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EFFECTS OF EYESTALK ABLATION ON GROWTH AND MOLT OF FRESHWATER PRAWN, *MACROBRACHIUM ROSENBERGII*

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Shu-Gin Huang, Bor-Yu Leu and Jian-Chyi Chen (1981). Effects of eyestalk ablation on growth and molt of freshwater prawn, *Macrobrachium rosenbergii*. *Bull. Inst. Zool., Academia Sinica* **20**(2): 41-47. An experiment of the effects of eyestalk ablation on growth and molt of *Macrobrachium rosenbergii* for a period of 105 days was carried out. One or both eyestalks were removed and the carapace length was measured every 15 days.

In the group with bilateral eyestalk ablation, the molt frequency and growth were greatly accelerated. The group with unilateral eyestalk ablation grew less and the control group grew least. The intermolt period of the group with bilateral eyestalk ablation was 12.8±6.6 days, the group with unilateral eyestalk ablation was 35.1±9.8 days, and control group was 48.7±16.3 days. The survival rate of the control group and the unilateral ablation group was 92%, and of the bilateral ablation group was 0%.

There was no significant difference between the body color of the unilateral ablation group and the control group, but the body color of the bilateral ablation group turned red.

There is a long history of the study on the effects of eyestalk ablation on molting in decapod crustaceans. Perhaps the first observation in this connection was that of Megašur[6] on *Astacus vulgaris*[2]. Brown and Cunningham[4] have established this relationship on a glandular basis for they were able to lower the high percentage of molting of eyestalkablated *Cambarus* by implanting the sinus gland. Smith[12] reported that the removal of both eyestalks caused a high percentage of death. Rao *et al.*[11] found that high mortality occurred after the first molt, and that none of the ablated lobsters survived more than three molts. Sochasky *et al.*[13] also experienced a high death rate in small ablated lobsters. Mauviot and Castell[8], however, have reported that survival of ablated juvenile lobsters improved markedly after feeding adequate food. It has been showed that the eyestalkless crustaceans grew too rapidly to prepare properly for molting and this led to failure at molt[9]. In an experiment with American lobsters *Homarus americanus*, ablated animals became five times as large as control animals after two hundred days. Consequently, eyestalk ablation may have important applications in the lobster culture industry[8]. The culture of the freshwater prawn, *M. rosenbergii* is popular in Taiwan and the effect of eyestalk ablation on growth and molt of this species was studied with a view to its application to aquaculture.

MATERIALS AND METHODS

Specimens of the freshwater prawn *M.*

rosenbergii used in this study were provided by the Jia-Nan shrimp culture farm in Tainan County. They were maintained in three aquaria for one month before the experiment. The mean carapace length of the experimental animals was 2.50 cm (in the linear regression equation, the total length = 3.30 + 2.85 x the carapace length). Seventy-two indiduals were divided into three groups: untreated intact prawns as controls (C); prawns from which the right eyestalk was removed (I); prawns from which a pair of eyestalks were removd (II). Three prawns were reared in an aquarium (inside dimensions 60.5 × 29.5 × 35.0 cm deep) separated into four compartments by nylon mesh. Each compartment was 446 cm^2 in area. The compartment containing an aeration pipe and thermostat did not hold prawns, the apparatus is shown in Fig. 1.

The eyestalk was removed with a pair of small heated scissors at the base. The second eyestalk was removed one week later by the same procedure as the first. The experiment lasted one hundred and five days (from January 24 to May 9, 1981). The molting rate was recorded and the carapace length was measured every fifteen days. Prawns were fed Golden Horse shrimp pellets twice daily at 0700–0800 h and 1700–1800 h; quantities were 5% of body weight per day.

Water was well aerated and changed every 5 to 7 day. Uneaten food and waste were siphoned out of the aquaria daily. The water temperature was maintained at 22.5 ± 1.5°C. All prawns received lightdark cycles equivalent to natural daylight during the experiment. The pH of the water was 7.55–7.80. The dissoved oxygen ranged from 7.30 to 8.30 ppm (determined by a Delta 2110 model DO meter).

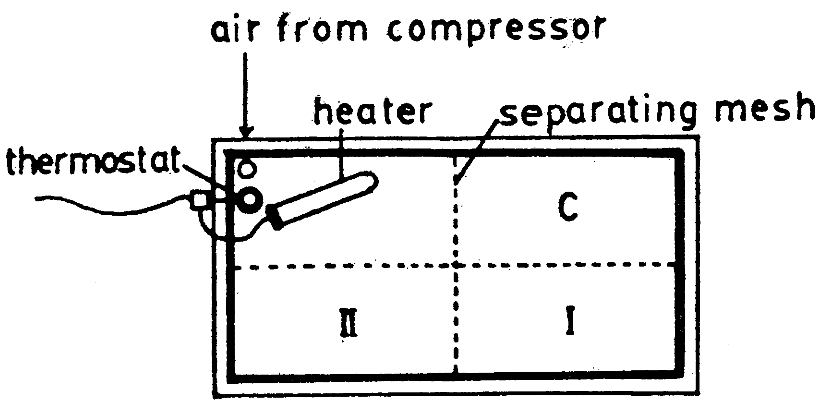

Fig. 1. Diagram of experimental aquarium, as seen from above.

RESULTS

Intermolt period and survival rate

The effect of eyestalk ablation on the intermolt period, molting frequency and survival rate are given in Table 1 and Fig. 2. The intermolt period in ablated prawns was shortened, especially in the bilateral ablation group. The majority of the mortalities in the bilaterally ablated group occurred during or shortly after the first postoperative molt. None of these animals survived beyond three molts. The mortality caused by eyestalk ablation was low

TABLE 1.
The duration of intermolt and survival rate in the different groups.

	group C	I	II
Duration of intermolt (days)	48.7±16.3	35.1±9.8	12.8±6.6
Survival rate (%)	92%	92%	0%

C: control, I: unilateral eyestalk ablation, II: bilateral eyestalk ablation.

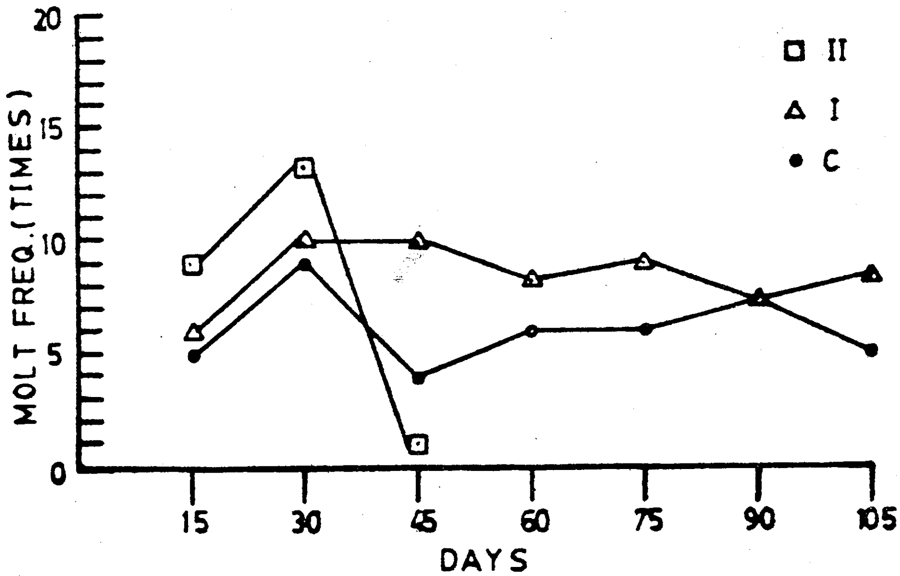

Fig. 2. The molt frequency (times) of *Macrobrachium rosenbergii* in the different groups. group C control, group I: unilateral eyestalk ablation, group II: bilateral eyestalk ablation.

and only one postoperative death occurred in the bilateral ablation group.

Growth

The growth rate was calculated from the formula:

$$\text{growth rate} = \frac{\text{final carapace length} - \text{initial carapace length}}{\text{initial carapace length}} \times 100\%$$

In Table 2 and Fig. 3, the experimental prawns grew faster than the controls. After forty-five days, the growth rate of the bilaterally ablated group was 2.7 that of the control group and 1.8 that of the unilaterally ablated group.

TABLE 2.
The percentage of average increment growth in the different groups.

group	days 15	30	45	60	75	90	105
C	3.5	4.3	5.6	6.6	8.0	8.7	9.9
I	5.6	7.2	8.8	10.0	12.3	13.0	14.8
II	5.7	11.6	15.8				

C: control, I: uniilateral eyestalk ablation,
II: bilateral eyestalk ablation.

There was significant difference in growth between the unilaterally ablated group and the control group (Student's *t*-test).

Sex molt and frequency

Of the forty-four prawns examined, sixteen were males and six females in the control group and fifteen were males and seven females in the unilateral ablated group. In male prawns had a greater molting rate than the females (Table 3). The bilaterally ablated male prawns often released their sperm cords to the genital pore or the first pair of swimming legs when they died (Fig. 4)

TABLE 3.
The molt frequency of male and female prawns in the different groups.

group	sex	number of prawns	molt frequency (times)
C	male	16	26
	female	6	12
I	male	15	42
	female	7	15

C: control, I: unilateral eyestalk ablation.

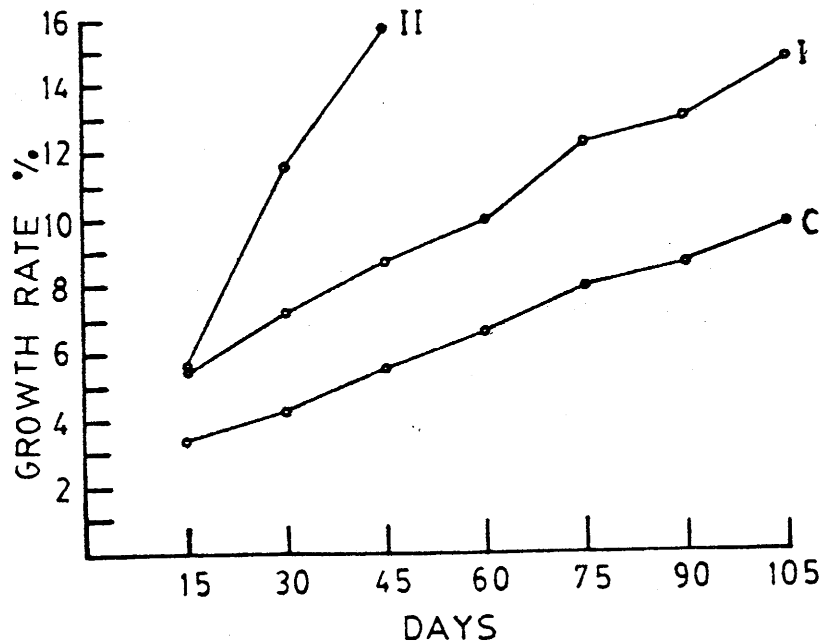

Fig. 3. The growth curves of *Macrobrachium rosenbergii* in the different groups. group C: control, group I: unilateral eyestalk ablation, group II: bilateral eyestalk ablation.

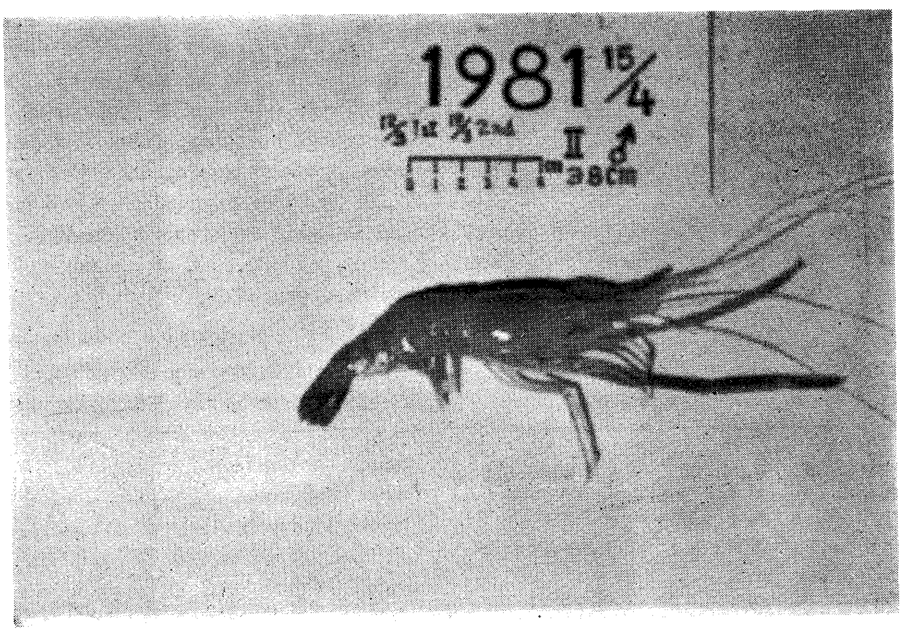

Fig. 4. The sperm cord was released to the first pair of swimming legs.

Coloration

The bilaterally ablated prawns became much redder in body color from the twelfth day (after the first postoperative molt). The change of color began with the telson, then the chelae, the ambulatory legs, and the rostrum. Finally, the whole body color turned pale red (Fig. 5). Bilaterally ablated prawns also exhibited some abnormal behavior such as loss of balance, reduced activity, incresed food-searching, they lay down on their sides, and released an unpleasant odor. Death occured after twenty-one days.

Regeneration

We observed that when eyestalk was not removed completely, the missing parts of the eyestalk was regenerated at the base. When the eyestalk removed completely, an antenna appeared after thirty days (Fig. 6). In the case that prawns with their legs lost, the regeneration of antennae did not occurr.

DISCUSSION

Adiyodi and Adiyodi[1] pointed out that the eyestalk in decapods contain a variety of hormones or factors controlling growth, molting, metabolic rate, heart rate, metabolism of sugars and protein, water balance, dispersion of pigment and sexual activity. The intermolt duration after unilateral and bilateral ablation was shortened in *M. rosenbergii*. Passano[10] has suggested that in some decapods, eyestalk ablation leads to precocious molt because of the removal of the molt inhibiting hormone (MIH) and consequent activation of the Y-organ which produces the molting hormone (MH). Ablated prawns seemed to be hungry seeking for food because of frequent molts and an increased metabolic rate. Mauviot and Castell[8] demonstrated the food was very critical for the survival of juvenile American lobsters. Diet may play an important role in the high mortality of ablated crustaceans. Because eyestalk ablation increases the growth rate, it may also raise the food consumption. Thus, adequate diet is essential to meet the nutritional requirement.

In analyses of haemolymph, the proportion of water was found to be high in bilaterally ablated prawns. Perhaps, the increase in growth is simply the result of absorption of excess water because of interference with the ability to maintain water balance (work in progress). In American lobsters, it has been found that the fast growth of ablated animals is the result of real tissue synthesis and protein deposition[8].

Astaxanthin and its esters were found to be the principal pigments of *M. rosenbergii*. The acceleration of the molt cycle may affect the carotenoid level as well as its interconversion[7]. Fox[5] has stated that eyestalk ablation increases molting frequency which should result in a loss of astaxanthin in *Panulirus interraptus*.

Eyestalk ablation result in an increase of pigment deposition, but pigment is lost at molting. The change of body color in bilaterally ablated prawns might due to reduced deposition of pigment and metabolism of carotenoids in *M. rosenbergii*. The regeneration of antennae in unilateral ablation prawns has been explained as a specific morphogenetic effect of the optic ganglia on the development of the eye. However, this hypothesis has not been confirmed, since the nervous system is not necessary for regeneration[3]. Much research remained to be done on the relationship between hormones and tissue composition in the eyestalk ablated crustacea.

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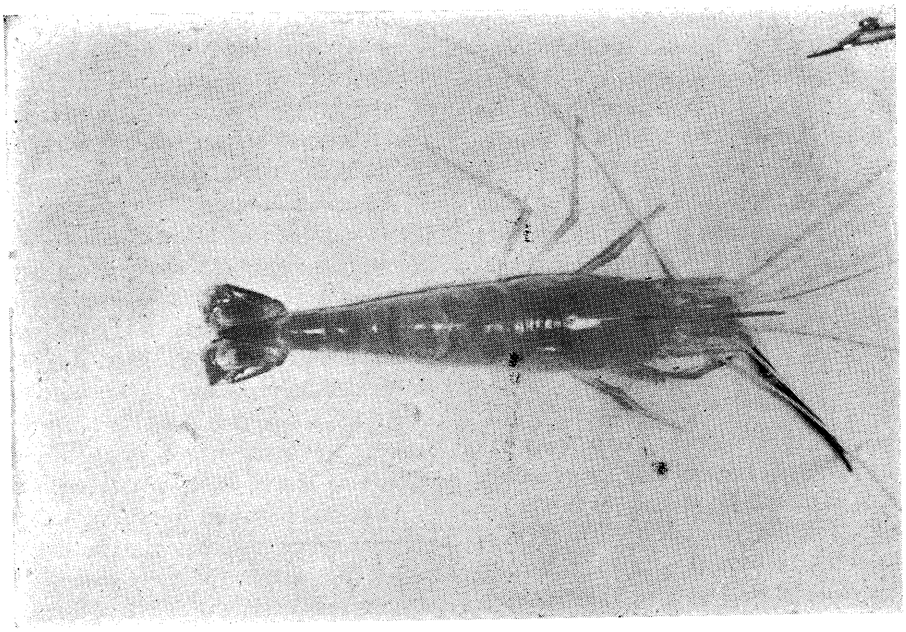

Fig. 5. The body color turned to red in bilateral eyestalk ablation prawn.

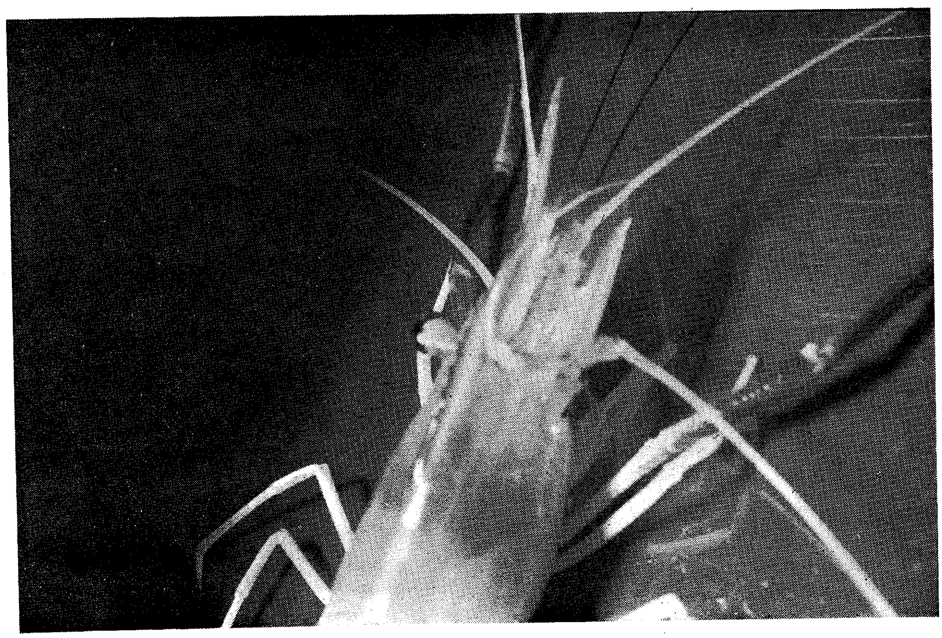

Fig. 6. The antenna was regenerated in unilateral eyestalk ablation prawn.

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眼柄切除對淡水長臂大蝦 (*Macrobrachium rosenbergii*) 成長與脫殼的效應

黃淑錦　呂伯瑜　陳健祺

眼柄切除對淡水長臂大蝦成長和脫殼影響實驗共進行 105天，其結果成長率以雙剪眼柄組最佳，單剪眼柄組次之，對照組最差；脫殼間期雙剪眼柄組 12.8±6.6 天，單剪眼柄組 35.1±9.8 天，對照組 48.7±16.3 天；體色變化上單剪與對照組無顯著差別， 雙剪組則有體色變紅現象；對照組活存率與單剪組皆為92%，雙剪組為 0%。