

Brooding of juveniles and observations on dispersal of young in the spider crab *Paranaxia serpulifera* (Guérin) (Decapoda, Brachyura, Majidae) from Western Australia

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Abstract

Aspects of the eggs, brooding behaviour and juvenile dispersal of *Paranaxia serpulifera* (Guérin) are described. Observed females carried in excess of 1000 large eggs, the highest recorded fecundity for a direct developing marine brachyuran. Most juveniles leaving the brood chamber dispersed over the posterior carapace and pereopods of the mother. Juveniles unattached to the mother and on an exposed substrate formed dense aggregations but dispersed when shelter was provided. Juveniles displayed decorating behaviour.

Introduction

Direct (epimorphic) development is uncommon in the Decapoda and very rare in the Brachyura (Williamson 1982). The terms 'abbreviated development' and 'direct development' have been accorded a variety of meanings in the scientific literature (Rabalais and Gore 1985) and are here employed as defined by Gore (1985: 21). The freshwater potamoid crabs and at least one freshwater member of the Hymenosomatidae display direct development and several species of terrestrial Grapsidae have very abbreviated development (Rabalais and Gore 1985), but there are few recorded marine examples. Table 1 summarises aspects of fecundity and hatching in known and possible examples of direct development in marine crabs. All of these species occur in Australian or New Zealand waters. In addition, Kurata (1970) noted direct development in an unidentified species of *Pinnotheres* (Pinnotheridae). Marine Brachyura with very abbreviated, or 'advanced', development as defined by Gore (1985: 23) are not included in the table (see Rabalais and Gore 1985: 82-85).

Of the family Majidae, only *Paranaxia serpulifera* (Guérin) has been recorded as having direct development (Rathbun 1914). This moderately large crab occurs from south-western Australia near Perth northward and eastward to northern Queensland, in depths ranging from the intertidal to approximately 30 m. Rathbun (1914) described and illustrated two stages of juvenile taken from the brood

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Table 1 Egg number, size and hatching stage in marine Brachyura with direct development; c.w. = carapace width, c.l. = carapace length.

Family	Species	Size of mature female (mm)	Number of eggs or young	(e) (y)	Egg size (mm)	Hatching stage	Reference
Dromiidae	<i>Petalomera lateralis</i> (Gray)	14.0-17.0 c.w.	± 20	(y)	1.14 x 1.00	Juvenile	Montgomery (1922), Hale (1925)
	<i>Cryptodromia octodentata</i> Haswell	→ 85.0 c.w.	530	(y)	± 2.00	Juvenile	Hale (1925), Hale (1927)
	* <i>Epipedodromia thompsoni</i> (Fulton and Grant)	11.0 c.w.	20	(e)	> 1.00	?	Hale (1925)
	* <i>Dromidia australis</i> (Rathbun)	40.0 c.l.	?		± 2.00	?	Hale (1927)
Xanthidae	<i>Pilumnus novaezealandiae</i> Filhol	19.0-22.5 c.w.	67-96	(e)	1.50 x 1.40- 1.75 x 1.65	Megalopa	Wear (1967), Wear and Fielder (1985)
	<i>Pilumnus lumpinus</i> Bennett	12.0-22.5 c.w.	53-257	(e)	1.25 x 1.10- 1.45 x 1.35	Late zoea	Wear (1967), Wear and Fielder (1985)
	<i>Pilumnus vestitus</i> Haswell	→ 18.0 c.w., 12.5 c.l.	→ 100	(e)	1.50 x 1.10	Megalopa	Hale (1931)
	Hymenosomatidae <i>Elamenopsis bovis</i> (Barnard)	5.5 c.w.	30	(e)	?	Juvenile	Barnard (1950), Lucas (1980)
	* <i>Haliscarcinus afecundus</i> Lucas	5.4 c.w.	24	(e)	0.70	?	Lucas (1980)
Majidae	<i>Paranaxia serpulifera</i> (Guérin)	59.0 c.w., 92.0 c.l. - 85.0 c.w., 129.0 c.l.	1250-1690 162-176	(e) (y)	2.40-2.90 (\bar{x} = 2.70)	?	Rathbun (1914), Present study

* Suspected direct development

chamber between abdomen and thorax of a female from the Monte Bello Islands, north-western Australia.

In January 1986, two females of *P. serpulifera* with juveniles held in their brood chambers were netted in Cockburn Sound, 10 km south of Perth. This is only the second recorded observation of brooding in this species and the first in waters in the south of its range. In March 1986, I collected two ovigerous females from Shark Bay, 650 km north-north-west of Perth.

Sizes of specimens are indicated by carapace length (c.l.) and carapace width (c.w.) excluding lateral spines.

Observations of eggs

The ovigerous females (c.l. 115.8 mm and 107.9 mm, c.w. 76.6 mm and 72.8 mm) carried in the brood chambers *ca.* 1690 and 1250 subspherical eggs respectively (estimated by volumetric displacement). Comparison of species in Table 1 indicates that *P. serpulifera* is highly fecund for a direct developing crab and that the eggs are the largest recorded for marine brachyurans with direct development.

Eggs were attached to long, sparse oosetae on the endopods of pleopods. In life, eggs were burgundy with the embryos paler with distinct dark eyes. Embryos possessed a large yolk reserve. Pereiopods were distinctly segmented and the first pair were clearly chelate. The telson was weakly bilobed and the abdomen quite short and narrow. In these features, embryos resemble the zoea/megalopa transition stage of *Pilumnus novaezealandiae* (Wear 1967).

Observations of young

The smaller female with young (c.l. 107.8 mm, c.w. 71.5 mm) was recently dead when examined and carried 176 juveniles of a single size class in the brood chamber (Figure 1). Carapace lengths ranged from 6.1 mm to 6.6 mm, averaging 6.3 ± 0.11 (S.D.) mm. This compares with Rathbun's (1914) record of 162 juveniles of two size classes, averaging 3.5 mm and 5.7 mm c.l. respectively, on a female of c.l. 92 mm and c.w. 59 mm. As observed by Rathbun, the young were definitely juveniles ('in the adult state'). It is not known if they hatched as megalopas or late zoeas as in xanthids (Table 1) or if all larval stages were passed in the egg. Rathbun's observations indicated that at least one moult after eclosion occurs in the brood chamber. The juveniles described here correspond to the larger and presumably older of the size classes recorded by Rathbun.

The larger female (c.l. 129.0 mm, c.w. 85.0 mm) was maintained alive with young in a 45 cm long, 30 litre aquarium. Since it was intended to keep disturbance of the mother and young to a minimum, an accurate count of the juveniles was not attempted. Subsequent removal of the young as they died yielded 117 specimens, but this is certainly an underestimate of numbers due to

loss through cannibalism. Juveniles ranged from 6.0 mm to 6.7 mm c.l., averaging 6.3 ± 0.20 (S.D.) mm.

The large difference between numbers of apparently fertile eggs and brooded juveniles on similarly sized females implies a loss of many eggs prior to hatching, a very high mortality of recently hatched juveniles or sequential eclosion, perhaps with juveniles feeding on the remaining unhatched eggs or younger juveniles.

The juveniles appeared to be in the process of leaving the brood chamber of the female when the specimens were acquired. Numerous juveniles were still present on the female's pleopods but many were on her carapace and pereopods and others were loose in the bucket in which they were transported. It is possible that

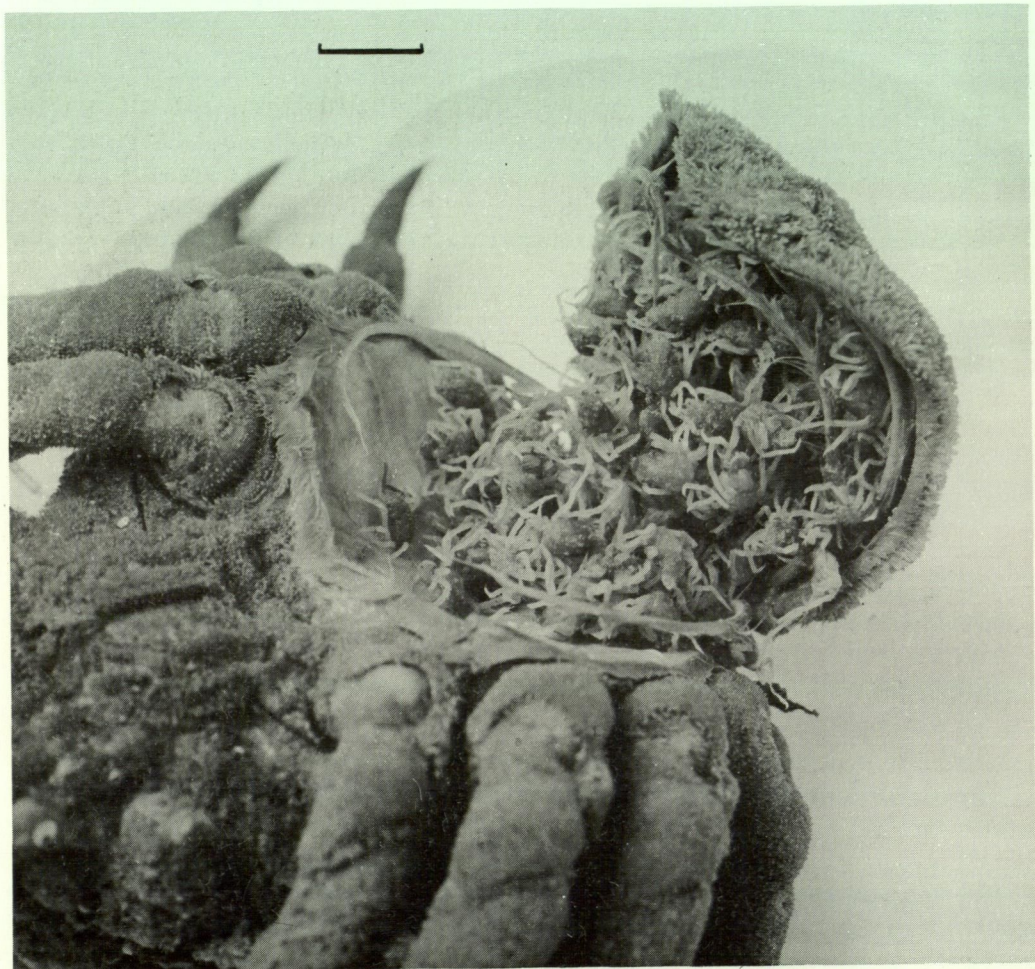


Figure 1 Ventrolateral view of female *P. serpulifera* showing juveniles in brood chamber. Scale = 10 mm.

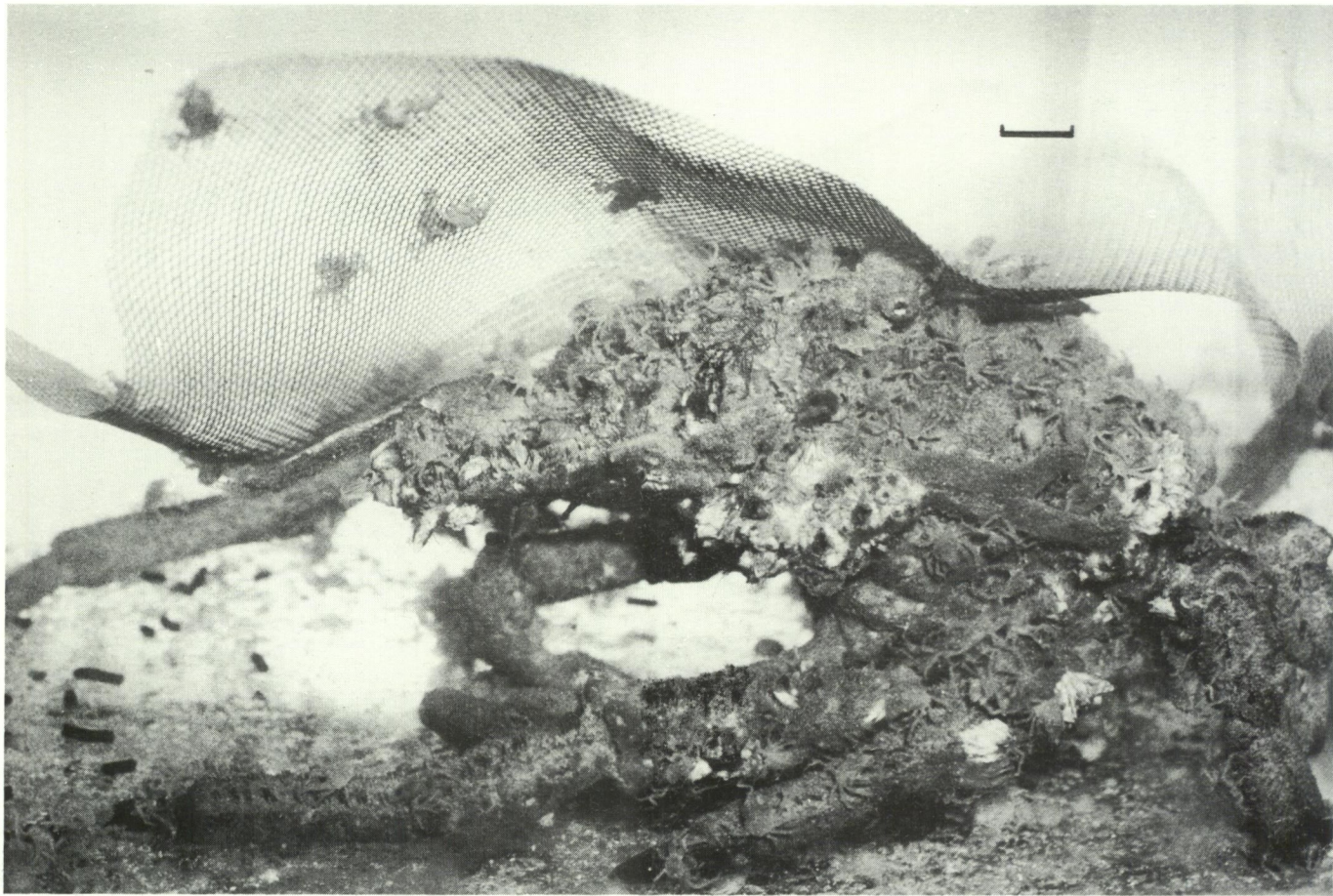


Figure 2 Female *P. serpulifera* with attached flyscreen, juveniles dispersed over female's carapace and pereopods and screen. Scale = 10 mm.

the exit from the brood chamber may have been premature due to the stress of capture. When introduced to the aquarium those juveniles separated from the female clumped together in associations of two to 20 or more individuals. Over a period of hours the clumps merged into one, comprising more than 100 juveniles. When touched by a second pereopod of the female (it was not evident if this was a deliberate or accidental contact), the large clump attached to the leg. By the following day, most of the juveniles in this aggregation had dispersed over the female's back and legs (Figure 2). Those juveniles unattached to the female formed several smaller clumps on the floor of the aquarium.

During this period, the female appeared to continually preen the growth of epizoid algal turf, sponges, barnacles and hydroids with her chelipeds. When a chela encountered a juvenile it was grasped lightly, the cheliped extended away from the mother and the juvenile dropped to the aquarium floor. After two days in the aquarium, most of the young still attached to the female were on her back or proximal segments of rear pereopods where her chelipeds could not reach.

Juveniles on the female did not display the obvious aggregating behaviour shown by juveniles on the aquarium floor. A small sheet of plastic flyscreen was introduced to the aquarium as an artificial substrate and young which moved onto and under this sheet dispersed from each other (Figure 2). The clumping behaviour of the young may be a protective mechanism when on an exposed substrate without shelter. The female attached the flyscreen to her carapace, apparently as a substitute for algae.

While on the female, juveniles fed upon either epizoid organisms or detritus caught in the epizoid growths. Only days after the animals were received, the juveniles displayed both carnivorous habits and decorating behaviour. The female was fed on pieces of crab meat (*Portunus pelagicus*) and fish, and small remnants of the meat were voraciously consumed by the young. Over a period of several days, the number of juveniles declined. Mortality was probably due in part to the aquarium environment but cannibalism cannot be discounted. Dead juveniles did not remain long intact. Siblings removed legs of the dead specimens and decorated their carapace with the appendages, especially on the rostrum and anterior carapace where attachment hooks are most numerous. In some instances the entire corpse of a juvenile was worn by a sibling.

The female was not observed to consume juveniles, either alive or dead, but the decline in numbers of the young over several days without leaving traces probably could not be ascribed only to dismemberment and decoration by other juveniles. All juveniles had died and been removed or had disappeared, presumably eaten, after 20 days of confinement. There was no evidence of juvenile growth in this period.

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