

# The Effect of the Pea Carb (*Pinnotheres pholadis*) on the Reproductive Capacity of the Blue Mussel (*Mytilus edulis galloprovincialis*)

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This study was carried out with blue mussels at Otsuchi Bay in Japan from August 1981 to May 1982, in order to investigate the effect of the parasitic pea crab (*Pinnotheres pholadis*) on the reproductive capacity of host blue mussels (*Mytilus edulis galloprovincialis*).

The results show that pea crabs delay gonad development of host mussels about one month and lower their fatness rate by intercepting nutrients. The parasitization with pea crabs is thought not to prevent spawning activity itself, but to reduce the number of germ cell resulting in the reduced space of gonads.

## Introduction

Parasitic pea crabs, *Pinnotheres pholadis*, are found chiefly in the mantle cavity of bivalves and they are reported to be distributed in the areas of the west coast of Korea (Kim, 1973) and the coast of Japan (Sakai, 1976).

Many studies have been undertaken on the ecological relationships between pea crabs and their bivalves hosts, and the interrelationships have variously been explained (Kruczynski, 1973, 1974; Sastry et al, 1962; Seed, 1969; Orton, 1921; Anderson, 1975; Stauber, 1945).

Recently, many researchers have agreed on the effect of pea crabs on the growth of bivalves hosts (Kruczynski, 1972; Stauber, 1945), but controversy exists on their effect on the reproductive capacity of hosts (Sastry, 1969; Anderson, 1975).

## Methods

The mussels were collected at subtidal zone on

concrete jetty in inland sea of Otsuchi Bay, Iwate prefecture in Japan, bimonthly from August 1981 to May 1982.

The shells were opened and inspected for crabs. The meats were fixed in Bouin's solution, dehydrated with alcohol and embedded in paraffin wax. Then the center of the body was cut in sections in 4-5  $\mu\text{m}$  and stained with Mayer's haematoxylin-eosin double staining. The degree of gonadal development was determined: resting spent stage (a), early developmental stage (b-1), late developmental stage (b-2), spawning stage (c-1), post spawning stage (c-2) and degenerative stage (d) (Yoo and Kajihara, 1983).

Because the period of spawning of the mussel extends from late developmental stage (b-2) to spawning stage (c-1), these two stages were taken for reproductive index. In this study the period when reproductive index exceeds 50 in more than 50% of examined samples is defined as the main spawning season.

In order to detect polysaccharide which represents

glycogen component in mussel, PAS reaction, one of histochemical methods, was employed on by 5 individuals for each test. Test results are classified into 4 levels; negative(-), weak positive(+), intermediary positive(++) and strong positive(+++).

Since the gonads of *Mytilus edulis galloprovincialis* develop in the mantle tissue, the gono-somatic index (GSI) can hardly be determined in terms of weight. Hence, the GSI is represented by the spatial index, i.e., the ratio of gonadal area to total area in cross sections of the body center. According to the degree of gonadal development, the following four stages are used: stage I through stage IV, less than 25%, 25%~49%, 50%~74% and more than 75% in gonadal area, respectively.

### Result

#### a. Growth

Table 1 shows that, at Otsuchi Bay, the rate of blue mussel, parasitized by pea crab ranges from 25% in February 1980 to 43.8% in August 1981.

**Table 1. Occurrence rate of pea crab (*Pinnotheres pholadis*) in blue mussel (*Mytilus edulis galloprovincialis*) collected at Otsuchi Bay**

Month	Mussel examined	Parasitized mussel	
		No.	%
Aug. 1981	48	21	43.8
Oct. 1981	18	5	27.7
Dec. 1981	27	11	40.7
Feb. 1982	24	6	25.0
May 1982	20	6	30.0

**Table 2. Differences of average meat weights between parasitized and non-parasitized groups with pea crab (*Pinnotheres pholadis*) in the blue mussel (*Mytilus edulis galloprovincialis*) at Otsuchi Bay\***

Shell length (cm)		Mussels examined	Average meat weight (g)	t Value
5.51~6.00	Non-parasitized	13	6.12	t=2.969 > t=2.878**
	Parasitized	7	4.62	
6.01~6.50	Non-parasitized	13	6.89	t=2.913 > t=2.845**
	Parasitized	9	5.58	

\* This fact was observed on the same classes with shell length of 5.50~6.00 cm and 6.01~6.50 cm, both classes containing more individuals than the other classes.

\*\* 99.5% confidence limit

Samples in August and December, both months with the highest parasitization rate, were taken, and the relationship between shell length and meat weight was examined. The results show that non-parasitized group has higher ratio of meat weight to unit shell length than that of parasitized group (Fig. 1).

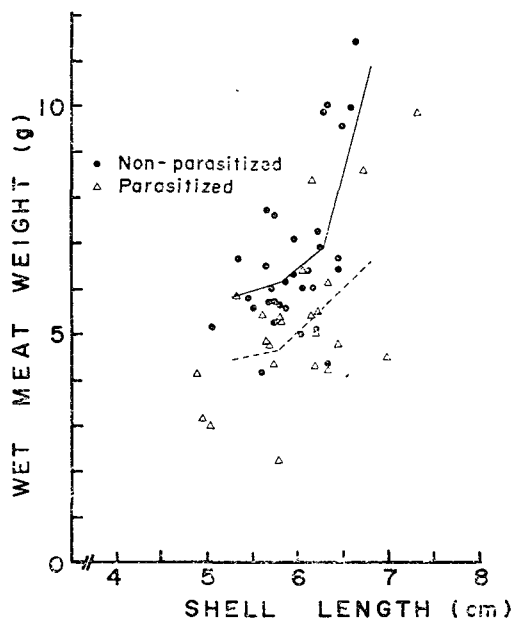


Fig. 1. Growth difference between parasitized and non-parasitized groups of blue mussel (*Mytilus edulis galloprovincialis*) at Otsuchi Bay parasitized by crab (*Pinnotheres pholadis*).

Similarly, average meat weight of non-parasitized group is significantly different from that of parasitized group with the confidence limit of 99.5% as shown in Table 2.

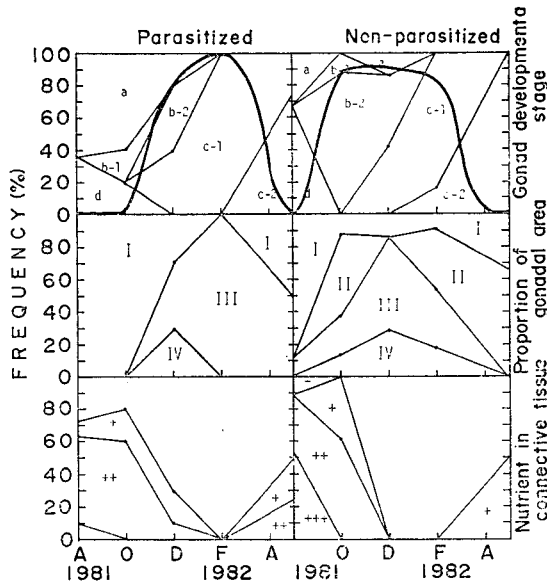


Fig. 2. Seasonal variations in gonad developmental stage (upper), proportion of gonad area (middle) and nutrient in connective tissue (lower) of parasitized group and non-parasitized group of *Mytilus edulis galloprovincialis* at Otsuchi Bay. Gonad developmental stage, a: resting spent stage, b-1: early developmental stage, b-2: late developmental stage, c-1: spawning stage, c-2: Post-spawning stage, d: degenerative stage. Bolt solid line indicates reproductive index. Proportion of gonad area, I: less than 25%, II: 25~49%, III: 50~74%, IV: more than 75%, Nutrient in connective tissue, -: negative, +: weak positive, ++: intermediary positive, +++: strong positive.

b. Gonad

Fig. 2 shows the seasonal variations in gonad developmental stage, reproductive index, proportion of gonad area to somatic area and polysaccharide in the connective tissue of parasitized group on one hand and non-parasitized group on the other hand.

This figure illustrates that the main spawning season of parasitized group (from November to March) begins one month later than that of non-parasitized group (from October to March). And from August to October, parasitized group has 60% of individuals in rest spent stage (a), an occurrence rate higher than in non-parasitized group. In May, all individuals (100%) are in the spawning stage (c-2) in non-parasitized group, but only 75% in the parasitized group. These facts indicate that the gonad development of parasitized group is delayed by about one month compared to that of non-parasitized group. However, the spawning activity of parasitized group proceeds almost as normally as in the non-parasitized group. This

suggests that the parasitic crabs delay the gonad development of parasitized mussels while they do not come to interfere spawning activity itself.

Concerning to the increase of proportion of gonad area to somatic area, parasitized group also proceeds the development later than non-parasitized group. Particularly in October, in all individuals of the parasitized group the proportion of gonad area is less than 25% (Stage 1), and stage IV (proportion of more than 75%) occurs only in December. On the other hand in non-parasitized group, this stage occurs from October to February, much longer period than in the parasitized group.

As for polysaccharide in connective tissue, individuals with abundant polysaccharide (III) are 10% in the parasitized group and 56% in the non-parasitized group in August. And individuals in which polysaccharide cannot be detected occur throughout the year in the parasitized group, but they occur only in the main spawning season or so in the non-parasitized group.

The above findings indicate that pea crabs delay gonad development of host mussels and lower their fatness rate by intercepting nutrients. And the physical factor that pea crabs press mantle tissue, region of gonad development, cannot be neglected. The parasitization with pea crabs is thought not to prevent spawning activity itself, but to reduce the number of germ cell resulting in the reduced space of gonads.

## Discussion

Many researchers agree that Pinnotherid crab competes with its host in search for food resulting in fatness damage.

The present study maintains the same view putting forward the fact that there is significant difference between parasitized and non-parasitized groups in terms of fatness.

Seed (1969) investigated *Pinnotheres pisum* in two types of *Mytilus* in southwest England. He argued that the meat weight per unit shell length of parasitized group is lighter than that of non-parasitized group. Also Kruczynski (1972) found a decrease in weight on bay scallop, *Argopecten irradians concentricus* infected with *P. maculatus*. However, Seed (1969) did not notice the effect on gametogenesis caused by the presence of the crabs. But present study clearly shows the effect of parasitization, i. e., the parasitization by pea crabs apparently delays the gametogenesis and reduces the gonad area.

The seasonal variations on storage and utilization of polysaccharide in the mussel, particularly of glycogen are in close relation with the reproductive cycle. Besides, they reflect the interdependence of food, temperature and growth (Gabbott, 1976; Lowe et al, 1982; Bayne et al, 1982). Bayne et al (1978) reported that mussels under stress produced fewer and smaller eggs, in smaller follicles, than mussels in normal situation.

It is assumed that natural consequences brought about by the food competitive relationship between pea crabs and parasitized mussels are as follows:

parasitized mussels have lower polysaccharide levels than non-parasitized ones; up to October their gonad area does not exceed 25%, and individuals in late developmental stage (b-2) do not appear.

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썩 속살이게, *Pinnotheres pholadis* 의 기생이 진주담치의 번식력에 미치는 영향

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1981년 8월에서 1982년 5월까지 日本 岩手縣 大槌灣에서 썩 속살이게, *Pinnotheres pholadis* 에 기생된 진주담치를 정기적으로 채집하고 寄生群과 非寄生群間의 殼長에 대한 肉重의 상관관계를 조사하고, 그 成熟度와 營養狀態의 差別 組織學의 方法에 의해 究明했다

썩 속살이게의 기생으로 말미암아 진주담치는 厓肉에 명백한 장해를 받음이 밝혀졌다. 또한, 生殖腺의 발달이 늦어질뿐 아니라, 생식세포의 수가 감소됨으로써 전체면적에 대한 생식선의 면적비가 낮아지게 되므로, 기생군의 번식력은 비기생군에 비해 현저하게 약한 것으로 추정된다.