

## Preliminary results on the artificial breeding of the abalone *Haliotis asinina* Linné, 1758 in Vietnam

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Wild-caught broodstock of the abalone *Haliotis asinina* were placed in a 600-l capacity composite tank and conditioned to photoperiods of 12 h light and 12 h darkness. Spawning occurred after 17-22 days. More than 400,000 newly hatched larvae were cultured. On average 1.29 % of them reached the juvenile stage, which appeared after 35-40 days of rearing.

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### INTRODUCTION

There are four species of abalone in Viet Nam: *Haliotis diversicolor* Reeve, *H. ovina* Gmelin, *H. varia* Linné and *H. asinina* Linné (Nguyen, Chinh 1996; Nguyen, V.C. & Le, D.M. 1996). Among them, *H. asinina* has the greatest potential for culture due to its larger body size and high growth rate. Studies on the reproductive biology of *H. asinina* were carried out for the first time in the Institute of Oceanography in 1998 (Le, D.M. 1999). On the basis of the results obtained we tried to develop the method of artificial breeding of *H. asinina* in laboratory to contribute to the development of abalone culture in Vietnam.

### MATERIALS AND METHODS

**Broodstock management.** - Broodstock abalone ranged in shell length from 60 to 80 mm and were maintained in a 4 m<sup>3</sup> cement tank at the hatchery of the Institute of Oceanography in Nha Trang. Ambient sand-filtered seawater (27.2-29.6 °C) was supplied to the tank at a 8-l/min flow rate. The tank was cleaned every day and water changed weekly. Fresh seaweeds *Gracilaria verrucosa*, *Sargassum* sp., and dried Chinese *Laminaria* were supplied to excess. Cement plates were put at the bottom

of the tank for abalone to hide.

Gonadal maturity was checked every 10 days as described by Le, D.M. (1999). When the gonad reached ripeness stage the testis was cream, the ovary was dark green and both were swollen.

**Spawning induction.** Abalone with a ratio of 1 male to 4 females were held in plastic baskets suspended within the 600-l capacity fiberglass tank. The tank was supplied with well-oxygenated seawater. This was achieved by using a combination of water flow and strong aeration. Abalone were fed on *Gracilaria verrucosa* which was given every two days in sufficient amounts. Water was delivered at 8 litres per minute. Spawning was induced by exposing mature abalone to a 12L:12D photoperiod (Kikuchi & Uki 1974a).

Abalone spawned at night and trochophore larvae were collected the following morning by siphoning into 100-l round fiberglass containers covered with black cloths and supplied with mild aeration. 10 ppm neomycin and streptomycin with a ratio of 1:1 were added to the rearing containers throughout the 3 days of veliger stage to control bacterial infection (Poomtong *et al.* 1997). Every day the containers were drained

Table 1. Percentage of abalone, which matured when fed various seaweeds.

Date of experiment	Number of conditioned abalone		Time of gonad maturity (days)	Percentage and number (n) of matured abalones		Seaweed
	Male	Female		Male	Female	
25/2/98-25/2/99	17	68	40-50	29% (5)	38% (6)	Dried Chinese <i>Laminaria</i> , fresh <i>Sargassum</i>
	10	40	43-47	30% (3)	35% (14)	
2/3/99-22/6/99	12	48	17-20	83% (10)	91% (44)	Fresh <i>Gracilaria verrucosa</i>
	7	28	20-30	85% (6)	89% (25)	

Table 2. Spawning induction of the abalone *Haliotis asinina* ( $\pm$  = standard deviation).

Number of abalone used		Period of spawning induction (days)	Number of eggs released	Number of trochophore hatched	Hatching rate (%)
Male	Female				
1	4	17	570,000	518,700	91
2	8	19	600,000	540,000	90
2	8	20	520,000	457,600	98
3	12	19	268,000	24,300	90
1	4	19	140,200	0	0 (no sperm)
2	8	17	550,000	511,500	93
Average			441,366 $\pm$ 173,422	410,420 $\pm$ 194,960	90.4 $\pm$ 1.62

Table 3. The survival of *Haliotis asinina* juveniles after rearing 35-40 days.

Number of trochophores	Days of rearing	Survival rate	
		Number of juveniles	%
518,700	40	736	0.1
540,000	35	1140	0.2
457,600	38	2450	0.5
24,300	35	1020	4.2
511,500	35	6972	1.3
Average	410,420 $\pm$ 194,960	2463 $\pm$ 2330	1.2 $\pm$ 1.5

and the larvae collected in the sieve. They were washed with clean seawater and placed in a new container.

*Larval cultivation and early development.* - After larvae reached the creeping stage they were transferred to a 600-l culture container provided with benthic diatoms *Navicula* sp.

growing on corrugated culture plates and container surfaces. About 400,000 larvae were put into the 600-l fiberglass culture container supplied with seawater which was treated with 15 ppm hypochlorite.

The crawling larvae were cultured for 30-40 days. Upon reaching 3-4 mm in shell length,

the abalone were transferred to a 4 m<sup>3</sup> cement tank with a continuous flow of sand-filtered sea water. At this time chopped pieces of the seaweed *Gracilaria verrucosa* were introduced gradually into the tank.

## RESULTS AND DISCUSSION

*Broodstock management.* - Table 1 shows the results of conditioning of *H. asinina* in the cement tank fed seaweeds: dried Chinese *Laminaria*, fresh *Sargassum* and *Gracilaria verrucosa*.

The method we used promoted gamete development and maturation, and ripe abalone were available all year round. Abalone maintained in continuous flow and fed the seaweed *Gracilaria verrucosa* had the highest percentage of maturity. In contrast, the abalone fed dried *Laminaria* and *Sargassum* had lower maturation rates.

*Spawning induction.* - Table 2 shows the results of 6 experiments on spawning induction. In total, 11 male and 34 female abalones were used in the spawning experiments. The mean number of eggs and trochophore larvae obtained in the 6 spawning experiments was 441,366 and 410,420 respectively.

The artificial photoperiod method used in the experiments is useful and inexpensive. Thus, it is suitable for us in Vietnam to stimulate spawning of *Haliotis asinina*. Moreover, the method works all year round and induces abalone to spawn out of season (Poomtong *et al.* 1997).

*Settlement.* - After 3 days of swimming in the water column, the larvae settled on the diatom

plates at an average of 410,420 larvae, but only 2,464 survived to become juveniles of 2.4 mm shell length (Table 3, Fig. 1).

This is the first time that *H. asinina* has been induced to spawn artificially with success in Vietnam. It is unfortunate that only a small proportion survived the first month but we anticipate survival can be reversed significantly in the future.

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