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Effect of eyestalk removal and eyestalk extract injection on oxygen consumption in the crab, *Sesarma boulengeri* Calman

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Abstract

The effects of eyestalk ablation and eyestalk extract injection on oxygen consumption of *Sesarma boulengeri* Calman were studied on (150) specimens over a 10-day period. Statistical analysis of the results shows significant differences between stalked and destalked animals as well as stalked and eyestalk extract injected ones. Oxygen consumed in destalked animals was higher than in stalked ones, whereas oxygen consumed by eyestalk extract injected animals was lesser than stalked ones. The differences were discussed on the hormonal basis.

Introduction

THE VARIOUS PROCESSES of crustacean metabolism are inadequately known and for this reason it is difficult to assess the effects of hormones on crustacean metabolism. However, most investigators agree on the relationship between eyestalk removal and oxygen consumption.

Scudamore (1947) recorded that normal oxygen consumption is strongly increased from one week before the moult until one week after the moult. Bliss (1953 a, b) found that if the eyestalks of the land crab *Gecarcinus* are removed, throwing the animal precipitously into proecdysis, the respiratory quotient or R. Q. (the ratio of CO_2 released to O_2 consumed) falls from 0.77 to 0.69. This shift is suggestive of a change in the metabolic pattern of the animal toward greater lipid utilization. Vonk (1960) indicated that bilateral extirpation of the eyestalks (and less so of the sinus glands) increase the normal oxygen consumption as much as 60%. This effect may last until the next moult although its duration and intensity differ somewhat according to species. The increased oxygen uptake, which occurs normally during moult, is further enhanced if the eyestalks have been previously removed (Edwards 1950; Scudamore 1947).

Silverthorne (1973) correlates the respiration in the eyestalkless *Uca* with temperature. He found that the removal of eyestalks increases the oxygen consumption of warm-acclimatized crabs by 117% and of cold-acclimatized crabs by 47% since cold-acclimatized crabs do not moult. It is assumed that crustecdysone is not produced even though the source of moult-inhibiting hormone is removed. That the oxygen consumption still increases in these animals suggests the existence of eyestalk hormones

that regulate oxygen consumption independently, and this is confirmed by the effect of sinus gland extract on oxygen consumption. Extract from cold-acclimatized crabs increases oxygen consumption when injected into warm-acclimatized crabs, and extract from warm-acclimatized crabs decreases oxygen consumption when injected into cold-acclimatized crabs. Two distinct eyestalk hormones might then affect respiratory metabolism, one reducing the metabolic rate of crabs under high temperature stress and the other increasing the metabolic rate of crabs exposed to cold stress. These hormones would thus be adaptive in enabling the poikilothermic crab a greater metabolic independence of the ambient temperature (Highnam and Hill 1978). Passano (1953, 1960) also recorded that if the whole eyestalk neurosecretory system were implanted into eyestalkless animals it showed that accelerated onset of proecdysis was delayed. It is apparent, therefore, that there is a strong relationship between the hormones present in the eyestalk and the respiration rate of the animal. Since there has been no such study on the crab, *Sesarma boulengeri* Calman, which is present in abundance near the banks of the Shatt al-Arab River, therefore it was thought to be worthwhile to investigate this problem in this convenient species.

Materials and Methods

The crabs, *Sesarma boulengeri* Calman, used in the present investigations were collected from the shore of the river Shatt al-Arab, Basrah, (30° 30´ N and 47° 50´ E). Crabs were almost of the same weight (9 ± 2 g) so as to eliminate any size effect. After collection, the crabs were kept in a large aquarium fitted with aerators. The volume of water was adjusted so that the animals were just submerged and they were kept at room temperature (22 ± 2 C) under the natural photoperiod. They were fed with some phytoplankton and some meat, and the water was replaced daily. After three days of acclimation the crabs were divided into 3 groups. One group served as a control and the second group, the experimental, the eyestalks of which were removed as described earlier (Sinha and Mooswi 1978; Sinha 1984).

In the third group crude extract of eyestalk prepared by grinding twenty eyestalks in a mortar with 2 ml of van Harreveld's perfusion fluid (Simpkins 1973) was injected. Since the mortality rate was high beyond the 10^{th} day, the estimations were limited to the first 8 days after eyestalk removal. The Q_{O_2} was determined by p_{O_2} electrodes (Model TWT Oxi 42). Samples of water in small jars were kept in a Kotterman incubator. Considering the same temperature of the ambient which was 21 C, and the oxygen content was determined before the animals were kept and one hour after the animals were put inside the jars. The difference will be the amount of O_2 consumed by the animal, the result expressed as ml O_2 / animal (Yousif 1981).

Results and Discussion

Comparison of the destalked crabs with the control (Table 1) showed that oxygen consumed by the first group increased significantly after removal of the eyestalk. The

increase started from the first 24 hours until the 8th day, where the difference is almost insignificant. This phenomenon is likely to have a hormonal basis (Scudamore 1947; Edwards 1950; Bliss 1953a, b; Vonk 1960).

Table 1. Comparison between oxygen consumption (ml O_2/animal/hr) in stalked and destalked *Sesarma boulengeri*

Duration	Sex	Stalked			Destalked			P
		N	M	S. D.	N	M	S. D.	
1st day	F	5	0.52	± 0.10	5	2.29	± 0.08	< 0.010
	M	5	0.49	± 0.05	5	1.80	± 0.27	< 0.001
4th day	F	5	0.39	± 0.03	4	2.16	± 0.10	< 0.001
	M	5	0.31	± 0.02	5	1.38	± 0.07	< 0.050
8th day	F	5	0.31	± 0.03	4	0.33	± 0.06	N.S.
	M	5	0.29	± 0.04	5	0.35	± 0.07	N.S.

N: number of specimens used. M: the mean values. S. D.: Standard deviation. P: level of significance. N.S.: not significant.

The removal of eyestalks or both sinus glands causes a considerable shortening of the normal intermoult period and thus induces preparation for moult (Scudamore 1947; Edwards 1950; Bliss 1953a, b; Jegla *et al*. 1983). This means that the crab is thrown directly into the proecdysis stage where the major physiological events of decapods occur. Among these events, oxygen uptake increases markedly just before exuviation (Bliss 1953; Scheer and Scheer 1954; Scudamore 1947).

In *Maja* at least the amount of respiratory pigment in the hemolymph reaches a maximum at this time (Zukerkandle 1956). It was also indicated by Sinha and Mooswi (1978) that the concentration of ascorbic acid in the muscle and hepatopancreas of the crab *Sesarma boulengeri* Calman increases significantly after the removal of eyestalks, since ascorbic acid is involved in oxidation-reduction reactions, its higher level may be due to increased demand of the tissues for the oxidation-reduction processes to meet the increased rate of oxygen uptake.

In the reciprocal experiment of the eyestalk-extract-injected animals, the oxygen consumed by this group is significantly less than the control (Table 2). This could be due to the reason that eyestalk extract injection delayed the accelerated onset of proecdysis and this consequently led to decreased oxygen consumption (Passano 1953, 1960). It seems from Figures 1 and 2 that the oxygen consumed by the female crab is higher than that of the male, and this could be explained by higher respiratory rate in the ovaries as indicated by Yousif (1981).

Table 2. Comparison between oxygen consumption (ml O_2/animal/hr) in stalked (control) and eyestalk-extract-injected *Sesarma boulengeri*

Duration	Sex	Control		Injected animals		P
		M	S. D.	M	S. D.	
1st day	F	0.52	± 0.08	0.12	± 0.03	< 0.001
	M	0.49	± 0.05	0.09	± 0.04	< 0.001
4th day	F	0.39	± 0.07	0.11	± 0.01	< 0.001
	M	0.39	± 0.07	0.10	± 0.04	< 0.001
8th day	F	0.31	± 0.03	0.07	± 0.01	< 0.001
	M	0.29	± 0.04	0.05	± 0.01	< 0.001

M: the mean values. S. D.: Standard deviation. P: level of significance. N.S.: not significant.

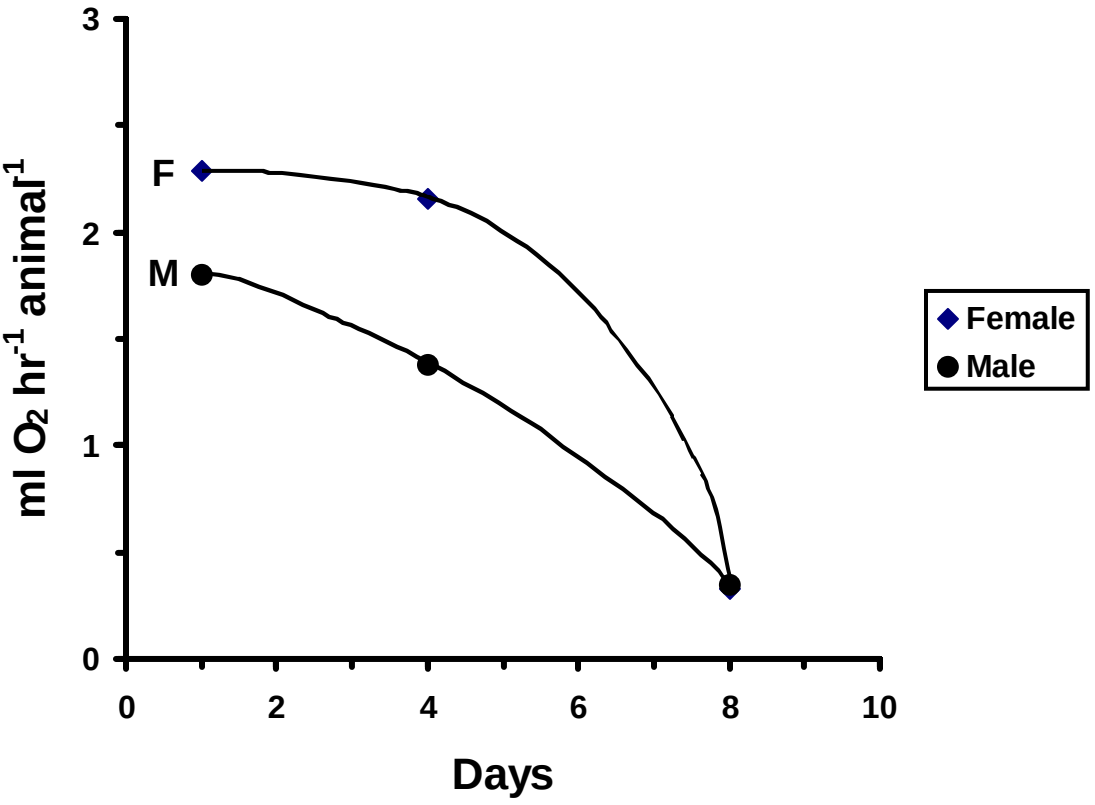

Figure 1. Oxygen consumption in male (M) and female (F) *Sesarma boulengeri* after extirpation of eyestalk.

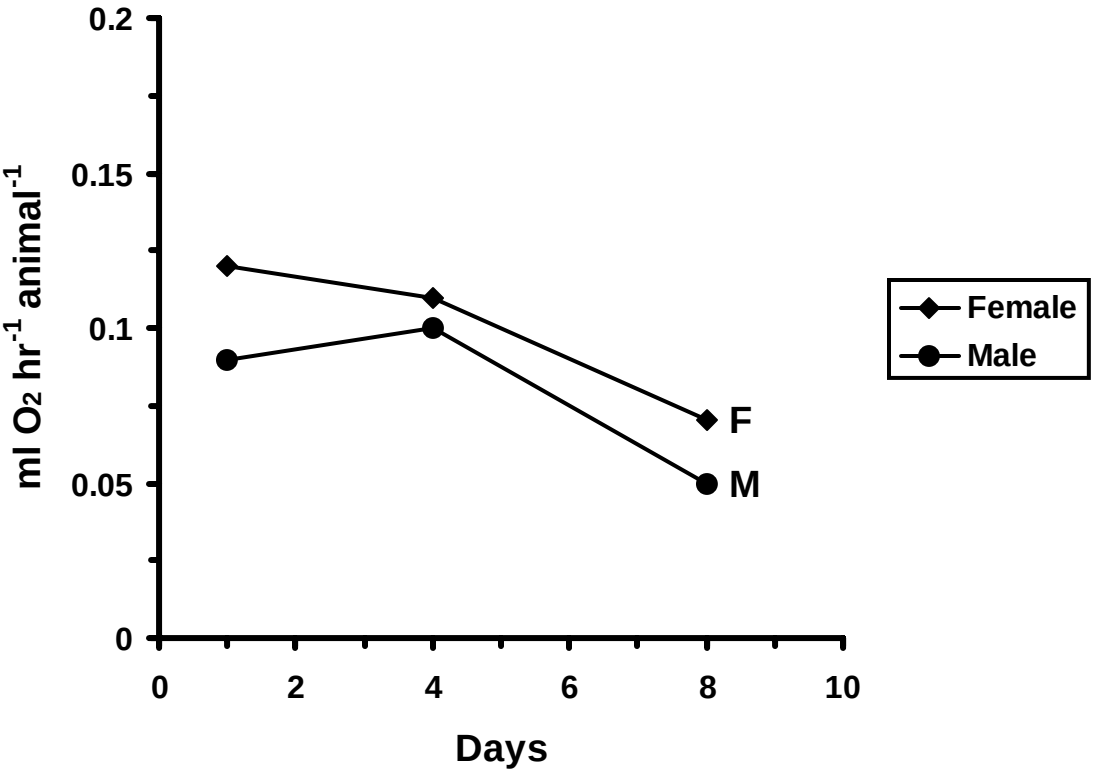

Figure 2. Oxygen consumption in male (M) and female (F) *Sesarma boulengeri* after eyestalk extract injection.

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