SUSPENDED CULTURE OF THE NOBLE SCALLOP (*CHLAMYS NOBILIS*, REEVE 1852) IN VUNG RO, CENTRAL VIETNAM

Nguyen Thi Xuan Thu
Research Institute for Aquaculture No 3. Nha Trang, Vietnam

ABSTRACT

Cultured spat of scallop (1 month old, mean height 1.5 ± 0.03 mm) were transferred from collectors in the laboratory to pearl oyster nets suspended at 2-8 m depth. Shell growth, plankton, temperature and salinity were monitored each month at the experimental site. After one year, the scallops had an average shell height of 52.7 ± 1.1 mm. After 1.5 years, the height was 70.1 ± 4.2 mm. The growth rate (%) was maximal in the first three months, but it gradually decreased as the scallops grew older. Cultivation density and the depth of the hanging cages affected scallop growth. The feasibility of cultivating *Chlamys nobilis* in Vung Ro is discussed.

INTRODUCTION

For many years, the main utilization of *Chlamys nobilis* Reeve, 1852 was through commercial fisheries. However, the exploitation was not coupled to resource management so the annual yield of scallops declined from 10,000 tons in 1986 to about 100 tons in 1997.

Nguyen & Nguyen (1995) have successfully cultured *C. nobilis*. They showed that sea farming of scallops has a considerable potential for production in Vietnam. Sea farming is therefore expected to increase in the coming years.

This project investigated the biological feasibility of the Japanese techniques to cultivate *C. nobilis* in Vung Ro, where there is no natural population of this species. The main objectives of the study were to determine growth and survival rate of scallops, optimal density, depth of culture, and the effects of environmental conditions on shell growth.

MATERIALS AND METHODS

The study site was located in Vung Ro in the Central part of Vietnam (109°4' N, 12°7' W). The site was suitable for suspended scallop culture because of limited fishing activity and low probability of damage to the nets caused by strong winds and typhoons.

One month old spat of scallop (mean height 1.5 ± 0.03 mm s.d) were transferred from collectors in the laboratory to the nets (30 x 30 x 30 cm) suspended by flotation at 2-8 m depth in May 1996. To determine the optimal density of the stock, scallops were kept at four densities (50, 100, 150, 200 scallops) at a depth of 4 m. Groups of four pearl nets were kept at depths of 2, 4, 6, and 8 m, each with 100 scallops, to determine the optimal depth of culture.

A total of 60 pearl nets were placed in groups of three on 20 ropes and suspended from a bamboo raft to determine the growth rate and survival rate. Each month (from May 1996 to May 1998) 30 randomly chosen scallops were measured with Vernier callipers (0.1 mm accuracy) and weighed on a beam balance (0.1g accuracy). The shell height of scallops was defined as the maximum distance between dorsal and ventral margin. The growth rate (G) was calculated by the formula:

$$G = \{(\ln L_2 - \ln L_1)/(T_2 - T_1)\} \times 100$$

(Bal & Jones, 1960)

Each month from January 1997 to December 1997, plankton biomass, temperature, and salinity were monitored

at the experimental site at 2 m depth.

Plankton biomass was measured by filtering the formalin preserved samples. Plankton left on the filter paper was washed down with distilled water from time to time to concentrate it at the bottom. Twenty to thirty minutes later, the filter paper was opened and the gathered plankton picked very carefully and moved to a watch glass. Excess water was drained, using a piece of filter paper, and weighed on an electronic balance.

Salinity was measured daily with a refractometer and the temperature by a self-registering thermometer. Mean temperature and salinity were calculated each month.

RESULTS

Environmental conditions

The water temperature at 4 m depth and the air temperature at Vung Ro, showed a similar seasonal pattern (Fig. 1). Water temperatures fluctuated between 24.4 and 25.7 °C from January to March 1997, and increased from 28 to 30.3 °C during April and September and then decreased gradually to 27°C in January 1998. The mean temperature for the entire year was 29.4 °C in the air and 27.6 °C in the water column (Fig. 1).

Salinity varied between 29.7 and 35.0 ‰ (mean 32.7 ‰ for the entire year) at Vung Ro. The salinity ranged from 29.7 to 32 ‰ in the rainy season and from 32 to a maximum of 35 ‰ in the dry season (Fig. 3).

Two hundred and one species of phytoplankton were determined. Diatoms

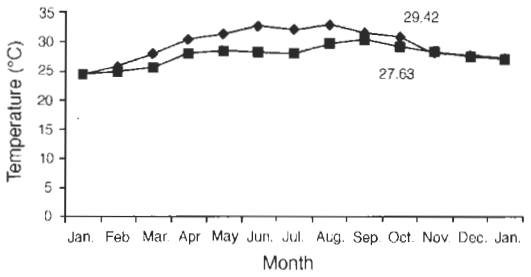

Fig. 1. Seasonal pattern of water (square symbols) and air temperatures at Vung Ro.

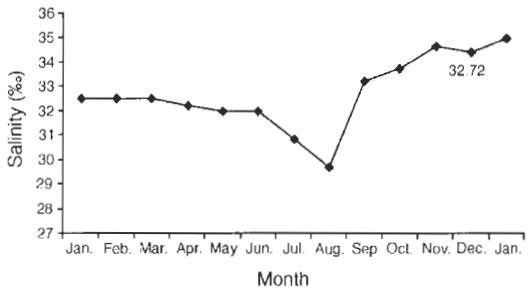

Fig 2. Seasonal variations of salinity at Vung Ro in 1997.

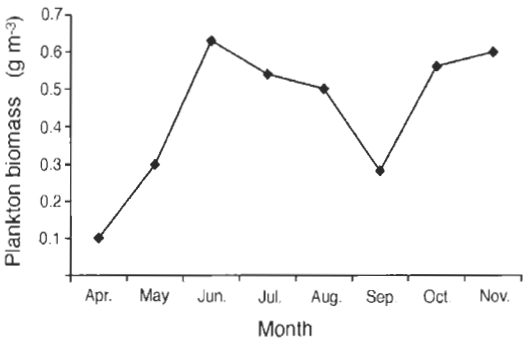

Fig 3. Phytoplankton biomass at Vung Ro measured as wet weight (g/m^3).

Table 1. The quantity of phytoplankton at Vung Ro on 6 occasions in 1997.

Number of cells l^{-1}	Date					
	14/05/97	12/06/97	11/08/97	13/09/97	16/10/97	14/11/97
Bacillariophyta	116	291	81	439	801	301
Pyrrophyta	47	57	90	40	43	21
Others	289	227	248	599	7	56
Total phytoplankton	452	575	419	1078	851	378

predominated with 122 species (61% of the total). The 60 species of Pyrrophyta accounted for 30% of the total. The rest of the species belonged to Chlorophyta and Cyanophyta.

The mean number of phytoplankton cells was 627 cells/ l. A maximum value of 1078 cells/l was observed in September and a minimum number of 378 cells/ l was recorded in November (Table 1)

The average plankton biomass was 0.4 g m^{-3}. The maximum was 0.63 and the minimum 0.1 g m^{-3} (Fig 4). The plankton biomass was higher in Vung Ro than in Nha Trang (Shirota, 1963).

Scallop growth and survival

Seasonal changes in shell length of the juvenile scallops and growth rate in mm/ year in the pearl nets are shown in Table 2, Figs 4 and 5. The relative growth rate increased during the first months, reaching a maximum at a shell length of 23 mm, after which it decreased.

By May 1997, after one year of culture, the scallops had an average shell height of 52.8 ± 1.09 mm s.d. In May 1998, after two years of culture, the height was 75.4 ± 3.5 mm s.d. and the length 71.2 ± 4.6 mm s.d.

The culture density affected the shell growth rates of scallops to a very modest degree. The growth rate was highest at a density of 50 scallops per cage but the difference between the lowest and highest densities were only 1-2 mm in shell height after nearly one year (Table 4 A)

The instantaneous growth rate (G) (% $month^{-1}$) was high (about 80%) during the first 3 months, after which it decreased constantly during the rest of the study period, although more slowly during the second year (Table 3). The mean growth rate was 9.9 % $month^{-1}$ in the first year and 1.1% $month^{-1}$ in the second year.

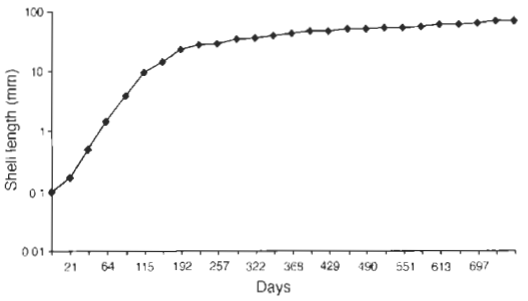

Fig. 4. Mean length of *Chlamys nobilis* during 2 years in suspended culture.

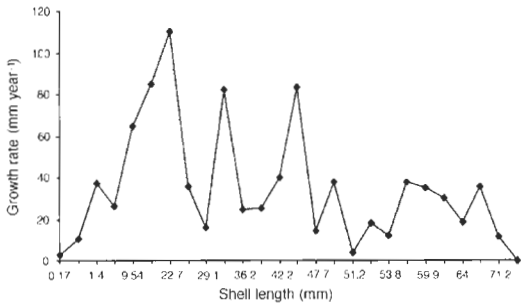

Fig. 5. The growth rate of scallop shell length in mm/ year in the pearl nets.

Table 2. Monthly changes in mean shell length and shell height for scallops maintained in cages suspended at Vung Ro.

Date	Year	Height	± sd.	Length	± sd.
May 7.	1996	1.5	0.0	1.4	0.0
Jun 10.	1996	4.5	1.0	3.9	0.8
July 12.	1996	11.8	3.1	9.5	2.5
July 31.	1996	16.4	3.5	14.0	3.1
Aug 29.	1996	26.1	3.5	22.7	3.0
Oct 10.	1996	31.3	3.5	27.3	3.3
Nov 11.	1996	33.3	3.3	29.1	2.8
Dec 20.	1996	38.7	4.2	34.8	3.8
Jan 10.	1997	40.6	5.3	36.2	5.2
Feb 23.	1997	43.4	7.0	39.2	6.6
Mar 22.	1997	47.2	8.6	42.2	7.6
Apr 10.	1997	51.8	5.6	46.5	2.7
May 10.	1997	52.8	1.1	47.7	5.1
Jun 10.	1997	53.7	5.3	50.9	2.3
July 10.	1997	55.8	4.5	51.2	2.4
Aug 10.	1997	56.9	2.9	52.7	2.9
Sep 10.	1997	57.3	3.6	53.8	3.9
Oct 10.	1997	61.3	3.6	56.9	3.4
Nov 10.	1997	62.9	4.1	59.9	4.3
Dec 10.	1997	65.7	4.1	62.4	4.4
Jan 10.	1998	66.9	3.0	64.0	3.1
Mar 4.	1998	71.5	4.8	69.2	5.6
May 7.	1998	75.4	3.5	71.2	4.6

Table 3. The instantaneous growth rate (G) of *C. nobilis*.

Growth in suspended culture	
Age (months)	G (% day^{-1})
3	80.1
6	23.6
9	8.9
12	6.5
15	3.5
18	3.3
21	3.0
24	2.8

Table 4. Effect of culture density on increment of shell height (A), survival rate (B), and instantaneous growth rate (C) of scallops in cages suspended in 4 m depth.

(A)

density	50	100	150	200
Shell height	mm	mm	mm	mm
Jun. 97	22.1	24.6	23.7	23.2
Jul. 97	25.1	29.1	27.6	24.2
Aug. 97	29.5	33.2	30.1	27.1
Sep. 97	37.6	37.5	35.5	32.4
Oct. 97	42.2	41.5	42.1	39.6
Nov. 97	46.4	45.4	46.8	42.6
Dec. 97	50.6	50.3	49.0	46.9
Jan. 98	61.8	56.3	54.9	54.6
Mar. 98	66.7	66.5	63.9	64.1
Apr. 98	66.9	66.8	64.3	64.9
May. 98	67.5	67.3	66.0	65.4

(B)

density	50	100	150	200
survival rate %	%	%	%	%
Jun. 97				
Jul. 97	100	100	100	100
Aug. 97	100	100	100	100
Sep. 97	98	98	100	97
Oct. 97	96	95	96	95
Nov. 97	94	93	92	89
Dec. 97	94	86	86	82
Jan. 98	92	84	78	75
Mar. 98	80	83	72	61
Apr. 98	78	80	70	58
May. 98	75	75	65	50
Average	90	89	85	80

(C)

density	50	100	150	200
G%	%	%	%	%
Jun. 97				
Jul. 97	12.95	16.97	15.23	4.22
Aug. 97	15.98	13.06	8.67	11.32
Sep. 97	24.30	12.20	16.50	17.86
Oct. 97	11.77	10.15	17.10	20.12
Nov. 97	9.28	8.99	10.43	7.37
Dec. 97	8.77	10.26	4.59	9.39
Jan. 98	19.99	11.30	11.47	15.22
Mar. 98	7.55	16.57	15.18	16.13
Apr. 98	0.29	0.52	0.62	1.16
May. 98	0.97	0.74	2.53	0.84
Average	11.18	10.07	8.84	10.36

The growth was described by the von Bertalanffy growth equation. The growth constant K and Sl_{max} were determined from the data, starting at a shell length of 23 mm (3.75 months after fertilization) with Sl_{max} = 92 mm; k=0.92 According to Yamaguchi (1975) the von Bertalanffy growth curve is not suitable for both very early and later stages of growth of marine invertebrates. For this reason the growth curve was calculated based on data after a shell length of 23 mm was reached.

The survival rates of scallops were good, both in experiments with variable density (Table 4 B) and as a function of depth. Although I found a slightly lower survival at 4 m than at 2, 6 and 8 m, I do not consider this finding significant.

DISCUSSION

The depth at which cages were hung did not have a clear effect on shell growth and survival rates of scallops. However, growth and survival were slightly higher at 2 and 8 m, and food was more abundant there than at 4 and 6 m.

Comparison of the shell growth of tropical scallops *C. nobilis* cultured in Vung Ro, Vietnam, with *Chlamys islandica* cultured in the temperate zone showed a similar growth pattern but the growth rates are very different. One year after settlement, the Iceland scallops reached an average height of 9.8 mm, while *C. nobilis* reached an average height of 52.7 mm. The Iceland scallops required 4 years to reach market size (60-70 mm) (Thorarinsdottir 1991, 1994) while the *C. nobilis* required only 1.5-2 years. In comparison with other tropical scallops, the shell of *Euvola (Pecten) ziczac* from Venezuela, generally attained about 46 mm in length after 7 months in suspended culture. In partly buried cages they attained 70-80 mm in about 1.5 years (Velez *et al.* 1995). Their growth rate was slightly higher than what was found for *C. nobilis* in Vung Ro. In general, the time to reach commercial size for the scallops depends on the species, location and culturing method (Thorarinsdottir 1996).

Suspended culture of scallops in Vietnam is suggested because of the advantages in terms of low mortality, abundant phytoplankton and fast growth with maximum rate in the water column. Suspended culture can be used in suitable areas with seed produced from the hatchery. However, a variety of techniques for commercial culture should be studied and developed.

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