling on the adjacent fishing grounds for any month between October and January inclusive would result in fewer juveniles caught incidental to the commercial catch of adult prawns. The timing of migration to the fishery of *M. endeavouri* (October to March) and *P. latisulcatus* (October to February) would be sufficiently similar to that of *P. esculentus* to enable a single closure time to be effective in reducing trawling of juveniles of all commercial prawn species common on the inshore nursery grounds. A closure during these times may not, however, be appropriate for other Queensland tiger prawn fisheries.

Approximately 26 km^2 of seagrass beds were mapped around the islands. Of the nine species of seagrass identified, five (*Cymodocea serrulata, Syringodium isoetifolium* and *Halophila spinulosa*) together with *Halodule uninervis* and *Halodule pinifolia* which were not separately identified, were common in the dense seagrass beds that characterised prawn nursery grounds. Detailed analyses of the relationship between the density of juvenile prawns and seagrass structure and composition are currently being undertaken.

A large proportion of the tiger prawns caught in the southeastern Gulf probably originate from seagrass nursery grounds around the Wellesley Islands. Otter trawling and dredging areas of seagrass, and changes to the environment that may limit size and growth of seagrass beds should be avoided.

The small total area of these seagrass beds emphasises the importance of conservation of these habitats for the long term maintenance of the tiger prawn fishery.

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