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The effect of eyestalk removal and eyestalk extract injection on the light and dark adaptation in the crab *Sesarma boulengeri* Calman

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Abstract

The present study is an attempt to investigate the effect of light and dark adaptation in eyestalkless and eyestalk-extract-injected crabs (*Sesarma boulengeri*). It was found that in eyestalkless crabs in respect to background, the dominant colour was the pale one with appearance of dark spots on the carapace, whereas with eyestalk extract injection, the dominant colour was the dark one in respect to background.

Introduction

COLOUR CHANGE WAS the first systemic study of a physiological process in crustaceans, which give evidence of endocrine regulation (Pouchet 1876; Koller and Perkins 1928; Barrington 1975). When eyestalkless animals are kept on a dark background, the chromatophores are fully expanded, and the injection of eyestalk extract causes a rapid and complete concentration of the pigments. After a short time, the effect of the hormone wears off and the pigments start to expand (Brown *et al.* 1952). Fingerman (1966) found that when the eyestalks of *Uca* are removed, the animals become permanently pale. Also, when the sinus glands are implanted into eyestalkless *Uca,* the rhythm is restored. Colour change shows a diurnal rhythm in some crustaceans. The fiddler crab *Uca pugilator* changes colour in daily rhythm becoming dark during the day and pale at night. This rhythm is controlled internally and does not merely reflect change in the environmental illumination (Brown *et al.* 1953). It was also indicated by Highnam and Hill (1978) that *Uca* showed a tidal rhythm of pigment movement superimposed upon the diurnal rhythm.

Many workers have studied the relationship of eyestalk removal and eyestalk extract injection to the retinal pigment and in regulation of many metabolic activities in crabs (Kleinhalze 1936; Brown *et al.* 1953; Kleinhalze 1972; Skinner 1985; McConaugha and Costlow 1987). As far as the authors know, there are no such studies on the crab *Sesarma boulengeri* Calman, which is abundant near the shore of the river Shatt al-Arab, therefore it was found to be of interest to proceed with such studies.

Materials and Methods

The crabs, *Sesarma boulengeri* Calman, were collected from the shore of the river Shatt al-Arab, Basrah, Iraq during October 1985 and October 1986. The temperature of the air and water were 32 C and 26 C respectively. The crabs were maintained in a large aquarium maintained with aerators. The volume of water was adjusted so that the animals were just submerged under water. The crabs were fed with phytoplankton and meat. The aquarium water was changed daily. The animals were left undisturbed for three days before starting the experiments. Two sets of experiments were carried out. The first set of experiments included four groups of crabs. In the first two groups, one of them was used as a control, whereas in the other group, the eyestalks were removed as described by Sinha and Mooswi (1978) and were kept in complete darkness. In the remaining two groups, one of them was used as a control and the other eyestalkless group was kept in an illuminated incubator all the time. The second set of experiments was carried out in the same way as previously described, except that the eyestalkless crabs were replaced by eyestalk-extract-injected ones. The extract was prepared as described by Simpkins (1973). Since the mortality rate was high beyond ten days, all estimations were made till the 8^{th} day of removal of eyestalk and eyestalk extract injection (Sinha and Mooswi 1978; Sinha 1984).

Results and Discussion

From Table 1 it seems that in the dark-adapted animals, irrespective of lengthening of the duration of the experiment, the control animals kept in complete darkness were adapted to such environment is indicated by pale colour as a whole during the experiment, but some individuals being slightly dark in colour. When the eyestalk was removed, the animals lost their ability to adjust body coloration to background condition as has been earlier recorded by Pouchet (1876) and Barrington (1975). Also, it appeared that animals being slightly more pale in colour with the upper part of the carapace somewhat dark and the lower part pale as well dark spots start to appear, converting the animals' color into a permanent blanch. This was confirmed by the finding of Fingerman (1966) that all crustaceans respond to eyestalk removal by either permanent blanching with concentrating of black pigment or permanent darkening. On the other hand, in light-adapted animals the control group was dark in colour and seemed to be fatigued, whereas the eyestalkless crabs became paler than the control. The appearance of more obvious dark spots in the middle of the carapace and sluggish movement also has been noticed. This might be explained according to Averett (1970), who found that with increased illumination with higher temperature, dark pigments are often concentrated and white pigments dispersed, thus allowing greater light reflection and retention of a more optimum body temperature (Barrington 1975).

Table 1. A comparison between control and eyestalkless crabs in light and dark adaptation

a. Dark adapted

No. of observations	Control	Eyestalkless
1st day	++	+
2nd day	++ (active)	*
3rd day	++	** upper carapace; ++ lower carapace
4th day	++	++ dark spots start to appear on carapace
5th day	++	+++ many dark spots in middle of carapace
6th day	**	+++ spots darker than before
7th day	**	++++ still more darkened spots
8th day	++	++++ more dark spots on carapace

b. Light adapted

No. of observations	Control	Eyestalkless
1st day	*	+++ less active
2nd day	(colourless spots appear on carapace, animals are active)	++
3rd day	++ (orientation of the carapace pigment is some-what altered	++ dark spots appeared on middle of carapace
4th day	*	+++ presence of dark spots
5th day	***	+++ presence of dark spots; sluggish
6th day	*	+++ more sluggish; occurrence of spots
7th day	*	++++ more sluggish
8th day	*	++++ more sluggish

+, ++, +++, and ++++ represents slightly pale, pale and more pale.
*, **, ***, and **** represents slightly dark, dark, and more dark.

In the second set of experiments, the eyestalk-extract-injected animals seemed to be almost dark in colour (in dark condition, Table 2). In light-adapted animals, the eyestalk-extract-injected animals seemed dark in colour, but some observation being pale and some colourless spots appeared on the carapace. This was also recorded by Brown *et al.* (1952) and Fingerman (1966). The appearance of dark colour in eyestalk-extract-injected animals both in dark- and light-adapted animals might be related to the eyestalk extract causing secretion of black-pigment dispersing hormone, or might be related to the eyestalk extract causing a release of active principle from the recipient's neurosecretory system, rather than acting directly upon its chromatophores (Barrington 1975).

Generally, the control animals that were exposed to the same regime as the treated animals, for unknown reasons their colour changed, and differed on the sixth and seventh day of the experiment as compared with that of earlier and on the eighth day.

Table 2. A comparison between control and eyestalk-extract injected crabs in light and dark adaptation

a. Dark adapted

No. of observations	Control	Eyestalk-extract injected
1st day	++	***
2nd day	++ (active)	**
3rd day	++	** swelling occurs in some animals
4th day	++	** - *** swelling animals starting to die
5th day	++	*** swelling animals die
6th day	**	** - ***
7th day	**	* - **
8th day	++	** swelling animals die

b. Light adapted

No. of observations	Control	Eyestalk-extract injected
1st day	**	****
2nd day	colourless spots appear on carapace	***-** less active, swelling of animals appears
3rd day	++ colourless spots somewhat altered	** colourless spots on carapace; swelling animals die
4th day	*	++ swelling animals die
5th day	**	+ - ++ swelling animals die
6th day	*	++ swelling animals die
7th day	* - +	++ swelling animals die
8th day	++	+ swelling animals die

+, ++, +++, and ++++ represents slightly pale, pale and more pale.
*, **, ***, and **** represents slightly dark, dark, and more dark.

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