MAINTENANCE OF NON-BREEDING POPULATIONS OF THE ESTUARINE PRAWN *CALLIANASSA KRAUSSI* (CRUSTACEA, ANOMURA, THALASSINIDEA)

A T FORBES
Zoology Department, Rhodes University, Grahamstown, and Department of Nature Conservation, Cape.
Accepted: June 1977

ABSTRACT

Despite the occurrence of populations of the anomuran prawn *Callianassa kraussi* Stebbing in salinities as low as one part per thousand, investigation showed that a minimum salinity of 25-30 parts per thousand was required for successful development of the eggs and larval stages. Dispersal into areas of low salinity and maintenance of these non-breeding populations is accomplished by migration of the early post-larval stages from higher salinity areas.

INTRODUCTION

The range of *Callianassa kraussi* Stebbing in southern African estuaries extends into areas of extremely low salinity. Day (1951) gives a minimum salinity tolerance of $1,25^0/_{00}$, while I have recorded populations in the upper reaches of the closed Mbotyi estuary (31°S/29°E) at $1,6^0/_{00}$ and in the upper Keurbooms estuary (34°S/23°E) at $1^0/_{00}$. Survival of adult *C. kraussi* at these low salinities is associated with a well-developed hyperosmotic and hyperionic regulatory ability (Forbes 1974).

Samples of prawns collected from these low salinity habitats never revealed any breeding activity and thus the mechanism whereby these populations are maintained is of interest. *C. kraussi* does not have a planktonic larval stage (Forbes 1973) and it was therefore decided to investigate the tolerance of the egg and larval stages to low salinities and to compare their tolerance with those of later stages in the life cycle. The significance of the post-larval stages in dispersal was also investigated.

MATERIALS AND METHODS

Low salinity tolerance of eggs and larvae.

Seven ovigerous females carrying freshly extruded eggs were selected from a sample obtained in the Umhlali estuary (29° 18′S/31° 20′E). The number of eggs carried varied

*Present Address: Department of Biological Sciences, University of Natal, King George V Avenue, Durban. 4001

from 12 to 40. The females were maintained individually in covered dishes (10 x 10 x 8 cm) in 250 ml of water at salinities of 5; 10; 15; 20; 25; 30 or $35^0/_{00}$. Those exposed to salinities below $15^0/_{00}$ were first acclimated to $15^0/_{00}$ for 24 hours. The eggs were examined daily until hatching occurred and the numbers of larvae recorded. They were then maintained at the salinity at which they hatched and the numbers which reached the first post-larval stage were recorded.

Differences in tolerance to low salinities between first and second larval stages were investigated using larvae hatched from eggs held in sea water ($35^0/_{00}$). Stage 1 larvae were exposed to salinities of 5; 10; 15; 20; 25; 30 or $35^0/_{00}$ in batches of 10, and the number which moulted to the second larval stage was recorded. This experiment was repeated using larvae which had reached State 2 in sea water ($35^0/_{00}$) and the number which moulted to the first post-larval state was recorded.

Dispersal

Dispersal was investigated in the Swartvlei lake system (34°S/22°45′E) and in the East Kleinemonde River estuary (33°S/27°E). The Swartvlei system (Figure 1) consists of a large brackish lake connected to the sea by a winding channel. The lake has a maximum depth of about 13 m but the channel is mostly two to three metres deep. The mouth of the system closes occasionally, after which the level usually rises. Following heavy rain the mouth is usually open. *C. kraussi* occurs throughout the channel and into the region of the

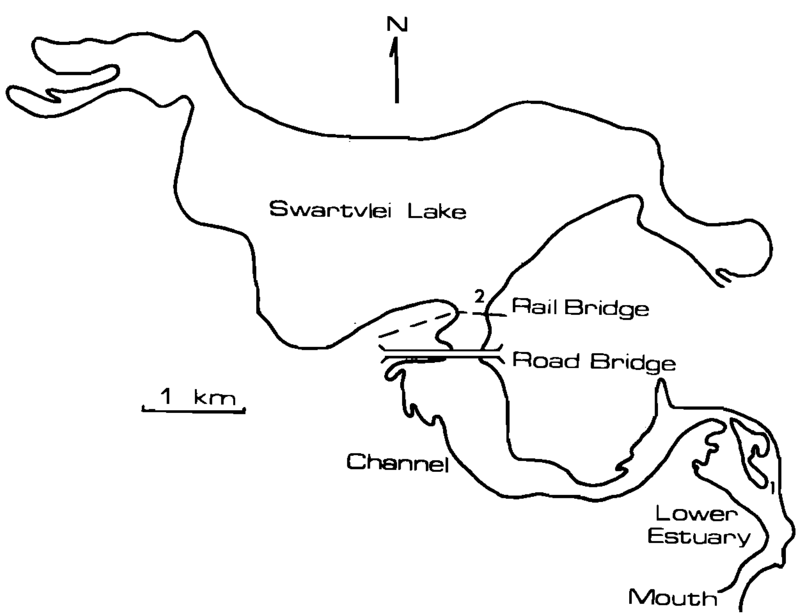

FIGURE 1
Sketch map of the Swartvlei system showing Areas 1 and 2 in the lower estuary and lake where *C. kraussi* was collected.

lake above the rail bridge (Area 2, Figure 1). At the time of this study extremely few prawns were found elsewhere in the lake.

Over the period June 1972 to October 1973, samples of *C. kraussi* were collected at two-monthly intervals in the lower estuary and lake at the points (1 and 2) shown in Figure 1. Prawns were collected using a prawn pump, an instrument similar to the yabby pump described by Hailstone & Stephenson (1961). The pump was operated in water up to 1,3 m deep and the contents expelled into a sieve (2 mm bar mesh) which retained prawns with a carapace length down to 1 mm (10 mm total length). Two hundred animals were collected in the lower estuary on each occasion but only one hundred in the lake where numbers were lower and collecting more difficult. The carapace length of each prawn was measured and the data divided into 1 mm size classes.

Bottom salinities were recorded in both areas from April 1972. Prior to June 1972 salinities were determined by chloride titration and conversion to salinities using Knudsen's tables. Subsequently determinations were made using an optical salinometer (American Optical Co.).

Migratory movement of *C. kraussi* was monitored in the East Kleinemonde estuary. This estuary was closed off from the sea by a sand bar during the course of the experiment. Four asbestos cement boxes 30 x 20 x 30 cm deep were filled to about 5 cm below the top with sieved estuary sand. They were then placed in about 1 m depth of water and buried so that the sides just protruded above the sand. The boxes were lifted approximately every two months and the contents sieved. Any prawns found were preserved, measured and sexed. The experiment ran for 23 months.

RESULTS

Tolerance of eggs and larval stages to low salinities.

Hatching success and survival to the first post-larval stage in different salinities is summarized in Figure 2. No eggs hatched in salinities below $20^0/_{00}$. There was a steady increase in percentage hatch with increasing salinity up to $35^0/_{00}$. Figure 2 also indicates that egg development can occur at salinities lethal to the newly hatched larva; although hatching occurred in $20^0/_{00}$ salinity there was no survival to the first post-larval stage in salinities below $30^0/_{00}$.

Second stage larvae were found to be more tolerant of low salinities than first stage larvae (Figure 3); 80 per cent of second stage larvae in $15^0/_{00}$ successfully moulted to the next stage, while no first stage larvae survived in salinities of $20^0/_{00}$ and below.

Dispersal

In August 1972 prawns with carapace lengths of 2-5 mm made up 63% of the population in the lower estuary (Area 1) of Swartvlei but none was recorded in the lake (Area 2) where the minimum size was 6 mm (Figure 4). In October 1972 prawns in the 3-5 mm carapace size classes were recorded in the lake (Area 2). Salinities in the lake declined from $12{,}6^0/_{00}$ in

June 1972 to 10,6$^0/_{00}$ in September and only began to rise in October after the mouth opened. *C. kraussi* requires 6-8 months to attain 5 mm carapace length (Forbes 1977) and in view of the absence of young prawns in August it is apparent that the presence of 3-5 mm carapace prawns in the lake in October indicates immigration from elsewhere in the system. Large numbers of small prawns were present in the lower estuary in August (Figure 4) and this would have been the probable source of recruitment to the lake population.

Sixty-one prawns, the offspring of the resident breeding population, were collected from the settlement boxes in the East Kleinemonde estuary. Seventy per cent were found in spring and summer (October - February) (Figure 5). All the prawns found had carapace

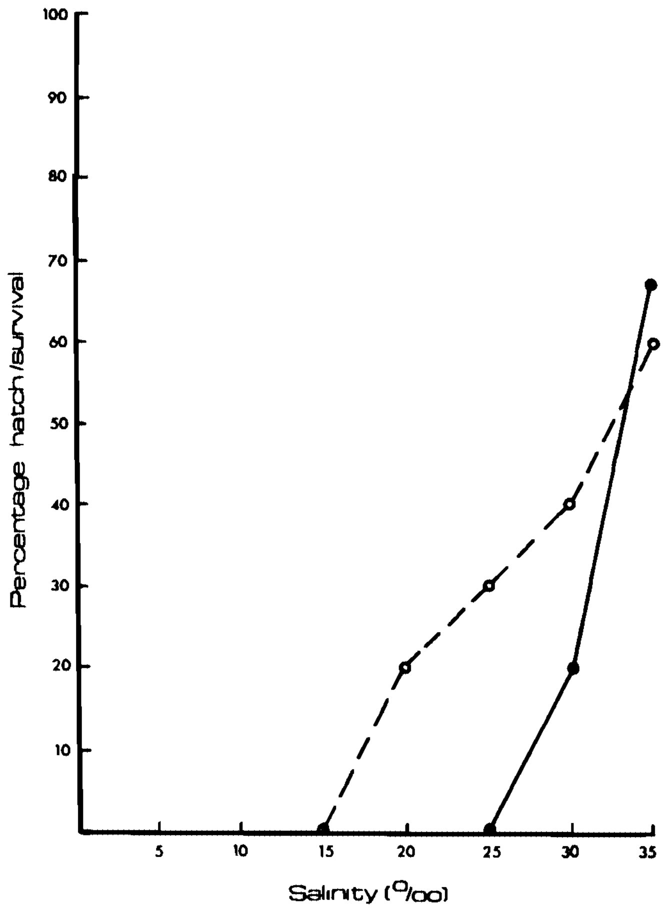

FIGURE 2
Percentage hatch of eggs (o——o) and percentage larval survival from hatch to first post-larval stage (•——•) in *C. kraussi* at different salinities.

lengths of 2-5 mm except for six larger specimens found in January 1974. These probably resulted from the longer than normal period for which the boxes had been left in the estuary on this occasion. The periods when maximum movement was recorded coincide with the periods when the 2-5 mm carapace size classes are dominant in eastern Cape populations of *C. kraussi* (Forbes 1977).

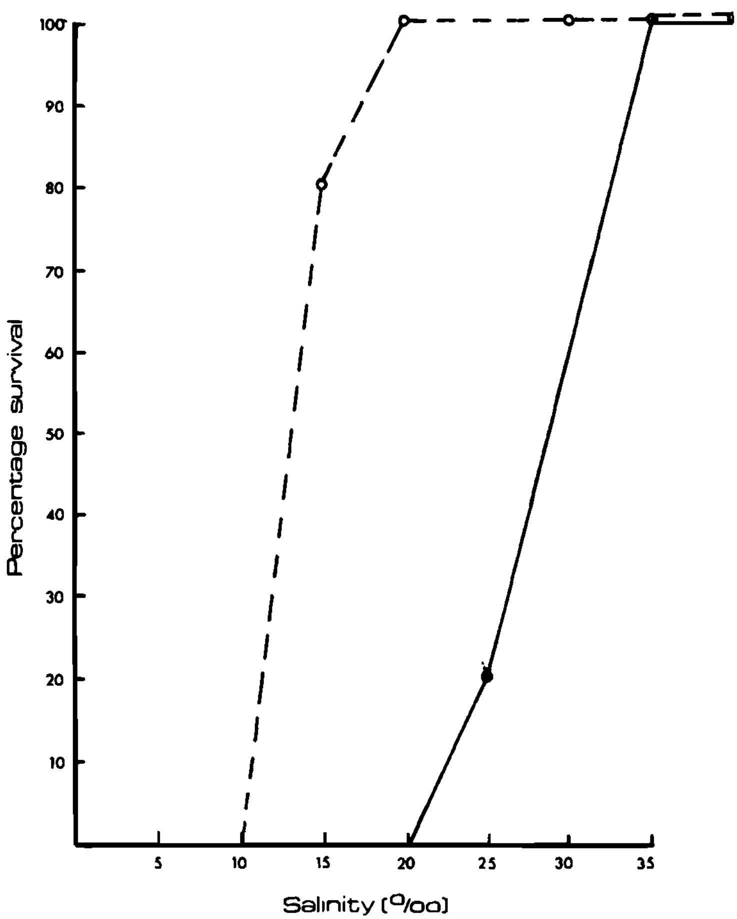

FIGURE 3
Percentage survival of first stage (•——•) and second stage (o——o) *C. kraussi* larvae at different salinities after hatching in sea-water (S35‰).

DISCUSSION

The brief review given by Thompson & Pritchard (1969) of the habitats of the different species of *Callianassa* indicates that although some species may be subjected to reductions in salinity, this is only a temporary situation. *C. kraussi* appears to be the only species in the genus which is capable of existing permanently in reduced salinities. The extent of this tolerance to low salinities is well illustrated by the presence of a population in the Keurbooms River estuary at a salinity of $1^{0}/_{00}$.

The experiments described in this paper indicate that successful development from the egg through to the post-larval stages requires salinities greater than $20^{0}/_{00}$. Even after acclimation, successful hatching and larval development is unlikely in salinities below

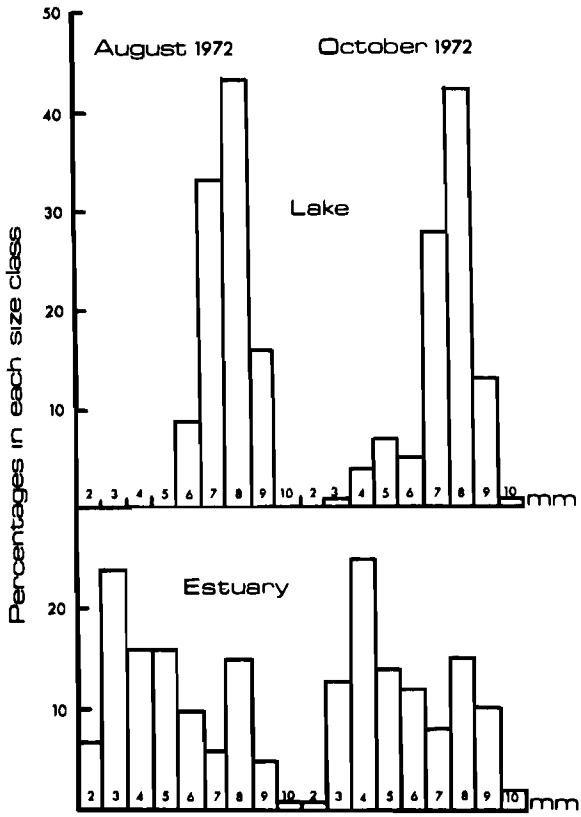

FIGURE 4
Population structure in the estuary (Area 1) and lake (Area 2) of the Swartvlei system in August and October 1972.

about $17^0/_{00}$. Thus populations living in areas in which the salinity is permanently less than about $17^0/_{00}$ are not self-maintaining and must be recruited from elsewhere.

The indication of substantial movement by the post-larval stages in the Swartvlei system is supported by the results from the Kleinemonde estuary where it appears that it is a regular occurrence in spring and summer. In both areas similar size groups were involved. Extra-burrow activity in post-larval callianassids is rare. Monod (1927) records annual migrations of *C. turnerana* in the Cameroons of West Africa. Hailstone & Stephenson (1961) postulate migrations of small post-larval stages of *C. australiensis* in Queensland but do not provide direct evidence. The situation where the early post-larval stages act as the dispersal phase in the life history seems to be unique to *C. kraussi* among the callianassids.

Although a reduction in the number of larval stages is known in other species of the genus *Callianassa* (Gurney 1942; Sandifer 1973) the loss of the planktonic larval phase appears to be unique to *C. kraussi*. This loss would reduce larval mortality and allow for production of fewer, larger eggs than in other species in the genus (Forbes 1973) with a consequent

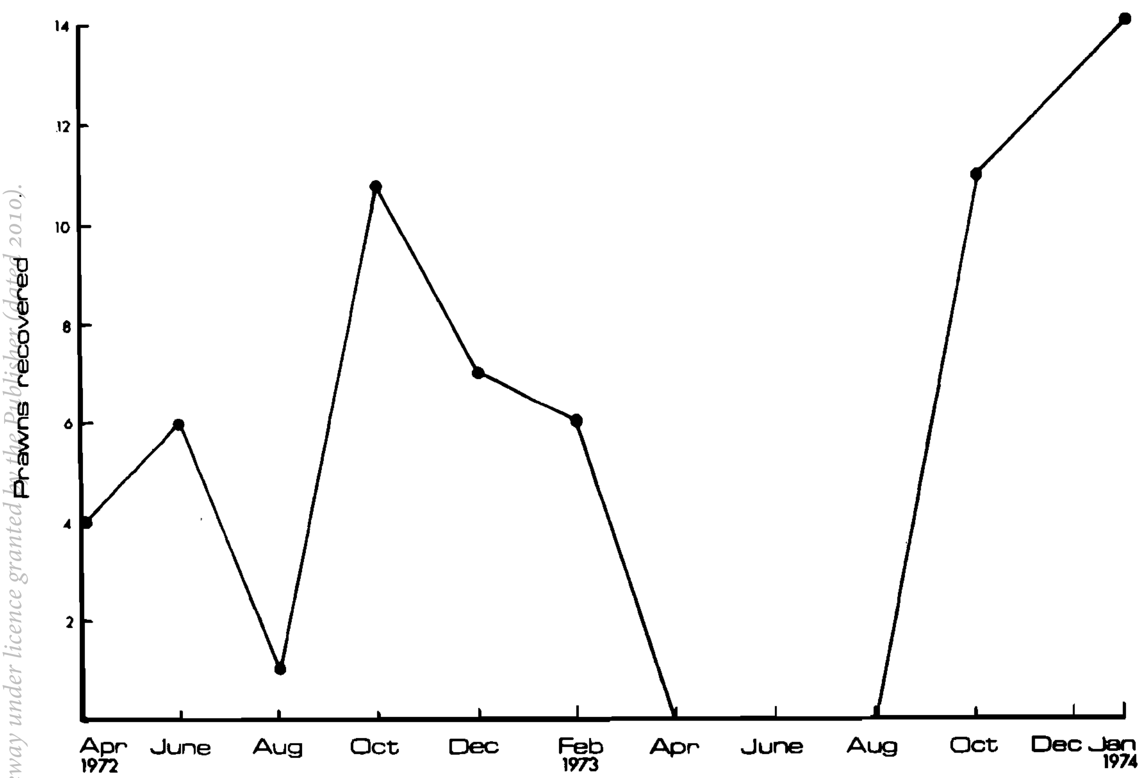

FIGURE 5
Recoveries from settlement boxes in the East Kleinemonde estuary over the period February 1972 - January 1974.

reduction of the salinity-sensitive larval stage, a feature of advantage to animals in an estuary subject to rapid salinity fluctuations. The role of the dispersal phase in *C. kraussi* has been taken over by the post-larval stages which are more tolerant of low salinities than the larvae permitting *C. kraussi* to spread into areas where it is unable to breed successfully.

ACKNOWLEDGEMENTS

The author acknowledges the financial assistance of the Department of Nature Conservation of the Cape Province of South Africa, and the South African National Committee for Oceanographic Research.

REFERENCES

DAY, J H 1951. The ecology of South African estuaries. Part I. A review of estuarine conditions in general. *Trans. R. Soc. S. Afr.* 23: 53 - 91.

FORBES, A T 1973. An unusual abbreviated larval life in the estuarine burrowing prawn *Callianassa kraussi* (Crustacea : Decapoda : Thalassinidea). *Mar. Biol.* 22: 361 - 365.

FORBES, A T 1974. Osmotic and ionic regulation in *Callianassa kraussi* Stebbing (Crustacea : Decapoda : Thalassinidea). *J. exp. mar. Biol. Ecol.* 16: 301 - 311.

FORBES, A T 1977. Breeding and growth of the burrowing prawn *Callianassa kraussi* Stebbing (Crustacea : Decapoda : Thalassinidea). *Zool. afr.* 12: 201 - 213.

GURNEY, R 1942. Larvae of decapod Crustacea. *Ray Soc. Publs,* 129: 1 - 306.

HAILSTONE, T S & STEPHENSON, W 1961. The biology of *Callianassa (Trypaea) australiensis* Dana, 1852 (Crustacea, Thalassinidea). *Pap. Dep. Zool. Univ. Qd,* 1: 259 - 285.

MONOD, T 1927. Sur le crustacea auquel le Cameroun doit son nom *Callianassa turnerana* (White). *Bull. Mus. Hist. nat. Paris,* 33: 80 - 85.

SANDIFER, P A 1973. Mud shrimp *(Callianassa)* larvae (Crustacea, Decapoda, Callianassidae) from Virginia plankton. *Chesapeake Sci.* 14: 149 - 159.

THOMPSON, C C & PRITCHARD, A W 1969. Osmoregulatory capacities of *Callianassa* and *Upogebia* (Crustacea : Thalassinidea). *Biol. Bull. mar. biol. Lab. Woods Hole,* 136: 114 - 129.