HATCHERY SEED PRODUCTION OF THE SCALLOP *CHLAMYS NOBILIS* (REEVE, 1852)

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ABSTRACT

Spawning of *C. nobilis* was induced by air exposure, or thermal stimulation. Fertilized eggs developed into the D-shaped larval stage within 20 hours. After 8-9 days pediveligers measured 0.165-0.180 mm. Survival from fertilized egg to the settlement of the larvae was 0.5-7.1 %. One month after settlement the spat measured 1-2 mm in shell length, and 4-7.8 mm after 2 months. Survival of the spat the first 2 months after settlement was 80-85 %. After 11 months the juveniles had reached a shell lenght of 48-60 mm with survival of 40-50 %. The mean growth rates were 4.52 mm per month. Heavy fouling and dissatisfactory environmental conditions were the main problems encountered in Vietnam.

INTRODUCTION

Biology of the scallop *C. nobilis* has been studied in Vietnam during the past 10 years. However, the majority of studies deal with distribution and abundance (Vo Si Tuan 1994). Exploitable populations of *C. nobilis* occur along the coastline of Binh Thuan Province at 15-30 m depth. The stocks have been overexploited resulting in decreasing mean size of the shells. The annual yield of scallops was 10,000 tonnes in 1986, but was reduced to only 200-300 tonnes within a decade. In consequence studies of the distribution, biology, population dynamics, and ecology of this species are deemed necessary to give information which can assist fisheries managers to make wise decisions concerning the level of exploitation. The topics were addressed by a national project, coded KNO4-08 "Research on seed production and commercial culture of scallop and sea cucumber" of the Research Institute for Aquaculture No. 3 (RIA No. 3) from 1991 to 1995. The project showed that sustainable scallop fishery implies a ban on landing of scallops smaller than 60 mm and not allowing fishing during the spawning season from April to August. Obviously such regulations are difficult to enforce, so other methods should also be considered to secure the continued availability of scallops. Aquaculture has the potential so the present study was initiated to provide needed data on hatchery production of spat of *C. nobilis* in Vietnam.

MATERIALS AND METHODS

C. nobilis broodstock of 50-60 mm shell length was collected from coastal waters of Binh Thuan province by diving. Fouling organisms were removed and shells cleaned by brushing.

The collected specimens were transported to the laboratory, maintained in rounded net cages, and cultivated in 2 m^3 breeder tanks containing filtered sea water with salinity of 32 ‰, temperature 27±3 °C, and pH 8. Continuous aeration was provided to maintain the oxygen level at more than 4 ml O_2 l^{-1}. The sea water was replaced daily. The scallops were regularly fed on unicellular algae such as *Platymonas* sp., *Chlorella* sp., *and Chaetoceros muelleri*.

When the average gonadal index reached about 16 %, spawning was induced by air exposure, thermal stimulation, or through desiccation and flowing water.

The formula used for calculating gonadal index is: G = (gw/sw)100 %, where G is the gonadal index (%); gw is fresh weight of total gonad (g); and sw is fresh weight of total soft parts including the gonad (g).

Fertilized eggs were kept at a density of 30 eggs per ml. The rearing density for lar-

Table 1. Environmental factors in the larval rearing tank.

Date (1997)	Stage	Environmental factors													
		Water temp. °C	DO	BOD	COD	Salt (‰)	TDS (‰)	pH	CO_3	H_2S	PO_4	NO_2-N	NH_3-N	SiO_2	Cond (ms)
25/3	D-shape	28	4.68	8	2.4	31.2	32.3	8.2	8	0.002	0.15	0.033	0.09	0.681	47.2
30/3	umbo	28.5	4.52	17.6	3.2	31.6	32.4	8.3	10	0.002	0.13	0.034	0.2	0.377	48.2
6/4	spat	29	5.6	5.6	7.2	32.2	33.2	8.3	8	0.002	0.13	0.076	0.11	0.282	49.2

val cultivation ranged from 2-5 larvae per ml. Larvae were fed daily with a mixture of unicellular phytoplankton (*Chaetoceros*, *Chlorella* and *Platymonas, Nanochloropsis*). D-stage larvae were fed on 3000 cells ml^{-1}. The density of algae was gradually increased to 10,000 cells ml^{-1} for spat of 1 mm length. The feeding rate was decided daily according to the amount of food in larval stomachs, when observed under a microscope.

During the early period of rearing, regular management procedures were observed with regard to feeding, exchange of water, observations of larval activity, removing waste from the tank bottoms, and counting numbers of larvae.

The total number of larvae was estimated by multiplying the number of larvae in 1 ml by the total volume of water in the tank. In the later period, especially when spat collectors were placed in the tanks, the flowing water method was used to change water in the rearing tank. Spat attached to the collectors were maintained in the tanks until they had reached 1 mm shell length. To investigate the development of the larvae, 20-30 individuals from each spawning were measured and photographed using a compound microscope with attached camera.

RESULTS

Larval rearing and development

Environmental factors in the larval rearing tank are summarised in Tab. 1.

Female gonads of *C. nobilis* are orange or yellow while the male gonads are white. Each female induced to spawn released between 1.5-4.8 million (average 2.8 million) golden-yellow eggs with a diameter of 60 µm. At temperatures from 27-29 °C, the polar body appeared 30 min after fertilization, the first cleavage (2 cells stage) in 45 min; the second cleavage (4 cells stage) after 1 h (Fig. 1A); morula within 5 h, and trochophore (Fig. 1B) 7 h after fertilization.

The D-stage appeared 18-22 h after fertilization (Fig. 1C) and the prodissoconch I shell on the first day. Veligers averaged 100 µm SL and 83 µm SH. The larvae developed into umbo larvae of 132 µm SL x 100 µm SH on day 4 and measured 190 x 160 µm on day 8 (Fig. 1D), then showing pigment spots.

Appearance of eye spots signalled the end of the swimming stage.

The umbones were then fully formed, and larvae competent to metamorphose on properly placed spat collectors. The foot and cement glands were detached, the velum lost, and the body became twisted. The shells became distinctly coloured and firmly attached with byssus when the shells reached 600-700 µm (Fig 1E). Fig. 2 shows the growth of *C. nobilis* larvae throughout the rearing period. The shell length of straight-hinged veligers increased approximately 10.21 µm day^{-1} until the pediveliger stage was reached and spat grew in length by 16.42 µm day^{-1}. Growth in length increased to an average of 8.86 µm day^{-1} for all larval stages. The spat had reached the length of 1 mm after 20-25 days (Fig. 1F) and 4-5 mm after 40-45 days of growth.

Survival rate from fertilized egg to spat ranged from 0-7.1 %, and it was 0-9.5 % from D-stage larva to spat (Tab. 2).

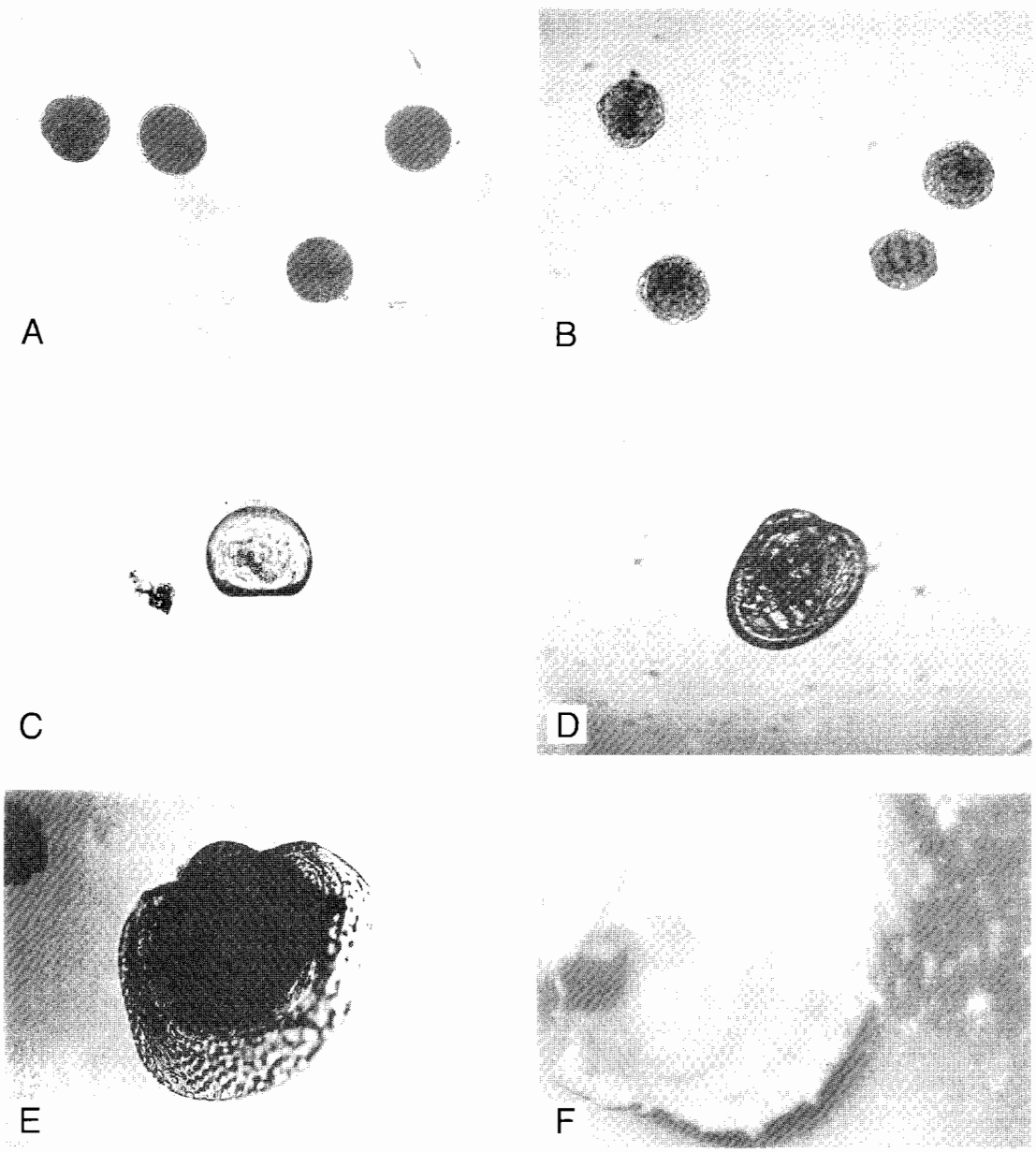

Figure 1. Development of *C. nobilis*. (A) Early cell division, 1 h after fertilization. (B) Trochophore after 7 h. (C) Straight hinged veliger (D-stage) after 1 day. (D) Veliger with eye spots after 8 days. (E) Spat stage (metamorphosing pediveliger) after 16 days. (F) Juvenile, fully coloured.

DISCUSSION

C. nobilis has great economic value in Vietnam but profitable investment in the resource is difficult because of highly variable natural stocks. Therefore, a management plan for exploitation of the natural resources, combined with development of scallop culture, are two necessary courses of action to be taken to stabilise the annual yield of scallops in Vietnam.

Table 2. *C. nobilis*. Log-book of experiments on hatching.

No.	Rearing period (dates)	Total no. of eggs (10^6)	Total no. of D-shaped larvae (10^6)	Total no. of Umbo larvae (10^6)	Total spat (10^6)	Survival rate (%)	
						Egg to spat	D-shape to spat
1	02.06.92 - 26.06.92	2	1.2	0.08	0.02	1	1.7
2	11.06.93 - 30.06.93	7.5	6	4	0.15	2	2.5
3	07.08.93 - 18.08.93	13	6.5	0	-	-	-
4	15.09.93 - 20.09.93	23.6	15	3.2	-	-	-
5	10.09.93 - 30.09.93	5	4.3	4	0.025	0.5	0.58
6	09.05.94 - 02.06.94	86	30	1	-	-	-
7	12.05.94 - 14.06.94	43	12	3	0.5	1.2	4.2
8	20.07.94 - 10.08.94	20	8	2	0.004	0.0002	0.0005
9	05.04.95 - 08.05.95	35	30	25	2.5	7.1	8.3
10	17.05.95 - 12.06.95	45	31.7	22.4	3	6.7	9.5

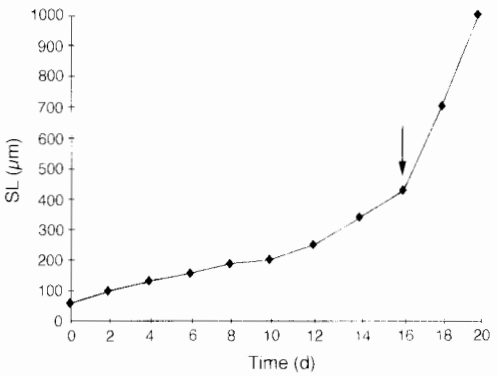

Figure 2. Growth of *C. nobilis* larvae throughout the whole rearing periods. Arrow indicates spat stage.

Hatchery seed production of *C. nobilis* has been established at the Wakayama Prefectural Sea-Farming Center of Japan in 1973 (Tomori *et al.* 1992) and in Guang Dong of China in 1976 (Shan & Quo 1982). The mean survival rate of the spat in the rearing tanks were 2.7 % in Japan and 6.3 % in China.

Studies carried out at the Research Institute for Aquaculture No. 3 have shown that hatching and rearing of *C. nobilis* larvae is possible, but larvae and juveniles have a very low survival rate. Culture of scallops in Vietnam is still in its experimental stage. Better rearing techniques and expansion of the grow-out culture need to be developed.

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