

CURRENT STATUS AND TECHNICAL SOLUTIONS NEEDED TO BE IMPLEMENTED FOR EFFICIENT AND SUSTAINABLE SNOUT OTTER CIAM (*Lutraria rhynchaena*) CULTURING

Nguyen Thi Bien Thuy¹*, Cao Truong Giang¹,
Le Van Khoi¹, Vu Thi Huyen¹, Dang Thi Lua¹

ABSTRACT

The article presents the results of the current status of Snout Otter Clam farming techniques in Quang Ninh, Hai Phong, and Khanh Hoa through questionnaires and information collection in order to determine the main technical parameters in the current Snout Otter Clam culture and some technical solutions that need to be implemented. This is the first facility to serve the construction of a highly efficient and sustainable commercial Snout Otter Clam farming technology process. Regarding the current status of farming techniques, the total area of Snout Otter Clam farming in the three surveyed provinces is estimated at 299 hectares, and farmers mainly apply the cage culture placed in the tidal flat on about 214 hectares. The stocking size is from 1 - 3 cm/individual with a density of 25 - 55 fish/cage, and the time of stocking is from March to April every year. The culture period is 10-14 months per crop, the harvested Snout Otter Clam size is 25 - 60 g/individual, the survival rate is 25 - 60%, and the yield is 355.37 - 470.84 g/cage/crop. Regarding the epidemic situation, there was no outbreak of disease. However, it was still recorded that diseased Snout Otter Clam appeared sporadically during the culture period. The characteristic presentation described is similar to that of Virus-like particles (VLPs). Snout Otter Clam are diseased at seed stage (size from 2 - 3 cm) and commercial stage (size from 20 - 35 g/head). The research results have provided the current status of Snout Otter Clam farming and suggested the main solutions that need to be taken to develop an effective and sustainable Snout Otter Clam culture.

Keywords: *Current status, technical solutions, farming techniques, snout Otter Clam.*

Received: 3 July 2023; revised: 5 September 2023; accepted: 23 November 2023

1. INTRODUCTION

Snout Otter Clam is one of the molluscs with the advantages of high economic value, suitable habitat conditions, and easy-to-apply farming techniques. Snout Otter Clam products are easy to consume in the market because Snout Otter Clam meat is fragrant, delicious, and rich in protein. In particular, Snout Otter Clam meat also contains 18 kinds of amino acids, of which some are not substituted and have a high content [1]. Snout Otter Clam are also widely cultivated in Southeast

Asia and the southeastern coastal areas of China and have become an important fishery species in these regions [2]. This species contributed an important part to the production of 16.1 million tons of bivalve molluscs in 2016, accounting for 21.4% of global aquaculture production [3] and most of the mollusc production. Marine bivalves (89%) come from aquaculture, with a total economic value of \$20.6 billion per year [4].

Snout Otter Clam has become one of the key species of mollusk farming in the past few years in Vietnam. Snout Otter Clam is mainly distributed in the northern region of Ha Long Bay (from Cat Ba Island, Hai Phong, to Van Don, Quang Ninh) and

¹ Research Institute for Aquaculture No.1

* Email: ntbtthuy@ria1.org

in the central coastal area (Nha Trang, Khanh Hoa), Snout Otter Clam farming is mainly concentrated in Quang Ninh, Hai Phong, and Khanh Hoa provinces. There were times when geoduck farming developed rapidly, with thousands of farming households in these areas [5]. Due to the serious disease situation in Snout Otter Clam, the Snout Otter Clam farming industry has decreased sharply in terms of farming area and production. However, it is undeniable that Snout Otter Clam is still one of the objects of great economic value among today's farmed mollusks. In order to effectively restore and develop Snout Otter Clam farming, it is necessary to develop a new farming technique in the direction of safety, sustainability, and an increase in output and value of goods. From these issues, the objective of this study is to survey and evaluate the current technical status of Snout Otter Clam farming in Quang Ninh, Hai Phong, and Khanh Hoa the main Snout Otter Clam farming provinces. Thereby assessing the limitations that need to be overcome and providing technical solutions that need to be implemented. This is a very important first step to solve, serving to build a highly efficient and sustainable commercial Snout Otter Clam (*Lutraria rhynchaena*) culture process from which it can be applied in production practice.

2. RESEARCH METHODOLOGY

2.1. Time, place, number of survey samples

- Execution time: From April 2021 to November 2021.

- Survey location: Quang Ninh (in Van Don, Cam Pha), Hai Phong (in Cat Ba), Khanh Hoa (in Nha Trang).

- Number of questionnaire samples: The total number of samples to collect information was 270, evenly distributed among the 3 survey provinces according to Yamane's formula (1967) [6]. Each province has 90 samples. In each surveyed province, 10 questionnaires were allocated to interview managers at the fisheries department and 80 questionnaires to interview Snout Otter Clam farming households. In the province, the

survey identified districts with Snout Otter Clam farming activities; accordingly, Quang Ninh concentrated on Van Don, Hai Phong concentrated on Cat Hai, and Khanh Hoa concentrated on Nha Trang. In each district, the samples are equally distributed to communes with current Snout Otter Clam farming activities, with the following numbers: Van Do (Ban Sen: 20 samples; Doan Ket: 20 samples; Ha Long: 20 samples; Cai Rong: 20 samples); Cat Hai (Cat Ba: 80 samples); Nha Trang (Vinh Luong: 80 samples). After calculation, the samples are randomly distributed to the corresponding farming areas. For communes with fewer farming households than the number of allocation votes, a survey of the entire number of farming households was conducted.

2.2. Building the survey form

Building four types of questionnaires to collect information, specifically as follows:

- Type 1: The questionnaire collects information from managers of the provincial fisheries departments on the current technical status of Snout Otter Clam farming. Each province surveyed five questionnaires, focusing on key information such as the number of farming households, total farming area, form of Snout Otter Clam farming, advantages and disadvantages of current Snout Otter Clam farming, and technical solutions that need to be implemented.

- Type 2: The questionnaire collects information from Snout Otter Clam farming households on the current technical status of Snout Otter Clam farming. Each province surveyed 40 questionnaires, focusing on key information including: water environment conditions in the farming area; farming form; density; stocking stock size; bottom material; density of cages; survival rate; harvest size; yield; and economic efficiency.

- Type 3: The questionnaire collects information from managers of the provincial fisheries departments on the current situation of Snout Otter Clam diseases. Each province surveyed five questionnaires, focusing on the

advantages and disadvantages of Snout Otter Clam disease management and the main technical solutions that need to be implemented to minimize the disease.

- Type 4: The questionnaire collects information from Snout Otter Clam farming households on the current situation of Snout Otter Clam diseases. Each province surveyed 40 questionnaires, focusing on key information including: diseased Snout Otter Clam and disease manifestations; time, season, and stage of disease occurrence. Subjective statements about the cause of the disease, measures that have been applied to prevent disease, and the effectiveness of the measures.

2.3. Methods of investigation and data collection

Using standardized questionnaires (survey form) and the Rapid Rural Appraisal (RRA) method [7], [8] directly interviewed Snout Otter Clam farmers, officials managed at the Fisheries Sub-Departments of Quang Ninh, Hai Phong, and Khanh Hoa provinces.

Primary data were collected through interviews and standardized questionnaires. For some water environment factors in the farming area (temperature, salinity, pH, and DO), they were collected by interview and combined with direct measurement. Temperature was measured with a mercury thermometer graduated in 0.1°C, salinity was measured with a refractometer with 1ppt graduations, pH was measured with a hand-

held pH meter, and DO was measured with a Kit Sera.

Secondary data were collected from research projects on Snout Otter Clam that have been accepted, from published articles, reports on disease situations in Snout Otter Clam and mollusc farming, and directive documents from management agencies at all levels.

2.4. Data processing methods

The data is processed by descriptive statistics through calculating the average (Mean), minimum (Min), maximum (Max), and analytical methods variance ANOVA on Minitab 16 software.

3. RESULTS AND DISCUSSION

3.1. Technical status of Snout Otter Clam culturing

3.1.1. Water quality in the farming area

Water quality in the farming area plays an important role in commercial Snout Otter Clam farming. Environmental factors affecting the growth and survival rate of Snout Otter Clam, such as hydrological, hydrochemical, and aquatic factors. In which these factors are interrelated and influence each other. The physicochemical factors such as salinity, clarity, temperature, and pH affect the growth and development of wild Snout Otter Clam as well as commercial Snout Otter Clam culture, in which the most important factors are salinity and turbidity of the water. The results of the survey and collection of some water environmental factors in Snout Otter Clam farming areas in three provinces are shown in table 1.

Table 1. Some water environmental favameters in Snout Otter Clamfarming areas

Survey province	Temperature (°C)	Salinity (‰)	pH	DO (mg/L)
Quang Ninh	15 - 30	26 - 30	8.0 - 8.5	5.0 - 6.5
Hai Phong	15 - 30	26 - 30	7.5 - 8.5	5.0 - 6.5
Khanh Hoa	22 - 30.5	28 - 32	8.0 - 8.5	5.0 - 6.0

The results show that some water environmental favameters in Snout Otter Clam farming areas in Quang Ninh, Hai Phong, and Khanh Hoa are relatively similar. The water temperature fluctuates between 15°C and 30°C, with an average of 26.5°C (in Quang Ninh and Hai

Phong) and 27.5°C (in Khanh Hoa). The water temperature in the farming area has little variation during the day; the difference between morning and afternoon is about 1 - 2°C. However, water temperature has a clear seasonal variation; the lowest temperature can be observed (15°C in

Quang Ninh and Hai Phong; 22°C in Khanh Hoa) on some days in the months from November to January. The highest temperature (30°C in Quang Ninh and Hai Phong; 30.5°C in Khanh Hoa) is observed in the months from July to September every year. According to Luca and Doan Xuan Nam (2012), the tolerance threshold for Snout Otter Clam is 12 - 37°C, and the optimal temperature for growth ranges from 24 - 28°C [9].

The salinity of the water environment measured at the time of the survey in Quang Ninh and Hai Phong ranges from 26‰ to 30‰. Meanwhile, the salinity in Snout Otter Clam farming areas in Khanh Hoa often fluctuates between 28‰ and 32‰. This is a suitable range of salinity for the growth and development of Snout Otter Clam [10].

pH values ranged from 8.5 - 8.5 (Quang Ninh, Khanh Hoa) and 7.5 - 8.5 (Hai Phong). This pH range is considered suitable for marine aquaculture species in general and Snout Otter Clam in particular [11].

Dissolved oxygen content ranged from 5.0 - 6.5 mg/l. The appropriate dissolved oxygen content for Snout Otter Clam is 5 mg/l or more, and the allowable oxygen level in the Snout Otter Clam habitat is 4 mg/l [12].

In general, in the surveyed Snout Otter Clam farming areas, temperature, salinity, pH, and dissolved oxygen were suitable for Snout Otter Clam growth.

3.1.2. Current status of farming areas and farming methods

Through the collection of available information and survey results in Quang Ninh, Hai Phong, and Khanh Hoa, it is shown that currently, Snout Otter Clam are farmed in a very limited areas, and production as well as farming area have decreased markedly compared to that of 5 - 10 years ago. The province with the largest Snout Otter Clam farming area in the three surveyed provinces is Quang Ninh, with about 152 farming households and an estimated total farming area of 209 hectares. Hai Phong is the province with at least 50 farming households and an estimated area of 40 ha (Table 2).

Table 2. General Status of Snout Otter Clam Farming

Survey provinces	Number of farming households (household)	Farming area (ha)	Farming form		
			<i>Cages hanging on raft (ha)</i>	<i>Cage placed on the tidal flat (ha)</i>	<i>Drop directly into the tidal flat (ha)</i>
Quang Ninh	152	209	60	149	-
Hai Phong	50	40	15	25	-
Khanh Hoa	60	50	18	40	2
Total	262	299	93	214	2

Snout Otter Clam farming methods include cages hanging on raft, cages placed on the tidal flat, and dropping directly into the tidal flat. Currently, only a few households in Khanh Hoa still keep farming in dropping directly into the tidal flat form, with an estimated farming area of about 2 hectares. Farmers mainly farm in the form of cages placed on the tidal flat, with a total farming area of about 214 ha (Table 2). Snout Otter Clam farming cages are hung below the tide with the lowest depth at low tide of 1.5 - 2 m (for the cages hanging on rafts) and placed relatively flat in the

intertidal areas (for the cages placed on the tidal flat), with the lowest depth at low tide of 0.5-1.5 m, the bottom is sand mixed with mollusk shells and coral debris. The current selection of Snout Otter Clam farming methods is completely consistent with reality in Quang Ninh, Hai Phong, and Khanh Hoa. For the form of drop directly into the tidal flat, the area of yards capable of natural stocking is not much, the management and the ability to recover commercial Snout Otter Clam are difficult for the tidal flats with great depth, and moreover, direct free-range farming has a very low survival

rate, so drop directly into the tidal flat is almost no longer applied. For the form of cages hanging on raft, the initial investment is quite high, and it is necessary to have a farming location that meets the requirements of depth and flow and is less affected by wind and storms to place rafts. This is not something many households can do. Therefore, the main farming method applied in

Quang Ninh, Hai Phong, and Khanh Hoa is still cage placed on the tidal flat.

3.1.3. The current status of some key technical parameters in Snout Otter Clam farming

The results of the survey on some current Snout Otter Clam farming specifications in Quang Ninh, Hai Phong, and Khanh Hoa are shown in table 3.

Table 3. Current Snout Otter Clam farming specifications

Specifications	Quang Ninh	Hai Phong	Khanh Hoa
Size of seed (cm/individual)	2.13 ± 0.13 1 - 3	2.10 ± 0.16 1 - 3	2.18 ± 0.15 1 - 3
Stocking density (individuals per cage)	32.98 ± 0.77 25-50	33.30 ± 1.06 25-55	33.20 ± 0.84 25-50
Density of cages (cages/m ²)	3.45 ± 0.14 ^a 2-4	2.65 ± 0.15 ^b 2-4	2.55 ± 0.14 ^b 2-4
Breeding period (months)	10.88 ± 0.13 10-12	10.95 ± 0.17 10-14	11.00 ± 0.21 10-14
Harvest size (g/individual)	31.88 ± 1.08 25-57	32.85 ± 1.02 25-60	34.63 ± 1.03 25-60
Survival rate (%)	33.25 ± 1.25 ^b 25-55	40.85 ± 1.58 ^a 30-60	40.67 ± 1.69 ^a 25-60
The yield (g/cage/crop)	355.37 ± 19.39 ^b	454.56 ± 32.22 ^a	470.84 ± 27.55 ^a

The Size of seed in Quang Ninh, Hai Phong, and Khanh Hoa were relatively uniform, ranging from 1 - 3 cm, with an average of 2.13 cm (Quang Ninh); 2.10 cm (Hai Phong); and 2.18 cm (Khanh Hoa). There was no significant difference ($P > 0.05$) in seed size at stocking in the three surveyed provinces.

Stocking density ranged from 25 to 55 individuals per cage (cage size is 60 cm x 45 cm x 35 cm) depending on stocking size, equivalent to about 100 to 200 individuals/m². Stocking density was also relatively uniform in the surveyed provinces ($p > 0.05$). In Quang Ninh and Khanh Hoa, stocking densities range from 25 - 50 individuals/cage, with an average of 32.98 individuals/cage (Quang Ninh) and 33.20 individuals/cage (Khanh Hoa). In Hai Phong, stocking density ranged from 25 - 55

individual/cage, with an average of 33.30 individuals/cage.

The density of cages was from 2 - 4 cages/m² in yards or hanging rafts. The average density of cages was different among the surveyed provinces ($p < 0.05$); the density of cages was highest in Quang Ninh (3.45 cages/m²), and there was no difference between the density of cages in Hai Phong (2.65 cages/m²) and Khanh Hoa (2.55 cages/m²).

The period of commercial Snout Otter Clam farming lasts from 10 to 14 months, depending on the seed size at stocking. The time of stocking is from March to April of the solar calendar, and harvesting is from January to February of the following year. The mean culture period in Khanh Hoa (11 months) tended to be longer than in Quang Ninh (10.8 months) and Hai Phong (10.9

months), but this difference was not statistically significant ($p > 0.05$).

The survival rate of Snout Otter Clam is often unstable, ranging from 25-60%. There was a significant difference in the survival rate of Snout Otter Clam in the three surveyed provinces ($p < 0.05$). The lowest survival rate in Quang Ninh is 33.25%, followed by Khanh Hoa at 40.67% and Hai Phong at 40.85%. There was no difference in survival rates between Khanh Hoa and Hai Phong. The results showed that the survival rate tended to decrease when the density of cages was high. In Quang Ninh, the density of cages was significantly higher than in Hai Phong and Khanh Hoa, where the survival rate was lower.

Snout Otter Clam production at harvest was also found to be different among the three surveyed provinces ($p < 0.05$). The lowest yield was obtained in Quang Ninh with 355.37 g/cage, the highest in Khanh Hoa (470.84 g/cage) and Hai Phong (454.56 g/cage). This result also shows that there is a tendency for the density of cages and survival rate to influence yield at harvest.

When the density of cages is high, the survival rate is low, and the yield is also lower.

3.1.4. Current status of Snout Otter Clam disease

The results of the survey showed that the disease in Snout Otter Clam is now much more limited than in previous years; there are no outbreaks of diseases because Snout Otter Clam farming households have decreased significantly in both quantity and scale. However, in the three surveyed provinces, Snout Otter Clam diseases were still recorded, appearing sporadically during the farming period. The initial subjective judgment of the households may be due to the quality of the input breed. The characteristic presentation is described as similar to that of Virus-like particles (VLPs). Diseased Snout Otter Clam seed stage (size from 2 - 3 cm) and commercial stage (size from 20 - 35 g/individual). For Snout Otter Clam seed, the disease period is usually from May to July every year. In the commercial stage, the disease period is usually from November to January of the following year (Table 4).

Table 4. Disease status in Snout Otter Clam

Status quo	Quang Ninh	Hai Phong	Khanh Hoa
Time of disease appearance	May-July; December - January of the following year	May-July; December - January of the following year	May-July; December - January of the following year
Disease stage and size of Snout Otter Clam	Seed stage (2 - 3 cm); Commercial stage (20 -30 g/ind)	Seed stage (2 - 3 cm); Commercial stage (30 - 35 g/ind)	Seed stage (2 - 3 cm); Commercial stage (20 - 35 g/ind)
Disease manifestation	The faucet is swollen and surrounded by white fluid.	The faucet is swollen and surrounded by white fluid.	The faucet is swollen and surrounded by white fluid.
Measures taken to prevent the disease	Select suitable breeding sites; select breeds according to color, uniform size, and no abnormalities; Stocking at the right time.	Select suitable breeding sites; select breeds according to color, uniform size, and no abnormalities; Stocking at the right time.	Select suitable breeding sites; select breeds according to color, uniform size, and no abnormalities; Stocking at the right time.

The survey results also show that, now that Snout Otter Clam farming has decreased sharply, many households have switched from Snout Otter Clam farming to Pacific oyster farming, clam farming, etc. Therefore, Snout Otter Clam farming

households currently mainly apply measures for mollusc farming in general to limit the occurrence of diseases, such as: selecting suitable farming sites; selecting breeding stock through the sense of color, size, and dimorphism; Stocking at the

right time; and checking Snout Otter Clam growth periodically.

3.2. Technical solutions to be implemented for effective and sustainable Snout Otter Clam farming

The evaluation of the survey results on the current status of Snout Otter Clam farming shows that Snout Otter Clam farming in Vietnam in general has not developed commensurate with its potential (in terms of water surface area, available food sources, etc.). Previously, in Snout Otter Clam farming technology, only different farming methods were introduced, but there was no specific farming protocol for different farming methods. Tran The Muu (2011) [10] initially successfully developed the commercial Snout Otter Clam farming protocol. Until now, Snout Otter Clam farming techniques have still applied this protocol. However, the protocol still has limited technical parameters such as small seed size, low stocking density, long farming time, low survival rate, and low productivity. The protocol has also not been mentioned regarding cage density, bottom substance in commercial Snout Otter Clam farming, and care mode. A solution to these specifications is needed for efficient and sustainable snout otter clam farming. The technical specifications are limited and need to be implemented, specifically:

Seed quality: The quality of seed is very important in Snout Otter Clam farming; the source of seed is a factor that can affect the whole farming process. The 2017 Fisheries Law has been implemented, which requires that the seed be quality quarantined before being sold. However, the results of the survey on the quality of seed showed that most of the Snout Otter Clam seed from the hatchery did not go through quarantine; the quality standards of the seed were only evaluated through the senses and based on the trust between the buyers and the seller. This leads to an uncontrollable source of disease from seed and a high risk of disease outbreaks. Dang Thi Lua (2018) have identified the VLPs agent at the stage of Snout Otter Clam rearing in hatcheries and confirmed that Snout Otter Clam larvae are

the main source of VLPs pathogens [5]. Therefore, when selecting seeds, it is necessary to check for VLPs to ensure that the seed are free from VLPs. At the same time, select seeds with clear origins from reputable seed suppliers, bright natural colors, uniform sizes, healthy, unbroken shells, and a low malformation rate.

Size of stock, stocking density, and time of rearing: the current stocking size is mainly small, the size fluctuates about 2 cm, and the stocking density is over 30 individuals per cage (120 individuals/m²). After 11 months of rearing, the commercial size is only 30 - 35 g/cage, and the yield is from 0.35 to 0.5 kg/cage. This seed size and stocking density are consistent with the procedure of Tran The Muu (2011) [10], which states that in seed selection, the appropriate initial stocking size is grade 2 seed (shell length 1.5 - 3 cm) with a stocking density of 25 - 30 individuals per cage. However, with such stocking density, the nutritional potential of the culture area has not been fully promoted, leading to low productivity. At the same time, small stocking sizes are also associated with enemy attacks and often cause high mortality. Research by MacKenzie Jr. (1977) on the stocking size of the clam *Mercenaria mercenaria* showed that stocking sizes < 20 cm are often attacked by many types of snails, crabs, and starfish [13]. For shrimp, the stocking size for commercial farming is over 2 cm [14]. According to the report of the Center for Agriculture and Fisheries Extension in Phu Yen, since 2010, the commercial Snout Otter Clam farming model has been implemented with a stocking size of 3 cm. Stocking density is 50 to 60 individuals per After nine months of stocking commercial Snout Otter Clam, it reached 45.4 – 50 g/individual. Therefore, in order for Snout Otter Clam farming to be more effective in improving survival rates, productivity, and reducing farming time, it is necessary to have studies on testing large stocking sizes of 2 cm or more and stocking density of over 30 individuals per cage.

Density of cages: Currently, there is no research on the appropriate density of commercial cages per unit of farming area. Farmers mainly put cages next to each other, affecting the water

exchange between the cage and the environment. At the same time, the survey results show that there is a tendency for Snout Otter Clam survival to decrease when the density of cages is above 3 cages/m². Therefore, it is necessary to have a trial to evaluate the effect of cage density on the survival rate of Snout Otter Clam. This can be a technical solution to improve survival rates, thereby improving productivity effectively and sustainably.

Care mode: in the process of raising Snout Otter Clam, most farmers do not pay attention to the cleaning and care of cages and are very limited in the frequency of inspection, cage cleaning, and bottom replacement. At the same time, current farming techniques have not mentioned the frequency of cleaning and care of the cages as being most effective. In a culture cycle with a long rearing time, the cage is not cleaned and cared for, which is also one of the causes of disease in Snout Otter Clam, reducing their survival rate [12]. In order for the Snout Otter Clam to grow well, have a high survival rate, and prevent disease, one of the solutions that needs to be implemented is to increase the frequency of cleaning and caring for the cages by periodically cleaning the cages, picking up all kinds of waste, washing sand, and adding sand to the cages if a loss of sand is found. The frequency of cage care also needs to be tested for the most effective Snout Otter Clam farming techniques.

Bottom substance in Snout Otter Clam culture: in the current commercial Snout Otter Clam farming process, not to mention the effect of bottom substance on commercial Snout Otter Clam, only studies on bottom substance have been done on the seed stage [10]. In the recent period, one of the causes of mass Snout Otter Clam mortality was also partly due to bottom degradation [5]. Bottom matter affects the growth and development of Snout Otter Clam, so it is necessary to study the composition of the benthic substance (sand and mollusk shell) for Snout Otter Clam and test it.

4. CONCLUSION

- The estimated total area of Snout Otter Clam farming in Quang Ninh, Hai Phong and Khanh

Hoa province is 299 hectares, of which 214 hectares are raised in cages placed on the tidal flat.

- In the three provinces, there are currently about 262 Snout Otter Clam farming households. Seed sizes at stocking are from 1-3cm/individuals, stocking densities ranging from 25 - 55 shrimp/cage, time of stocking from March to April, and harvesting between January and February of the following year. The farming period is from 10 to 14 months, the size of commercial Snout Otter Clam is from 25 to 60 g/individual, the survival rate is from 25 to 60%, and the yield is from 355.37 to 470.84 g/cage (1,316 - 1,744 g/m²).

- No outbreak of disease was found; however, there was still a phenomenon of sporadic disease in the rearing period. The initial subjective assessment may be due to the quality of seed. The characteristic presentation described is similar to that of VLPs. Snout Otter Clam were infected at the seed stage (size from 2 - 3 cm) and the commercial stage (size from 20 - 35 g/individual).

- Identified the main technical parameters that are still limited and need to be improved in order to raise the Snout Otter Clam effectively and sustainably, including stocking size, stocking density, cage density, bottom rate, and care regime. To improve these specifications, it is necessary to have experimental studies on stocking sizes above 2cm, experimenting with stocking density of over 40 individuals per cage, cage density of less than 3 cages per m², testing bottom material for rearing calves, and management.

REFERENCES

1. Pham Thuoc (2006). Investigate the current status and propose some solutions to protect and develop Snout Otter Clam resources in the waters of Hai Phong, Quang Ninh.
2. Su Q, Tong W, Li Q, Yang J, Chen R, Jiang Y, Cai D. (2009). Experimentation on the juvenile nursery of *Lutraria maxima* Jonas in ponds. *Journal of Guangxi Academy of Sciences* 3.
3. Fao (2018). Agriculture organization of the United nations 2016. The state of world fisheries

and aquaculture 2016. Contributing to food security and nutrition for all. Rome. 200 pp.

4. Wijsman J, Troost K, Fang J, Roncarati A. (2019). Global production of marine bivalves. Trends and challenges. Goods and services of marine bivalves, Springer, Cham: 7 - 26.

5. Dang Thi Lua (2018). Summary report of the ministry-level project "Research on technical and management solutions to effectively control proboscis disease in farmed Snout Otter Clam". Research Institute for Aquaculture No. 1.

6. Yamane. T. (1967). Statistics: An introductory Analysis, 2nd edition, Harper and Row, New York, pp. 886- 887.

7. R. Groves, F. Fowler, M. Couper, J. Lepkowski, E. Singer, and R. Tourangeau (2004). Survey Methodology. Wiley Series in Survey Methodology.

8. University of Can Tho, PRA (Participatory Rural Assessment).

9. Luca, M and Đoan Xuan Nam (2012). Hatchery techniques applied for the artificial production of Snout Otter Clam (*Lutraria rhynchaena*) in small scale farms in Nha Trang city, Vietnam. Aquac Asia 17: 25 - 29.

10. Tran The Muu (2011). Improvement of technology for seed production and commercial Snout Otter Clam farming (*Lutraria philippinarum* Reeve, 1854). Project summary report, code KC06.DA16/06-10.

11. QCVN 10-MT: 2015/BTNMT. National technical regulation on sea water quality.

12. Thieu Van Thanh (2012). Study the current status and propose solutions to develop shrimp farming (*Lutaria rhynchaena*) in Van Don district, Quang Ninh province. Master's thesis. Nha Trang University: 68 pages.

13. Mackenzie Jr, C. L. (1977). Predation on hard clam (*Mercenaria mercenaria*) populations. Transactions of the American Fisheries Society 106(6): 530 - 537.

14. Parisi G, Centoducati G, Gasco L, Gatta P, Moretti M V, Piccolo G. (2012). Molluscs and echinoderms aquaculture: biological aspects, current status, technical progress and future perspectives for the most promising species in Italy. *Italian Journal of Animal Science* 11 (4): e72.