

## INFLUENCE OF SALINITY ON THE RESPIRATION OF AN ESTUARINE MUD CRAB, *HELICE CRASSA* (GRAPSIDAE)

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**Abstract**—1. The oxygen consumption of the euryhaline mud crab, *Helice crassa* (Grapsidae), was measured in 150, 100 (33.5‰), 50 and 10‰ seawater (SW) at 10°C.

2. In all salinities, there was a positive logarithmic relationship between body size (dry weight) and rate of oxygen uptake.

3. Compared with the rate in 100‰ SW, oxygen uptake was not significantly different in 150‰ SW, but was significantly lower in 50‰ SW and significantly elevated in 10‰ SW ( $P < 0.01$ ).

4. The weight exponent "b" (of the equation  $y = ax^b$ ) showed the opposite relationship from oxygen consumption to salinity change, and was highest in 50‰ SW and lowest in 10‰ SW.

### INTRODUCTION

The many studies of the effects of salinity on the oxygen consumption of euryhaline crustaceans (e.g. review by Kinne, 1971) indicate that respiratory rate may be unaffected (Eltringham, 1965; McLusky, 1969; Jones, 1974) or elevated (Pampapathi Rao, 1958; King, 1965; Dimock & Groves, 1975; Taylor, 1977) under conditions of osmotic stress. There has been no work of this sort with New Zealand crustaceans although certain species, such as *Helice crassa* Dana, 1851 (Grapsidae), occur in high numbers in estuarine and brackish water areas throughout the country (Jones, 1980). Previous work on the effects of salinity on *H. crassa* has shown it to be a hyperosmotic regulator (Bedford, 1972) and extremely euryhaline (Jones, 1981). In the present paper, we examine the influence of salinity on the respiration of *H. crassa*.

### MATERIALS AND METHODS

Crabs were collected from the Avon-Heathcote Estuary (43°33'S, 172°44'E), Christchurch on 15 May 1979 and transported immediately in a styrofoam cooler to the Portobello Marine Laboratory. They were placed in aquaria through which seawater (SW) (33.5‰) flowed continuously and which were half-filled with soft substrata to give a choice of terrestrial and aquatic habitats. Crabs were maintained in the laboratory for at least one week prior to use in experiments. Oxygen consumption of individual animals in salinities of 150, 100, 50 and 10‰ SW at 10°C was monitored according to the method described by Crisp *et al.* (1978). *H. crassa* has low mortality within this salinity range (Jones, 1981). Dilute salinities were prepared by adding rainwater to seawater and 150‰ SW by evaporation. Salinity changes were abrupt and each crab remained in the experimental chamber for 15 min before the oxygen readings were begun; crabs were not fed during

the experimental period. They were subsequently dried in an oven at 70°C for 24 hr.

### RESULTS

In all salinities, oxygen consumption was related logarithmically with crab dry weight (Fig. 1). Regression line data are given in Table 1.

Oxygen uptake did not change when the salinity was increased from 100 to 150‰ SW, however, oxygen consumption was significantly lower in 50‰ SW and significantly elevated in 10‰ SW compared with that measured in 100‰ SW (Fig. 1) (lines fitted by method of least squares and differences tested by analysis of covariance,  $P < 0.01$ ).

The weight exponent ( $b$ ) showed a different relationship from oxygen consumption to salinity changes. Maximum values of  $b$  were obtained in 50‰ SW and minimum values in animals exposed to 10‰ SW (Table 1; Fig. 2).

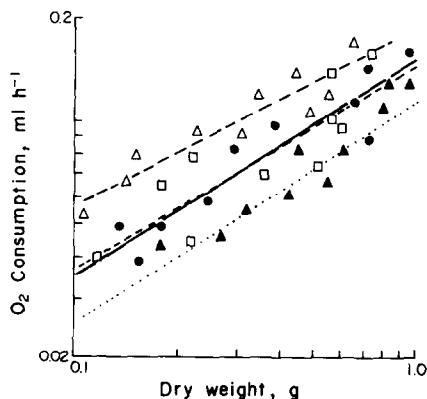


Fig. 1. Oxygen consumption of *Helice crassa* at 10°C in relation to dry weight and salinities of 150‰ (□), 100‰ (●), 50‰ (▲), and 10‰ seawater (△). Regression data are given in Table 1.

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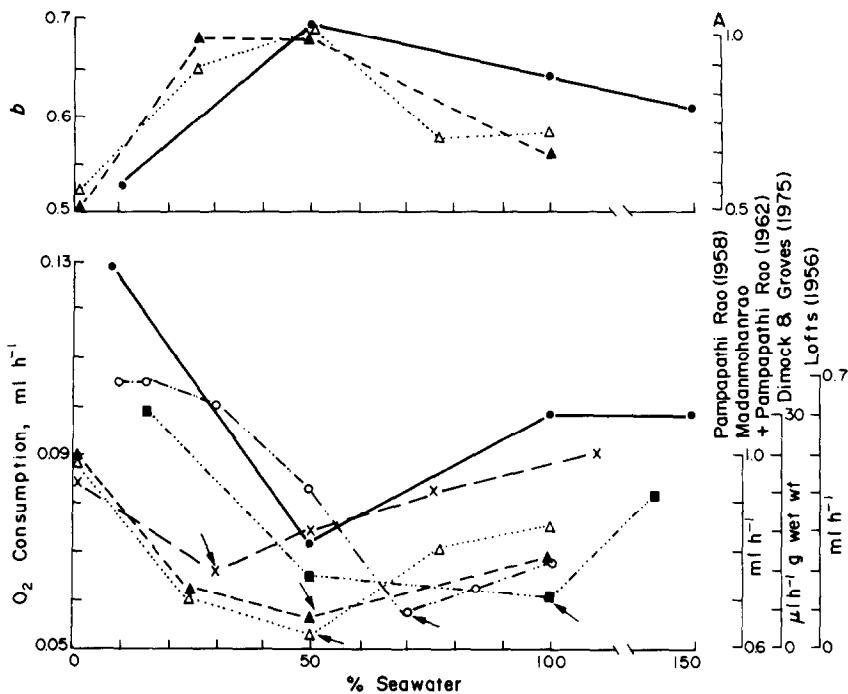


Fig. 2. Upper—effect of salinity on the weight exponent  $b$ . Lower—effect of salinity on oxygen consumption. Species included are *Helice crassa* (●); *Metapenaeus monoceros* (▲) (Pampapathi Rao, 1958); *Palaemonetes varians* from a marsh pool (○) and a sluice pool (×) (Lofts, 1956); *Sesarma plicatum* (△) (Madanmohanrao & Pampapathi Rao, 1962); *Panopeus herbstii* (■) (Dimock & Groves, 1975). Arrows indicate acclimatisation salinity for each species.

#### DISCUSSION

The results reported here for *H. crassa* show that the respiratory rate changed when the salinity was altered. This response to salinity has been reported previously for many euryhaline crustaceans (Kinne, 1971). The respiratory rate of *H. crassa* was at a minimum in 50% SW and at a maximum in 10% SW. These data support the notions that the respiratory rate of crustaceans is at a maximum when the osmotic difference between the blood and the external medium is also maximum (Pampapathi Rao, 1958; King, 1965; Hagerman, 1970), and that minimal respiration rates of brackish water and estuarine species may occur in salinities to which animals are acclimatised (Fig. 2) (Lofts, 1956; Madanmohanrao & Pampapathi Rao, 1962; Dimock & Groves, 1975). Newell (1979) pointed

out that the lowest energy expenditure was achieved when osmotic work and routine activity were at a minimum. These conditions are most probably met under optimum salinity. Thus, for an estuarine crab such as *H. crassa* which inhabits waters of wide salinity concentrations (Jones, 1977), it is perhaps not surprising that minimum oxygen consumption was recorded in 50% SW, i.e. in the middle of its tolerance range (Jones, 1981).

Several theories have been advanced to explain increased respiration in low salinities (Flemister & Flemister, 1951; Wikgren, 1953; Potts & Parry, 1964; McFarland & Pickens, 1965; Halcrow & Boyd, 1967; Hagerman, 1970; Schleiper, 1971; Seibers *et al.*, 1972; Gilles, 1973) but none are accepted universally. Gross (1957) attributed the increase to an increase in locomotory activity associated with behavioural avoidance responses. *H. crassa* were not active during the experiments, therefore this suggestion may be ruled out here. Lange *et al.* (1972) proposed that the increased solubility of oxygen at low salinity, combined with an oxygen-dependent respiration was responsible for enhanced consumption at reduced salinities. However, this cannot be applied to oxygen-independent respirers such as *H. crassa* (Shumway, unpublished).

The weight exponent  $b$  has received much discussion (Zeuthen, 1953; Hemmingsen, 1960; Shumway, 1979), and in the present work, highest values of  $b$  were found in salinities where oxygen consumption was at a minimum and *vice versa*. This relationship between  $b$  and oxygen consumption occurs for other crustaceans (Fig. 2) (Pampapathi Rao, 1958; Madan-

Table 1. Oxygen consumption of *Helice crassa* in relation to weight and salinity

Seawater (%)	$a$	$b$	$n$	Correlation coefficient
150	0.149	0.605	10	0.860
100	0.153	0.640	10	0.934
50	0.124	0.693	10	0.960
10	0.186	0.526	10	0.940

Data were fitted to the equation,  $y = ax^b$  ( $y$  = oxygen consumption in  $\text{ml h}^{-1}$ ;  $a$  = intercept;  $x$  = dry weight in g;  $b$  = weight exponent).

mohanrao & Pampapathi Rao, 1962), however, the significance of this correlation awaits further investigation.

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