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Effect of Propodus Excision on Growth and Survival in Giant Freshwater Prawn *Macrobrachium rosenbergii*

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Abstract Cannibalism often obscures the analysis of results of rearing experiments on nutritional requirement in prawn. The present study carried out in order to prevent cannibalism in high density culture of prawn under laboratory condition. Giant freshwater prawn, *Macrobrachium rosenbergii,* with a body length of 6-7 cm were reared for 60 days. The prawns that were excised the tip of propodus of both chelae (fixed finger) were compared with untreated group in terms of growth, survival, and spawning.

In the excision of propodus, fixed finger could not be regenerated easily after consecutive molts rather than dactylus.

The survival of the excised group was 92%, while that of untreated group was only 25%. Because of the mortality due to cannibalism, total production was impaired in the untreated group.

The female of the excised group spawned a total of 11 times (1.83 spawnings/female), while the spawning rate of the unexcised group was 0.17/female.

Thus it was concluded that the cannibalism can be markedly reduced by excision of the tip of propodus without spoilage of growth, molt, and spawning.

INTRODUCTION

For studies on nutritional requirement in crustaceans, cannibalism often prevents the clarity of the experimental results. Cannibalism control under crowded condition in laboratory scale is commonly necessary to evaluate dietary effects. KENDALL *et al.* (1982) tried to prevent the cannibalism in an American lobster, and the individuals receiving treatment had no effect on survival and growth.

Therefore, we find a proper treatment to control cannibalism in the giant freshwater prawn in terms of growth and survival.

MATERIALS AND METHODS

Rearing

The rearing of the prawn was conducted in 45 ℓ aqualia containing freshwater at 28°C and provided with chicken wire as a shelter. Each aqualium had a bottom area of 0.17 m^2. A total of 6 prawns with 6-7 cm in size were introduced into each of 4 aqualia (35 prawns/m^2). Sex ratio of the stocked prawns was settled 1:1. Care was taken to select healthy prawns with both chelae (second pair of preopods) intact. The prawns were fed *ad libitum* with

commercial pellets for kuruma prawn. The rearing lasted for 60 days in the laboratory under natural circadian rhythm.

Treatment

The prawns of two of the aqualia received no treatment (reference group), while those of the other two aqualia were treated by excision of the tip of propodus (fixed finger) of both chelae near the articulation of the dactylus, as shown in Fig. 1. Survival, molt, and number of spawning in female were recorded from daily observation.

Biological Measurements

Percent weight gain and daily growth rate were measured by the following equations:

Percent weight gain (%)$=(W_1-W_0)/W_0\times100$

Daily growth rate (g/day)$=(W_1-W_0)\times100/\{T\times(W_1+W_0)/2\}$

where W_0=initial body weight, W_1=final body weight,

T=days in rearing period

RESULTS

In aggressive postures that are recognizable during agonistic behavior in the prawn, it is notorious a repeated "snipping" of the dactylus and propodus of chela, usually with one of the chelae directed toward the prospective victim. If body contact overcomes, scissoring posture by a chela follows, in which the aggressor can grasp at the rostrum, eyes or limbs or other body parts of the opponent. Furthermore, a chela fight position that in many instances results in damage of the opponent. During agonistic interactions if the attacked prawn is too slow or too weak to respond to chasing, cannibalism is likely to occur.

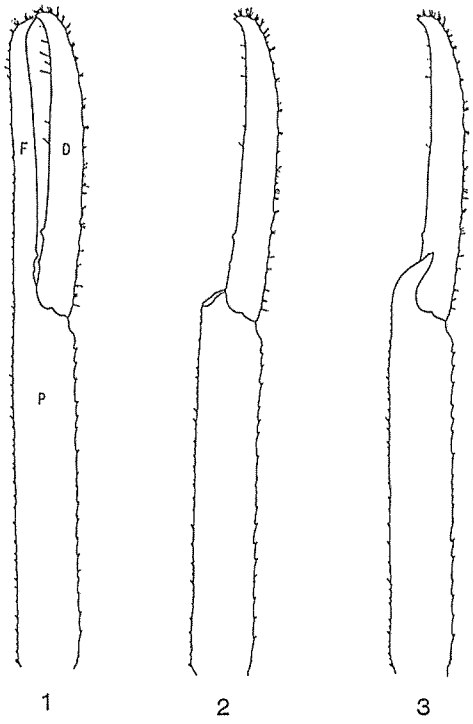

Fig. 1. Appearance of chelae (1), excised propodus (2), and after one or more subsequent molts (3). D: dactylus (movable finger), F: fixed finger, P: propodus (palm)

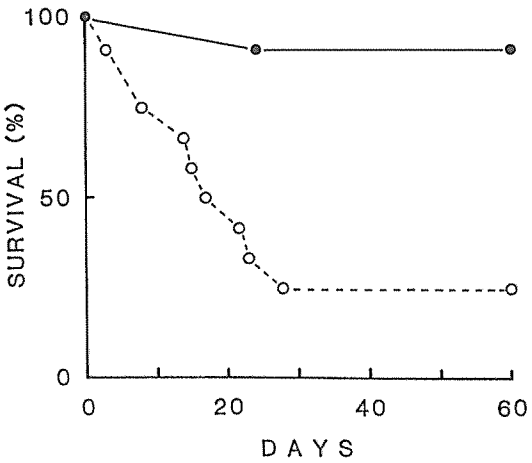

Fig. 2. Survival of prawn receiving propodus excision. Black circles: propodus-excised group. White circles: untreated group (reference group)

After the propodus excision, the wound usually bled, but healed in a few days. On subsequent molting the propodus was usually regenerated in a deformed or atrophic way (Fig. 1). In some individuals it was necessary to remove the tip of propodus repeatedly after consecutive molts.

The survival of the propodus-excised prawns was 92%, while that of the reference group was only 25% after 60 day rearing (Fig. 2). In all instances mortality was provoked by cannibalism.

The initial mean body length and body weight were not different between both groups. Nevertheless these values were significantly higher in the reference group at the end of rearing, as shown in Table 1. Furthermore, as expressed the growth as percentage weight gain or daily growth rate, the reference group was higher. Notwithstanding, the total mass of prawns of the reference group after 60 days showed a negative balance, while the value of the propodus-excised group presented a substantial net growth comparatively.

The number of observed molt per individual was found to be two times more abundant in the propodus-excised group (Table 2). The intermolt period was separately observed as normal molts (growth molt) and spawning molts of ovigerous females. There were no differences in the intermolt periods between both groups, but intermolt period of spawning molt was longer than that of normal molting. In this respect, the females of the treated group spawned a total of 11 times (1.83 spawnings/female), while the spawning in the reference group was 0.17 per female (Table 2).

Table 1. Influence of propodus excision on growth in giant freshwater prawn

	Reference group		Excised group	
	Initial	Final	Initial	Final
Body length (cm)	6.6±1.1	8.4±1.6	6.7±0.7	7.6±0.6
Body weight (g)	8.4±3.3	18.3±9.7	8.2±3.7	12.9±4.3
Weight gain (%)	—	118	—	57.3
Daily growth rate (g/day)	—	1.24	—	0.74
Total mass (g)	100.9	54.9	98.9	142.2

Mean & SD

Table 2. Influence of propodus excision on spawning and molt during 60 days in giant freshwater prawn

		Reference group	Excised group
Sex ratio (M:F)	Initial	1 : 1	1 : 1
	Final	2 : 1	0.8 : 1
Number of spawning		1	11
Spawning/female		0.17	1.83
Number of molt		11	31
Molt/individual		0.9	1.8
Intermolt period	Growth molt	19.8±5.4	18.8±2.5
	Spawning molt	34.0	25.5±1.3

Mean & SD

DISCUSSION

The survival of the reference group decreased markedly during 30 days of the first half, while all but prawn survived in the group excised fixed finger of chelae. Active cannibalism was the cause of death of the prawns in this rearing condition.

During communal rearing, the interaction between prawns of different sizes has been reported to affect both growth and survival (Ra'anan, 1983; Takeuchi and Ohno, 1986). The dominance hierarchies and aggressive behavior were well documented in decapod crustaceans (Tamm and Cobb, 1978; Sastry and Ehinger, 1980; Berzins and Caldwell 1983).

Lee and Fielder (1983) have described 14 different postures during agonistic encounters of *Macrobrachium australiense*. Koenekoop and Livdahl (1986) have defined cannibalism as the combined acts of intentional or accidental killing and ingesting conspecifics with the same population consequence. In some species, cannibalism has been discussed as an advantageous class of interaction among individuals, because it can simultaneously provide an individual with a food resource and act as a source of mortality for potential competitors in a food-limited environment. Dionne (1985) showed that food level had influence on occurrence of cannibalism, and reproductive output was responsive to cannibalism in mosquito fish (*Gambusia affinis*). Meffe and Crump (1987) demonstrated in *Gambusia affinis* that cannibalistic individuals may experience growth or reproductive advantages over those that do not. However, in the present experiment the reproductive output of non-cannibalistic prawn which were excised propodus was higher than the untreated prawn. The survived prawns in the reference group were larger size than the excised group. This difference might be derived from not only direct nutrient absorption from the killed prawn, but relative effect of rearing density as the prawn population decreased. Incidentally large individuals tended to be more territorial, and consequently more cannibalistic. In this respect, the effect of population density and of available food was found to be the cause of incidence of exceptionally large (tobi) individuals (Nakamura and Kasahara, 1955). Another population consequence is the modification of the intermolt period. The intermolt period of lobster, *Homarus americanus* increased depending on social (hierarchy) condition (Cobb and Tamm, 1974), but in the present experiment the intermolt period was similar in both groups.

Communal rearing introduced variables that may reduce confidence in the estimation of nutritional requirement and nutritive value of a diet. Therefore, Kendall *et al.* (1982) tested the effect of chelae immobilization or removal on the growth and survival of the lobster *H. americanus*. Mortality was the highest in the groups in which either the dactylus or the complete chelae were removed, and it was found that chelae immobilization had no effect on growth. In this experiment, the removal of the tip of propodus was aimed to eliminate the capacity to inflict wounds during agonistic encounters and thus diminish the occasions of cannibalism. The propodus excision to eliminate cannibalism gave positive effect in growth and survival. Karplus (1986) reported 2 prawns/m^2 as the best density in terms of mass of prawn produced. Thus rearing density tested in this experiment (35/m^2) represented a rather high value. The number of spawning and net prawn mass in the excised group were indicators that the effect of cannibalism could be reduced by the excision.

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オニテナガエビの高密度飼育における鋏脚先端切除の影響

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一般に甲殻類の飼育実験において共食いの発生は実験結果に重大な影響を及ぼし，共食いの防止が実験結果の信頼性を高めるので，本研究では体長 6～7 cm のオニテナガエビに，脱皮による再生の緩慢な鋏脚先端（掌部）の切除を行って60日間飼育し，成長，生残率，産卵に及ぼす影響を調べた。

無処置のエビの60日間の生残率は共食いにより25%と著しく低かったが，鋏脚先端を切除した場合の生残率は92%であった。生残個体の平均サイズは無処置エビが鋏脚先端切除エビより優ったが，全成長量では著しく劣った。鋏脚先端を切除した雌エビの１尾当たりの産卵回数は1.83回であったが，無処置エビでは0.17回であった。

以上のことから，鋏脚先端の切除はオニテナガエビの高密度飼育における共食いを防止し，生残率の向上に極めて有効であった。