ON THE REARING OF ANADARA BROUGHTONII (SCHRENK) AND HALIOTIS DISCUS HANNAI INO

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ON THE REARING OF *ANADARA BROUGHTONII* (SCHRENK) AND *HALIOTIS DISCUS HANNAI* INO*

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The ark *Anadara broughtonii* and the abalone *Haliotis discus hannai* are useful edible molluscs in Japan. The authors have succeeded in rearing the larvae and the youngs of these species in the Laboratory at Sabusawa in Matsushima Bay. In the course of rearing, we could follow their life history and observe the habits of larvae and youngs.

In this paper, the results of rearing in tank and some observations on the larvae and the youngs are reported.

1. *Anadara broughtonii*

(a) Artificial fertilization and early development

The breeding season of *A. broughtonii* in Sendai Bay is from June to August. The spawning was induced by means of repeated thermal stimulation (KAN-NO 1962), and the fertilized eggs were thus obtained. At the water temperature of 23–24°C, they developed to the gastrula within 7 hours, the trochophore stage within 15 hours and the veliger stage within 22 hours after fertilization.

(b) Rearing of larvae in tank

The rearing was continued for a period from 6th August to 14th September in 1961. The young D-shaped veligers of about 90μ in shell length and about 70μ in shell height, which passed 24 hours after fertilization (Fig. 1–1), were reared in the concrete tank containing about four cubic meters of sea water. The rearing was carried out in two tanks, Tank I and Tank II. The number of larvae set in the tanks were 500,000 and 430,000 respectively. The food of the larvae was non-colored naked flagellate, *Monas* sp., which was reported as an appropriate food to larvae of marine animals by Imai et al. (1949, '50 and 1953). Density of *Monas* sp. in the tanks was kept at 1,200–5,400 per ml of sea water. Light was screened with black vinyl sheet with a thickness of 0.1 mm, in order to restrain the growth

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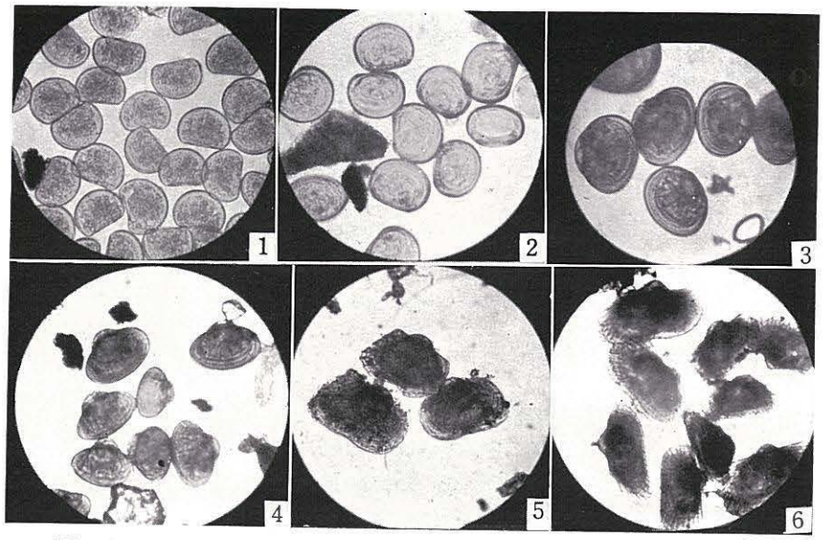

Fig. 1. The larvae and young of *A. broughtonii*
(1) D-shaped veliger (2) Veliger larvae after 5 days (3) Umbo stage and full grown larvae (4) Full grown larvae after about three weeks (5) Early attached young after about four weeks (6) Young spat after two months

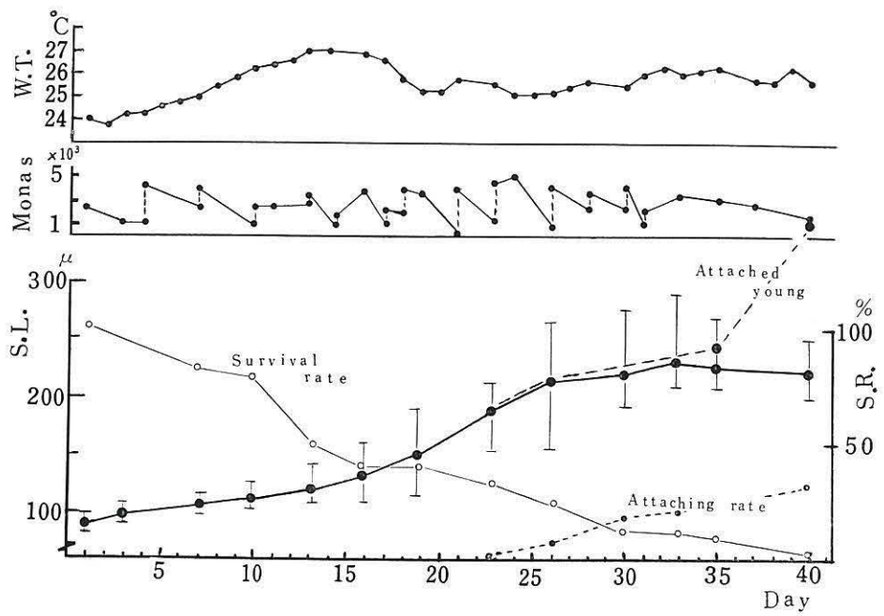

Fig. 2. Rearing record of *A. broughtonii* larvae in tanks
S.L.; Shell length. S.R.; Survival rate of swimming larvae

of phytoplankton in the tanks. The water was stirred by continuous aeration every day. The water temperature was 23.8–27.0°C, the clorinity 15.95–17.03‰, the oxgen saturation 81–102% and pH value 7.9–8.1 in the upper layer. The rearing record in Tank I is shown in Fig. 2.

The first prodissoconch stage lasted for about 13 days, and then the umbo began to develop. When the larvae reached over 190μ in shell length, the foot developed and before long the larvae crawled on the substrata with both of the foot and velum action. The full grown larvae over 230μ in shell length attached on collecter by their byssus in about four weeks after spawning (Fig. 1–5). Size of the attaching young was the same as that of natural ones reported by Yoshida (1953). The young spat were collected on oyster shells, scallop shells and the barks of hemp-palm (Fig. 1–5), and 6). The estimated number of the collected young were 168,000 in Tank I and 43,000 in Tank II. Therefore, the survival rates were 33 and 10 per cent respectively.

(c) Rearing of young spat

After the collection, the young spat were reared in the tanks by running sea water, and the spat grew to 1.3–3.0 mm in shell length and 0.7–1.6 mm in shell height at the end of November in 1961. At the time, survival rate was only about four per cent of collected young spat in the tanks.

2. *Haliotis discus hannai*

(a) Artificial fertilization and early development

The breeding season of *H. discus hannai* in Matsushima Bay is from September to October. The fertilized eggs were obtained by raising the water temperature or by electric stimulation. Sometimes the natural spawn was also used. At the water temperature of 25°C, the trochophore stage was reached in about 8 hours after fertilization at which the animal rotated within the egg membrance. About 10 hours after fertilization, trochophore larvae hatched out of the egg membrance and began swimming in sea water. About 14 hours after fertilization they developed to the veliger larvae (Fig. 3–1). Finally they entered into bottom life after three days.

(b) Rearing of young spat in vessels

The rearing of young spat in vessels was continued for about six months from early September 1961 to March 1962. The veliger larvae were set in the vessels containing 100 liters of sea water. During swimming stage no food organism was added. The water was kept stirring by aeration.

The young spat, which had entered into creeping bottom life (Fig. 3–2), were reared in running sea water which was enriched with nutritive elements such as KNO_3 and Na_2HPO_4 in order to promote the growth of attached algae on the substratum. Vinyl plates were set in vessel for the purpose of collecting the young spat and also for providing the surface on which the food organisms grew.

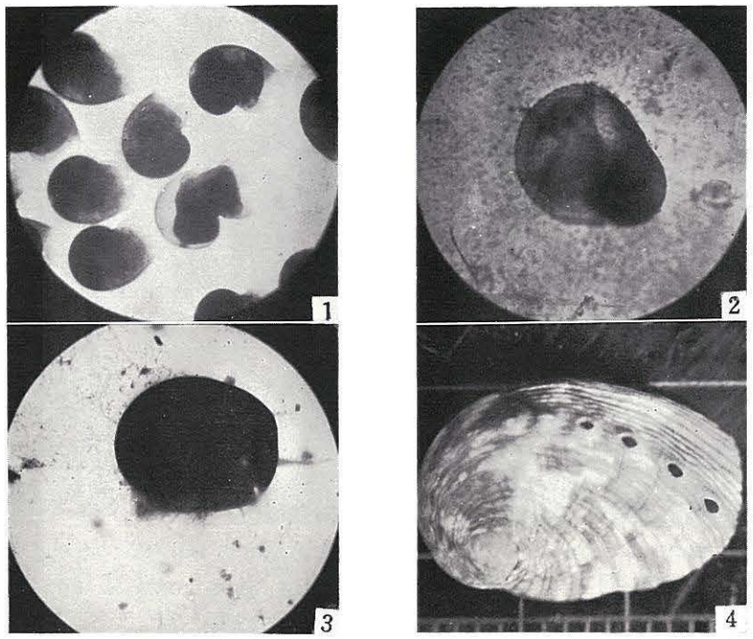

Fig. 3. The larvae and young of *H. discus hannai*
(1) Veliger stage (2) Early creeping stage at 10 days (3) Young spat with the first respiratory pore. (4) Young spat of 1.6 cm in shell length four months old

The food organisms were attached algae composed mainly of *Navicula* sp. until the spat grew about 1.3 cm in shell length. Thereafter, the seaweed, *Enteromorpha* sp., was given at intervals of several days. During the rearing, the water temperature was kept at about 19°C by electric heater. The rearing record is shown in Fig. 4.

Young spat scraped off the attached algae actively by means of radula as reported by Ino (1952). The shell length reached 0.8 mm after 17 days, and 2.2 mm after 42 days, when the first respiratory pore appeared (Fig. 3–3).

The mortality was high for the period from veliger stage to the young of 1 mm in shell length. The death-rate at this stage was 78–99 per cent. In the spat over 2 mm in shell length, it was very low and most of spat survived through the rearing period.

After about four months of rearing when the animals reached 1.3 cm in shell length, the following feeding experiment was carried out. In one rearing vessel the animals were fed on seaweed (Exp. 1–A), while in the other they were fed on attached algae (Exp. 1-B) for a period of about five months.

After about five months the animals fed on seaweeds reached 2.2 cm in shell length, and after about six months they reached 2.6 cm in shell length (Exp. 1-A).

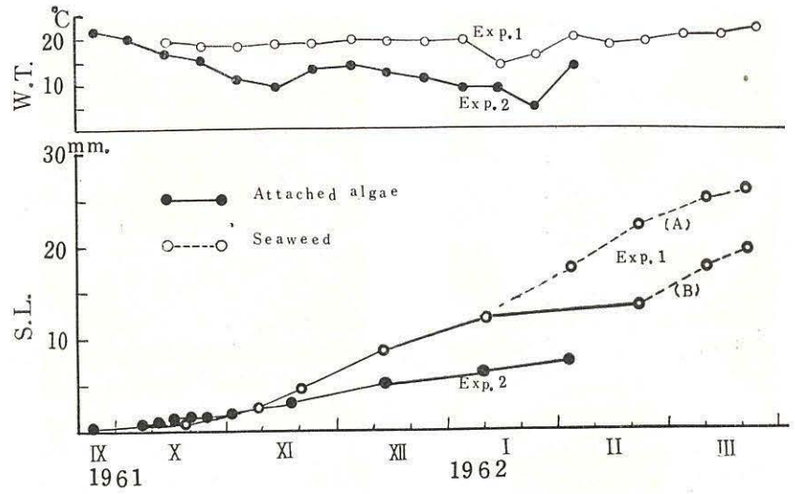

Fig. 4. Rearing record of *H. discus hannai* in vessel (Exp. 1) and tank (Exp. 2)
The solid line shows the food of attached algae, and the dotted line shows the seaweed.

The size was very close to that of natural ones in the sea at that time. While the animals fed only on attached algae (Exp. 1-B) showed poor growth as compared to those of Exp. 1-A.

(c) Rearing of young spat in open tank

The rearing in open tank was carried out for about five months from early September 1961 to early February 1962. The rearing method was almost the same as above mentioned. However, the range of water temperature was from 5°C to 23°C and only the attached algae were used as food during the rearing. The record of rearing is shown in Fig. 4 (Exp. 2).

The growth rate was far low as compared to the rearing experiments in the vessels. This seemed to be due to the lower temperature and the kind of food. In early February of 1962, the animal reached only about 7 mm in shell length. Unfortunately, most of them were lost by accident.

(d) Relation between water temperature and growth of young spat

In order to see the relation between water temperature and the growth of young spat, the following rearing experiment was carried out from December 30th, 1961 to January 16th, 1962. Young spat of about 1 mm in shell length were used for the purpose. They were reared in glass vessel containing 12 liters of sea water. They were kept in running sea water. The food organisms were attached algae. The water temperature was maintained at five different levels between 5°C and 25°C. The result of experiment is shown in Fig. 5.

The young spat hardly grew below the water temperature of 10°C. They died below 2°C. At higher temperature, they grew better.

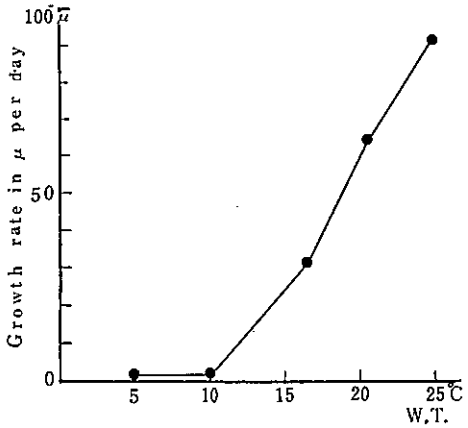

Fig. 5. Relation between temperature and growth rate of early young spat

From the results of these rearing experiments, we can conclude that the water temperature and the kinds of food organisms are the primary factors in artificial rearing of young spat of abalone.

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