Activity as a function of salinity in two species of intertidal crab, *Hemigrapsus oregonensis* and *Hemigrapsus nudus*

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The activity of *Hemigrapsus oregonensis* was compared to that of *Hemigrapsus nudus* over a 4-min exposure to each of four salinity conditions (0.0%, 33.3%, 66.6%, and 100.0% seawater). Activity increased with decreases in environmental salinity for both species. Differences between sex of S and species of S were nonsignificant. The results suggested that increased salinity discrepancy was aversive, that subsequent activity due to salinity variance may be part of an avoidance response, and that both species utilize the same behavioral response to salinity discrepancy.

Studies on the effect of environmental changes in marine poikilotherms have demonstrated the ability of decapod Crustacea to compensate for salinity change through ionic and osmotic regulations. *Hemigrapsus nudus* and *Hemigrapsus oregonensis*, two species of crab which inhabit the same ecological niche, are known to compensate for salinity variance by manipulation of oxygen consumption (Dehnel, 1960, 1962).

Dehnel (1960) reports that when respiration is compared at 25% seawater over various acclimation temperatures, oxygen consumption in *H. oregonensis* is greatest at low salinity. Respiration rate for *H. nudus* parallels that of *H. oregonensis* when the acclimation temperature is low (5°C); but at high temperature acclimation (20°C), *H. nudus* has greatest oxygen consumption at high salinity conditions. It is conceivable, then, that differences in physiological compensation between these two species may reflect a difference in overt behavioral reactions to environmental salinity change.

Gross (1957) has suggested that increased osmotic stress, i.e., increased oxygen consumption, is the result of increased muscular activity. For instance, *Pachygrapsus* exhibit overt escape patterns when placed in an aqueous milieu discrepant from normal seawater concentration. Gross has further demonstrated that *P. crassipes* prefer normal seawater when exposed to concentrations varying from 50% to 150% seawater.

Symons (1964) reported that the distance traveled in response to thermal stimulation was greater in male *H. oregonensis* than in females at high environmental temperatures. This finding suggests a sex difference in locomotor activity when responding to ambient temperature. Hence, the possibility arises that a sex difference may also exist when responding to

differing degrees of environmental salinity.

The present investigation was concerned with a comparison of responses to various salinities between two species of crab indigenous to the same habitat, and with determining if there was any difference in response attributable to the sex of crab.

METHOD

Source and Maintenance of Animals

Thirty-two *H. oregonensis* and 32 *H. nudus* served as Ss in the present study. The mean weights for male and female *H. oregonensis* were 5.2 and 3.4 g, respectively, and for male and female *H. nudus*, 5.8 and 3.7 g, respectively. The Ss were captured at Post Point, Bellingham, Wash., during the month of June. The animals were transported from Post Point to the laboratory in a covered plastic pail filled with seawater. Within the laboratory, the Ss were maintained in approximately 12.5 cm of seawater in a flat-black tank, 62 cm long, 36 cm wide, and 24 cm high. All animals were tested 2-4 h after being captured.

Experimental Apparatus

The experimental apparatus consisted of a gray Plexiglas chamber, 18.5 cm long, 8.5 cm wide, and 5.5 cm high. Two infrared photoelectric cells were mounted on the outside of the chamber, 6.5 cm from each end. Each light source beam passed through a separate 1.5-cm aperture approximately 1 cm above the interior floor of the chamber. Disruption of either photoelectric beam activated an electronic counter. The water level in the chamber was 3.5 cm.

Procedure and

Experimental Design

Eight *H. nudus* (four male and four female) and eight *H. oregonensis* (four male and four female) were assigned randomly to a 0.0%, 33.3%, 66.6%, or 100.0% salinity condition. All salinities are expressed as percentage

seawater, based on standard seawater—31.88% salinity and 17.65% chlorinity at 25°C as 100.0% seawater. Salinities below 100.0% were obtained by adding distilled water to normal seawater. During experimentation, the water temperature was $6^{\circ} \pm 1^{\circ}\text{C}$.

All crabs were tested individually. At the beginning of each session, the S was placed in the chamber midway between one end of the apparatus and the nearest photoelectric beam, facing the opposing end. All Ss were tested over a 4-min period.

RESULTS AND DISCUSSION

The 4 by 2 by 2 factorial analysis of variance yielded a significant salinity effect ($F = 11.34$, $df = 3/45$, $p < .01$). All other effects were nonsignificant ($p > .01$). Multiple comparisons were made, using the Duncan multiple-range test. Significant differences were obtained between all comparisons, except the 33.3% and 66.6% salinity conditions for *H. oregonensis* ($p < .01$).

Figure 1 presents the mean frequencies of responses for *H. nudus* and *H. oregonensis* over the four test salinities. As can be observed from this figure, activity in both species of shore crab increased with decreasing salinity. The present results are in agreement with the suggestion of Gross (1957) that decreased salinity (osmotic stress) should give rise to increased locomotor activity. Based on the findings of Gross and the present investigation, it seems apparent that the more divergent the salinity level from normal seawater, the more aversive it becomes. Furthermore, it is likely that the observed increase in activity was part of a behavioral escape pattern.

Although previous research has indicated differences in *H. nudus* and *H. oregonensis* in physiological

Fig. 1. Changes in activity as a function of salinity in two species of crabs.

reaction to salinity variance, the results of the present study suggest that both species utilize the same behavioral response to salinity discrepancy. This suggestion is plausible when it is recalled that both species occupy the same habitat.

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