THE BURROWING HABIT OF THE KOONAC *CHERAX PLEBEJUS* (DECAPODA:PARASTACIDAE)

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INTRODUCTION

Most, if not all, freshwater crayfish dig burrows and are classified by Hobbs (1942, 1981) into primary, secondary and tertiary burrowers; digging is a conspicuous feature of their biology. However, the question "Why do crayfish dig burrows?" is no closer to being answered today than when posed by Abbott (1873). It is possible to postulate advantages to the crayfish such as protection from predators, access to underground food and water, and the creation of microhabitats with optimal moisture, temperature and oxygen gradients. The burrows may play a significant role in population regulation, being part of a defended territory.

Whatever the reason for burrowing, it is reasonable to suppose that digging a structure which may reach down in excess of two metres into the substratum, and ramify through a large volume of soil, represents a significant component in the energy budget of crayfish. In turn, their efforts probably have a significant influence on the movement of oxygen (Richardson, in press), nutrients substrate particles and drainage throughout the substrate profile in areas inhabited by crayfish.

This paper reports on a study of *Cherax plebejus* burrows carried out near Dunsborough, Westen Australia, during 16 and 17 February 1980. Austin (1979), in a biochemical revision of *Cherax* species from Western Australia, provided strong evidence that *Cherax plebejus* and *C. preissii* are synonymous, with the latter having chronological priority. However, as this work is not yet published (and in fact is being extended to cover all other *Cherax* species), further changes in nomenclature may be made. Until these taxonomic issues have been resolved, and because the specimens described in this study have the form and lifestyle of crayfish widely regarded as "koonacs" or *C. plebejus*, we will use these terms.

STUDY AREA AND METHODS

The study area lies 7.1km north-west of Dunsborough in a headwater seepage of a small coastal creek (Figure 1) at an altitude of 90-100m. Although much of the area around the study site has been cleared for agriculture, patches of the original vegetation (predominantly of peppermint *Agonis flexuosa* and marri *Eucalyptus calophylla* remain, especially along the seepage line where rushes (*Juncus* sp. and a Restionaceae), a sedge (? *Lepidosperma* sp.) and introduced arum lilies (*Zantedeschia aethiopica*) also occur. All the burrows examined were found within a strip of 4-5 metres width and 15 metres length, through which a semi-permanent creek meandered; all burrows were associated with this winter water course. The inclination of the seepage was approximately 5°.

The burrows were carefully excavated using a spade. Maximum vertical depth of each burrow was recorded as the straight line distance from the bottom of the deepest chamber to the surface. This measure will underestimate slightly the length of each burrow. Plaster of Paris was poured into two burrows to make permanent records of burrow morphology.

RESULTS AND DISCUSSION

Occupancy of burrows.
Koonacs were found in 22 of the 32 burrows investigated, representing an occupancy rate of 69%. Given the size of the specimens, the absence of juveniles and the care taken, we do not believe it likely that we overlooked specimens form the 10 burrows apparently empty. This occupancy rate is lower than the value of 83.5% recorded for *Parastacoides tasmanicus* in the South West of Tasmania (Lake and Newcombe, 1975).

Twenty-eight koonacs (14 males and 14 females, carapace length 15.2 - 16.1 mm) were recovered during the exercise. A single specimen was found in 16 burrows, the remaining 6 occupied burrows harboured 1 female and 1 male specimen in each case. Each koonac was located in the bottom chamber of the burrow and, where male and female were found together, the female was situated vertically above the male; the significance of this is not known.

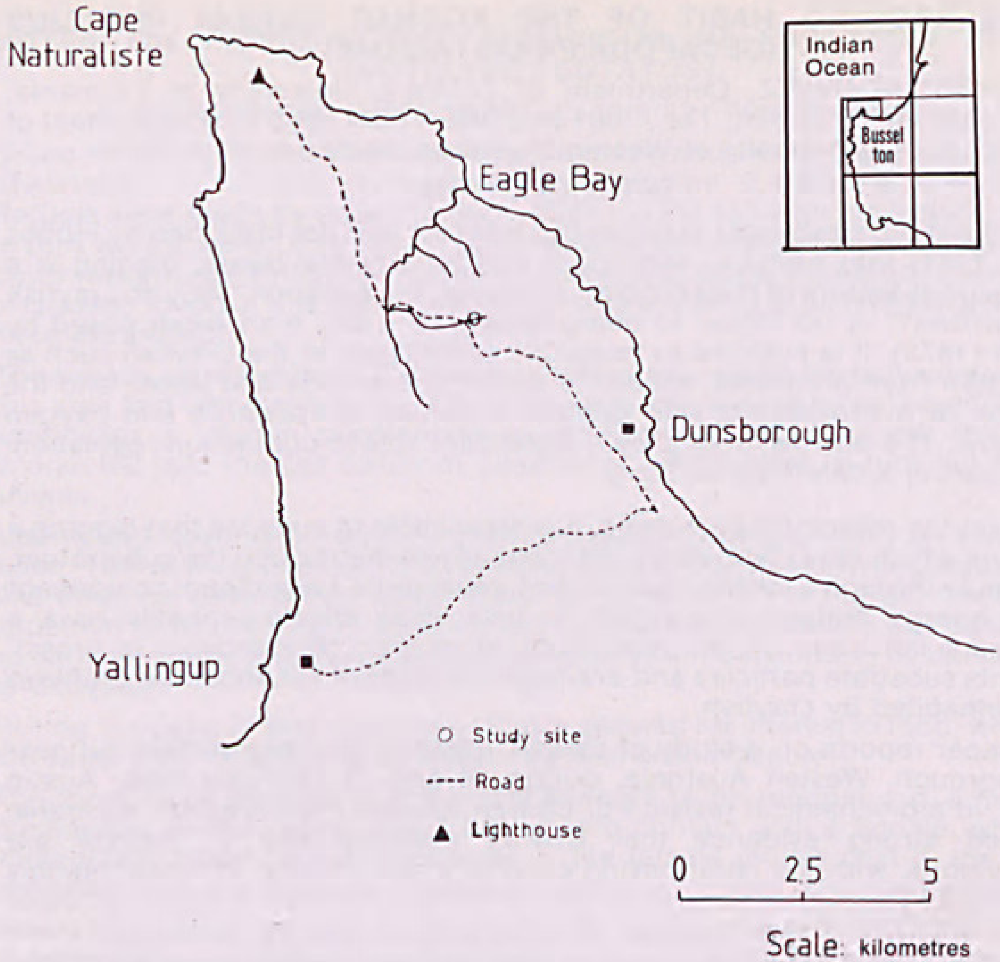

Figure 1 Map showing the sample site in the south west of Western Australia. The area represented by the large scale map is indicated within the Busselton section of the insert.

In 3 of the 6 co-occupied burrows the females were gravid and the eggs were of pre-larval stage 1 condition (Hopkins, 1967), showing only coloration of yolk and eye spots. This suggests relatively recent fertilization, possibly occuring in the burrow and on the basis of this we can propose that koonacs form short-lived family units, based in a burrow, and consisting of a male and gravid female and, later, juveniles. Under this scheme the juveniles should be released when the water level in the burrow rises significantly after the summer dry. Family groups have also been described for *Engaeus* spp. in Tasmania and Victoria (Clark, 1936; Riek 1969; Suter and Richardson, 1977). The family unit concept appears, at first, to contradict the notion (of Huxley, 1906) that freshwater crayfish are aggressive and cannibalistic. It has been proposed, however, that any mechanism which will seasonally lower the agonistic behaviour between the sexes would be selectively advantageous (Atema *et al.*, 1979).

Burrow Morphology

Of the 22 occupied burrows, 15 were sealed with a soil plug and the remainder opened beneath a log or piece of vegetation. Plugs consisted of soil raised into a small chimney protruding above ground level. Judging by the size and fit of the plugs such sealing of burrows must be a deliberate act on the part of the crayfish, a point of view previously adopted by Girard (1852), and will have strong adaptive value for crayfish inhabiting areas where surface waters are not permanent and ambient temperatures are high, such as the South West of Western Australia. The plugs, therefore, may function in the retention of moisture levels within the burrow.

Burrow depths increased from 0.60m at the lowest point of the study area to 1.12m at its highest (Figure 2). It is not surprising, therefore, to find a strong correlation between the depth of the water table and burrow depths (correlation coefficient $r = 0.921$, $n = 11$, $P < 0.001$), since it is commonly considered that the depth of crayfish burrows reflects the lowest depth that the water table has reached in recent times (Tarr, 1884; Harris, 1903). The structure of koonac burrows near Dunsborough must be considered simple

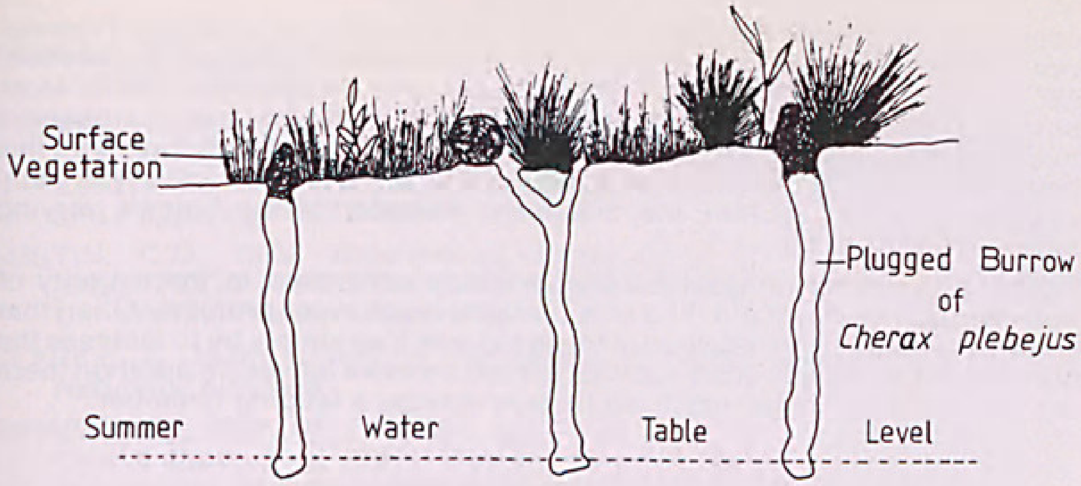

Figure 2. A diagram representing a longitudinal section of the sample site, showing the relationship between burrow depth and the water table level.

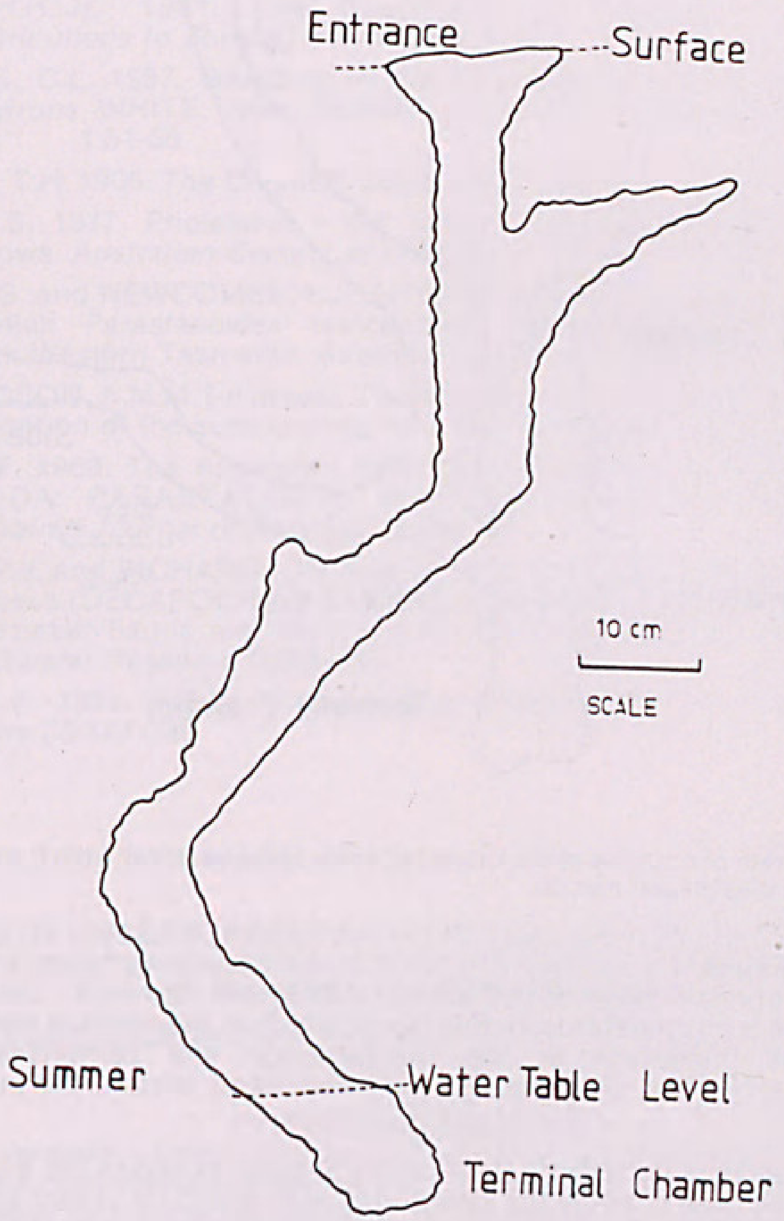

Figure 3. Diagram of a 'typical burrow of the koonac (*Cherax plebejus*) at Dunsborough. Drawn from a plaster cast mould.

compared to those described for other parastacids, for example *Engaeus victoriensis* (Clark, 1936) *E. fossor* and *E. cisternarius* (Suter and Richardson, 1977) and *Parastacoides tasmanicus* (Lake and Newcombe, 1975). Most burrows had a single entrance, although some had two, and comprised a tunnel leading more or less directly down to a terminal chamber (Figure 3), this being full of mud at the time of excavation. Each tunnel was generally broadly elliptical in cross section, the maximum diameter of the tunnels varying between 6 and 10 cm.

Figure 4 shows an unusual burrow structure compared to the majority of burrows explored by hand. The side tunnel is much more prominent than that shown in Figure 3; the function of these tunnels may simply be to increase the burrow area to expose more roots or to hold an extra female. In addition there is a second side tunnel which we believe may be a feeding chamber.

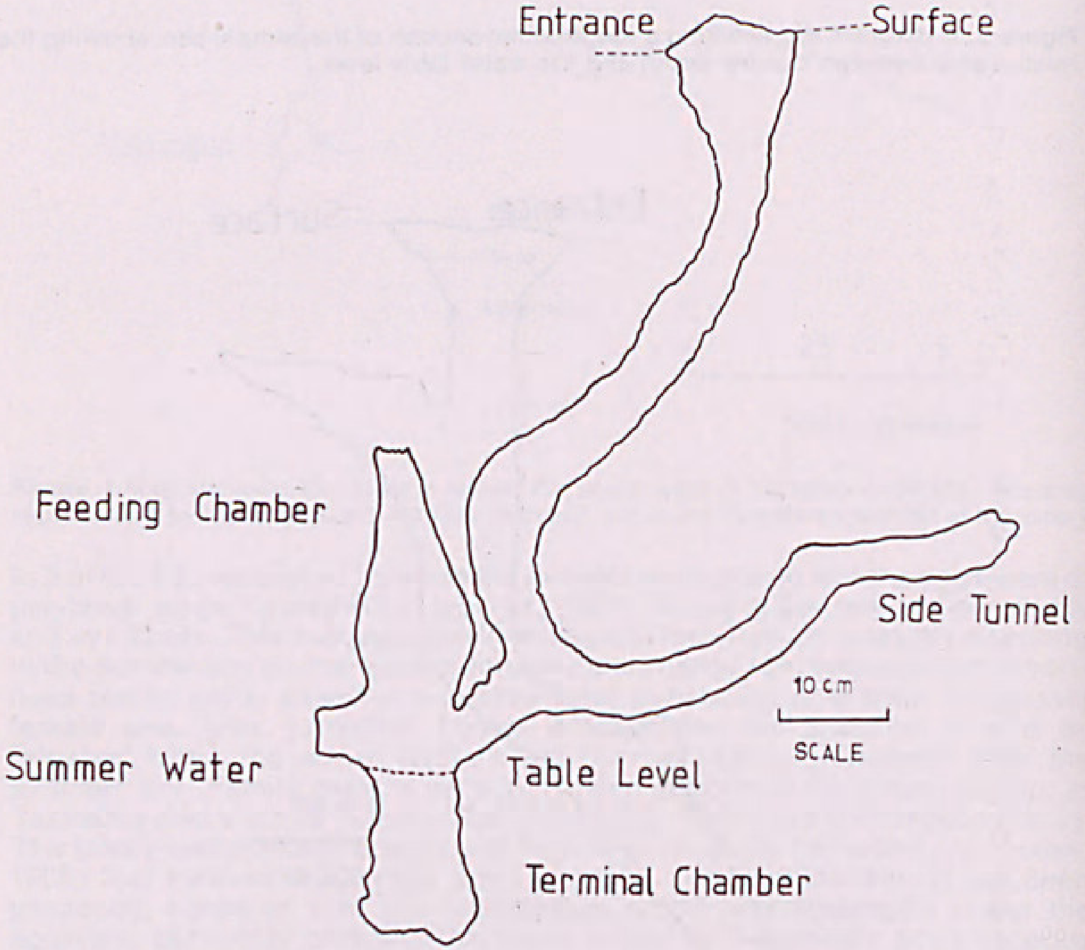

Figure 4. Diagram of a burrow of the koonac (*Cherax plebejus*) taken from Dunsborough. Drawn from a plaster cast mould.

Associated Fauna

Few other animals were found co-inhabiting the burrows. Lake (1977) proposed the term pholeteros for this fauna, which in Tasmania at least is quite diverse. The pholeteros at the Dunsborough site comprised several amphipods and a few oligochaetes in the sediments around the burrows.

ACKNOWLEDGEMENTS

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EFFECTS OF UNSEASONABLE RAINS IN JANUARY 1982 ON WATERFOWL IN SOUTH-WESTERN AUSTRALIA I. RESPONSES OF SELECTED SPECIES ON COASTAL SUMMER REFUGES.

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ABSTRACT

A marked decrease in overall waterfowl numbers was observed on two wetlands on the coastal plain, Herdsman and Jackadder Lakes, after exceptionally heavy rains in January 1982. However differences were observed between the responses of some species of waterfowl. While numbers of Black Swans *(Cygnus atratus)* were apparently unaffected, Pacific Black Duck *(Anas superciliosa)* showed a slight drop in numbers, Australian Shelduck *(Tadorna tadornoides)* decreased by more than fifty percent, and Grey Teal *(Anas gibberifrons)* left these lakes completely.