Distribution of the portunid crab *Ovalipes punctatus* (De Haan) in Algoa Bay and salinity and temperature tolerances of its zoeae

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The three-spot swimming crab *Ovalipes punctatus* is commonly found in surf zones off sandy beaches in Algoa Bay. It is exclusively marine and occurs down to a depth of 38 m. Large crabs were found close inshore while smaller crabs were predominantly found in deeper water, suggesting that settlement mainly occurs offshore in water 25 – 38 m deep. Gravid females were found closer inshore in shallow water. The zoeae could not tolerate high temperatures (>27,5 °C) or low salinities (<15‰). The optimal temperatures and salinities for survival of the zoeae were 15 – 22 °C and 34 – 35‰ respectively.

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Die driekolswemkrap *Ovalipes punctatus* word algemeen aangetref in die brandersone van sandstrande van Algoabaai. Die krappe is uitsluitlik seelewend en kom gewoonlik voor tot 'n diepte van 38 m. Groot krappe word hoofsaaklik in vlak water aangetref terwyl kleiner krappe in dieper water aangetref word. Dit blyk dus of die larvale stadia hulle vestig in dieper water (25 – 38 m) en dan kuswaarts beweeg soos die krappe groei. Wyfiekrappe met eiers word hoofsaaklik naby die kus aangetref (maksimumdiepte 32 m). Die larwes kan nie lewe in seewater waarvan die temperatuur hoër is as 27,5 °C en die soutgehalte laer is as 15‰ nie. Die optimale temperatuur en soutgehalte van die seewater vir oorlewing van die larwes is onderskeidelik 14 – 22 °C en 34 – 35‰.

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The three-spot swimming crab *Ovalipes punctatus* has been recorded along the South African coast from Port St Johns to Sandwich Harbour (Barnard 1950; Stuart 1975). Swimming crabs of the genus *Ovalipes* are also found in Australia, China, Gough Island, Japan, South America (*Ovalipes punctatus*), New Zealand (*Ovalipes catharus*), Northwestern Florida Gulf Coast (*Ovalipes guadulpensis* (Saussure)) and North Carolina (*Ovalipes occellatus* (Herbst)) (Barnard 1950; Caine 1974; G. Rossouw, pers. comm.; R.G. Wear, pers. comm.). *O. punctatus* commonly occurs on sandy beaches (McLachlan, Wooldridge & Van der Horst 1979; Du Preez 1983) and has been recorded to depths of 80 m (Barnard 1950). In Algoa Bay beaches harbouring these crabs range from relatively sheltered in the south-west to extremely exposed in the east (Beckley & McLachlan 1979). This study investigated the distribution of *O. punctatus* (size and sex) in relation to depth in Algoa Bay. The temperature and salinity tolerances of the first zoeae were also investigated to compare the optimal temperatures and salinities for survival of the zoeae, and the sea temperatures and salinities in Algoa Bay.

Material and Methods

Distribution

Swimming crabs were collected from Kings Beach by means of seine netting (two nets (i) 60 m × 2 m, mesh 35 mm; (ii) 30 m × 1 m, mesh 15 mm), dredging (width 0,5 m; mesh 1,5 mm) and baiting, and from Maitlands River Beach by means of dredging and baiting. Offshore trawls were performed during February, May, August and November 1980, with a 5 m otter trawl (cod end mesh 15 mm). In the laboratory the swimming crabs were sexed and the carapace width measured with vernier calipers.

Larval tolerance

Gravid females were collected from Kings Beach and kept at 20 ± 0,5 °C in the laboratory. The eggs hatched during March, May and June 1980, and the larvae (1st zoea stage) were collected within 5 h after hatching. Batches of 100 – 200 (mean 140) larvae were transferred to 200-ml beakers containing 80 ml of sea water. The beakers were then floated in water baths at the desired temperature. A number of combinations were tested in which the salinity ranged from 10 to 35‰ and the temperature from 5 to 35 °C. The temperature change took 30 to 60 min but the salinity changes immediately. This procedure limited the exposure time of each experiment to 24 h, ensuring that the larvae were still in the first zoea stage. The experiments were terminated after 24 h and approximately

70 ml of sea water was added to each beaker with a salinity below 35‰. All the beakers were permitted to revert to room temperature (18–21 °C). Momentary beating of appendages or bending of the abdomen of moribund larvae was taken to indicate survival. The number of dead larvae was counted and the percentage survival calculated.

Results

Male and female swimming crabs were commonly found in the surf zones off sandy beaches and offshore in Algoa Bay. Most of the larger crabs were found in relatively shallow water with the smaller crabs occurring in deeper water (Figure 1). The best relationship between depth and mean crab size is expressed by:

$y=49{,}53\ e^{-0{,}018x}$ ($n=125$; $r=0{,}81$; $p < 0{,}005$) for males and

$y=50{,}90\ x^{-0{,}171}$ ($n=177$; $r=0{,}87$; $p < 0{,}005$) for females

where x is the depth in metres and y is the mean carapace width in mm. There was no significant relationship between depth distribution and sex ratio (Table 1). However, the number of females on the beaches (1 m depth) was significantly greater (Kings Beach: $\chi^2_3 = 8{,}36$, $p < 0{,}05$; Maitlands River Beach: $\chi^2_2 = 5{,}00$, $p < 0{,}05$) than the number of males. Offshore in Algoa Bay there was no significant difference ($\chi^2_{14} = 13{,}36$, $p < 0{,}5$) between number of males and females (Table 1).

The results of the tolerance experiment are summarized in Figure 2. The percentage survival in each temperature-salinity combination is shown next to each point and the 50% and 90% survival curves fitted by eye. Above 23 °C less than 90% of the larvae survived and mortality increased rapidly to nearly 100% at 27,5 °C. The larvae were capable of tolerating low temperatures with mortality exceeding 10% at 7 °C. The larvae could not tolerate low salinities. At 32‰ only 90% survived and at 10‰ there was 100% mortality. In many of the combinations the larvae were completely inactive, the only indication of life being the beating of appendages or bending of the abdomen. The 'active line' (Figure 2) indicates that larvae were only active at 10,5–25 °C and 20–35‰. The high temperatures which caused mortality did not cause cessation of activity in survivors.

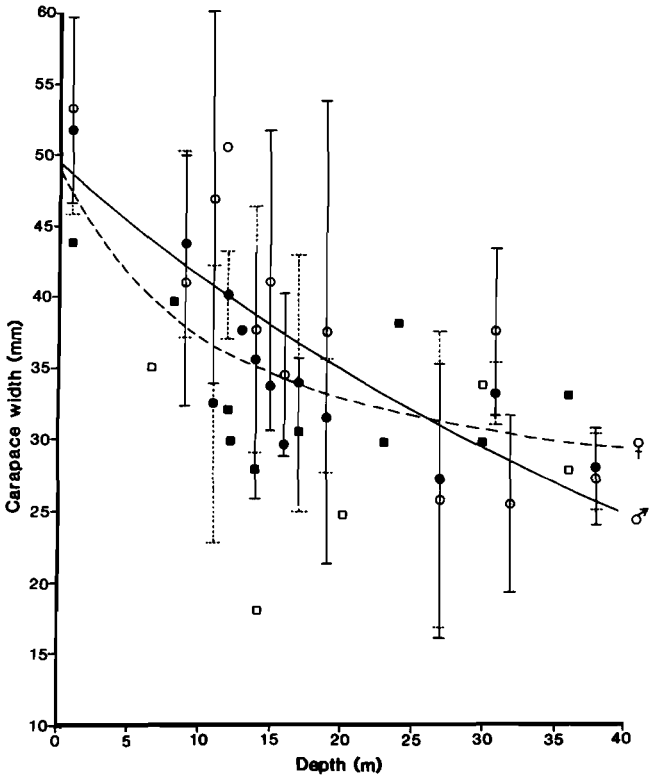

Figure 1 Relationship between mean crab size and depth for male and female *O. punctatus* for Algoa Bay and also showing mean values for other sampling positions outside Algoa Bay. • males from Algoa Bay; ○ females from Algoa Bay; ▪ males outside Algoa Bay; □ females outside Algoa Bay.

Discussion

During the offshore sampling period *O. punctatus* was only found to depths of 38 m, although the maximum depth trawled was 97 m. Most of the larger swimming crabs occurred in the shallow water close inshore. Barnard (1950) recorded *O. punctatus* at depths between 40–80 m in Algoa Bay, but

Table 1 Summary of numbers of *Ovalipes punctatus* caught at Kings Beach, Maitlands River Beach and offshore in Algoa Bay [modification of Table 1 from Du Preez & McLachlan, (in press)]

		Depth (m)																
		1		9		12		15		18		27		32		38		
Date	Locality	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	Total
February	Offshore	–	–	15	25	–	–	–	–	11	10	–	–	19	3	–	–	83
1980	Kings Beach	8	27	–	–	–	–	–	–	–	–	–	–	–	–	–	–	35
	Maitlands River Beach	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
May	Offshore	–	–	–	1	–	1	1	3	–	–	–	–	1	8	2	2	19
1980	Kings Beach	11	18	–	–	–	–	–	–	–	–	–	–	–	–	–	–	29
	Maitlands River Beach	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
August	Offshore	–	–	–	1	5	2	4	2	–	–	7	1	–	–	–	–	22
1980	Kings Beach	6	16	–	–	–	–	–	–	–	–	–	–	–	–	–	–	22
	Maitlands River Beach	–	7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
November	Offshore	–	–	1	7	6	9	5	8	11	10	1	–	–	–	–	–	58
1980	Kings Beach	11	13	–	–	–	–	–	–	–	–	–	–	–	–	–	–	24
	Maitlands River Beach	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total		36	84	16	34	11	12	10	13	22	20	8	1	20	11	2	2	302

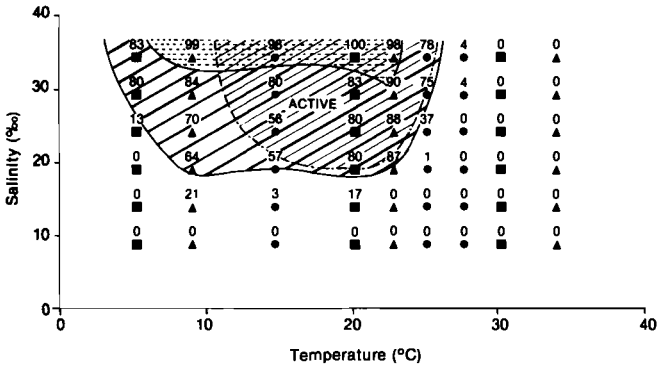

Figure 2 Survival of first stage zoeae of *O. punctatus* in various combinations of temperature and salinity. Three batches of larvae were obtained and identified by different symbols: • hatched on 10 March, 1980; ▲ hatched on 22 May, 1980; ■ hatched on 3 June, 1980. The area shaded with dots encloses combinations in which 95–100% survival occurred. The solid line encloses combinations in which 50 to 90% survival occurred. Area enclosed by dashed line indicates combinations in which normal swimming activity occurred.

did not indicate the trawling positions or the size, sex or number of crabs found. It may therefore be assumed that these crabs do occasionally occur at depths exceeding 40 m.

The tolerance experiments showed that optimal temperatures and salinities for survival of the first zoeae range from 15–22 °C and 34–35‰ respectively. At low temperatures (5–10,5 °C) the larvae were alive but moribund. During summer the day-to-day variation in sea temperature in Algoa Bay is greater than in winter (Figure 3). This variation in temperature is due to summer upwelling at Woody Cape (e.g. 8 °C drop in 12 h, February 1981; Beckley 1983). This suggests that the swimming crabs would spawn from May to October when the variation in sea temperature is least and the temperature range well inside the tolerance limits (optimal spawning temperature 15–22 °C). This is supported by the findings of Du Preez & McLachlan (in press) that *O. punctatus* has an extensive spawning period during winter (April to September) ensuring that the larvae (up to 10^6 eggs per female) are produced at a time when they have the best chance of surviving.

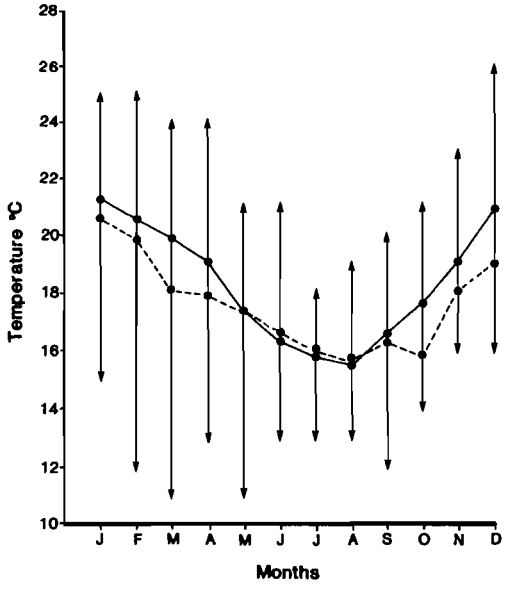

Figure 3 Sea temperatures (± SD) in Algoa Bay. •——• mean surf temperatures [highest (▲) and lowest (▼) recorded temperatures from Humewood Beach (1975–1979): •———• mean offshore temperatures from Maritime Weather charts (January 1975–September 1977; from Beckley & McLachlan 1979).

A sharp thermocline develops ± 12 m below the warm surface layer during summer (Beckley 1983). This suggests that spawning during summer would be at depths less than 40 m (temperature ± 15 °C) to ensure maximum survival of the larvae. Owing to isothermal water conditions during winter (Beckley 1983) larvae could possibly be produced at depths to 90 m as the temperature range is 15–18 °C throughout this zone (Beckley 1983). During the sampling period gravid females were found to 32 m depth but most of the gravid females were closer inshore (<10 m).

Gravid females are frequently found in surf zones off sandy beaches (Du Preez & McLachlan, in press) but have never been recorded in the Sundays River or Swartkops River estuaries (P.E.D. Winter and J.F.K. Marais, pers. comm.). This is possibly the result of the inability of the larvae to tolerate low salinities. *O. punctatus* may therefore be considered exclusively marine.

The first zoeae of the *Scylla serrata* were found to tolerate higher temperatures (Hill 1974: up to 35 °C) and lower salinities (10‰) than the first zoeae of *O. punctatus*. These differences may be due to the different life styles of the adult crabs. *S. serrata* is mainly an estuarine species which migrates offshore to spawn (Hill 1974), while *O. punctatus* is exclusively marine and does not migrate offshore to spawn. The optimal spawning temperatures for *S. serrata* (14–20 °C) and *O. punctatus* (15–22 °C) are, however, in the same range.

It may therefore be concluded that *O. punctatus* is an inshore marine species in which winter spawning is coupled to stable temperatures near the larval optima. Spawning occurs close inshore, mostly in water less than 5 m deep and the larvae settle later in water mostly 20–30 m deep. They subsequently migrate inshore as they grow.

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