

# Study on Growth's Rule of Hard Clam (*Meretrix lyrata*) in Bach Dang Estuary, Viet Nam

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## Abstract

Fraction of tidal flat at both sides of Bach Dang estuary is the fine sand –silt shape which is created by the interaction between river and tidal currents. Plentifully nutrient resources are discharged from continent brought to the estuary by medium-speed tide contribute to advantage condition for growth of hard clam. With the unique characteristics of hydro chemical and current, process of hard clam (*Meretrix lyrata*) hatchery have different properties in compare with other areas such as size of seed hard clam, period of growth, point of beginner. The rule of development of the hard clam is formulated as  $y$  (months old) =  $5.5676 + 0.0386e^{2.6636H}$ , with  $H$  height (cm). It means that their stages of development were strongly affected by local environmental variables.

**Keywords:** Hard clam (*Meretrix lyrata*), Rule of growth

## 1. Introduction

Bach Dang estuary, with two sides distributes into tidal flats, is salient terrain in tidal areas. Fraction of tidal flat is fine sand-silt created by the interaction of tidal and rival flow (Tran Duc Thanh et al., 2000). Fraction of tidal flat is appropriate to habitat of hard clam (*Meretrix Lyrata*) (MCD, 2009).

There are many advantage conditions as nutrition, current, salinity, pH, DO, detritus and plankton brought by the flow the continent to estuary, so hard clam here is developed widely. Area of hatchery of hard clam at Bach Dang estuary, concentration at Dong Bai commune – Cat Hai district (figure 1) far from Cat Ba Island about 20km, is 23.9 ha (2000) to 155.5 ha (2007) (Tran Dinh Lan & Luc Hens, 2009). With specific character at Bach Dang estuary so rule of growth of hard clam (*Meretrix Lyrata*) is different from others such as Nam Dinh province, southern Viet Nam (Tien Giang province, Ben Tre province).

Nguyen Huy Yet et al. (2007) studied the growth rate of hard clam (*Meretrix spp.*) at Nam Dinh province which is central hatchery of hard clam in northern Viet Nam. The results show the significantly relationship between size and growth of hard clam (*Meretrix lyrata*). Truong Quoc Phu (1999) also showed the relationship between weight

and length of hard clam (*Meretrix lyrata*) following Von Bertalanffy formula which was the correlation among length and time (months old) with growth rate, and seasonable growth. With hard clam grown Bach Dang areas, especially estuary, there hadn't any result for rule of growth rate.

The result is signification highly in science that age of hard clam (*Meretrix lyrata*) is determined by size of shell (length, width or height). With hatchery of hard clam, the result evaluates growth rate to increase productivity.

## 2. Materials and methods

### 2.1 Materials

The article is a part of thesis at Ha Noi University of Technology: "Studying on capacity of bioaccumulation mercury of Hard clam (*Meretrix Lyrata*) at Bach Dang estuary, Hai Phong – Viet Nam". (Figure 1)

### 2.2 Methods

#### 2.2.1 Design of experiment

Tidal range in the studying area is around 2.5 to 3.2 m at spring - tide, and from 0.5 to 01m at neap - tide (Tran Duc Thanh et al, 2000). So the experiment was designed the following:

- Setup two areas (10m<sup>2</sup>) on surface to be perpendicular dike (Figure 2).
- Area 1 (symbol: **OTN**) in high tidal flat with 8 hour dry. Rate sand/ mud are 90:10.
- Area 2 (symbol: **AD**) in low tidal flat with 5 hour dry. Rate sand/ mud are 70:30.

#### 2.2.2 Measure size of hard clam

To measure the size of hard clam, we used Palmer meter according to hatchery manual of MCD (2009) (Figure 3 & Figure 4).

#### 2.2.3 Steps hatchery of hard clam

See Figure 5.

#### 2.2.4 Specific growth rate

30 individuals of hard clam are monthly sampled for each area. Hard clams are gathered in defined areas so their size are quite unity.

The result shows that rule of growth rate of bivalves is logarithm function (Truong Quoc Phu, 1999). Growth rate of hard clam in Nam Dinh province (*Meretrix meretrix*, *Meretrix lusoria*, *Meretrix lyrara*) between size and age is shown in the table (Nguyen Huy Yet et al, 2007). Result is shown by Excel 2003, relationship is logarithm.

The relationship between size (length, width or height) and age (months old) of hard clam is  $X = a \log Y + b$ . Use software Sigmaplot for Window Version 11.0 (Copyright 2008 Systat Software, Inc).

With: - X is size of hard clam (cm).

- Y is age of hard clam (months old).

- a and b are constant, are determined by experiment.

#### 2.2.5 Statistical analysis

To set up two areas of hatchery of hard clam distributed along sea level so growth rate of hard clam is deferent between two areas. Size's differences between hard clam breeding in two areas were tested by analysis of variance (ANOVA). If size of hard clam is different from two areas then to established function (size and age of hard clam) differently. If size of hard clam isn't different in calculation average size then hard clam at Bach Dang estuary was calculated with only a function. Statistical analysis was performed by use of the software Excel 2003 for Windows (Microsoft Office Excel, USA).  $F$  and  $F_{crit}$  (to determine by software Excel 2003) are parameter to access relationship two series of figure. If  $F > F_{crit}$  then supposition ( $H_1$ , series is different) is accepted or on the contrary supposition ( $H_0$ , series is not different) is accepted.

## 3. Result

### 3.1 Water quality (environmental conditions)

#### 3.1.1 Temperature

The figure shows that temperature of water at hatchery of flat change in according to two main climate reasons annually. Temperature is the highest in July (34°C), correlatively summer and is the lowest in Jan (15°C) (Figure 6).

### 3.1.2 Salinity

Salinity in Bach Dang water had characteristic of salt – brackish, widely fluctuated, changes from 5 - 30‰ and varied in two main seasons of year. In dry months, salinity of water was the highest (30‰). In rainy season, salinity of water was less than 10‰. (Figure 7)

### 3.1.3 pH

pH in Bach Dang estuary was changed from 6.4 to 8.3, average value is 7.6. pH were changed lightly during two main seasons of year. pH of water is median because the consequence of the interaction between freshwater and seawater (Figure 8).

### 3.1.4 Total suspended solid (TSS)

Content of TSS is often- high varied seasonally in the range of 159.1 - 1382.0 mg/l with average value of 667.2 mg/L. In day time, TSS was ranged from 195 to 935mg/l with average value of 440mg/l in dry season and of 159.1÷1382.2mg/l with average value of 666.0 mg/l in rainy season (Figure 9).

### 3.1.5 Fraction of tidal flat for hatchery

Kind of sediments is fine sand with rate of mud/sand (24:75). Character of tidal flat is suitable for hatchery of hard clam (MCD, 2009; Truong Quoc Phu, 1999; Nguyen Huy Yet et al, 2007).

## 3.2 Age of hard clam

Determination of age of seed hard clam is important to establish relationship between size and age of hard clam. It is necessary to discriminate age of hard clam and a period hatchery of hard clam. Age of hard clam = age of seed + the period hatchery of hard clam. Calculation of age of hard clam depends on reference materials and practical investigation (Table 1).

For example: To know a period of hatchery of hard clam in the field is 3 months so age of hard clam is 6+3= 9 months old.

Adult hard clam, size about 52 individuals per kg, is collect for processing food. Age of hard clam is 18 months old.

## 3.3 Rule of growth rate of hard clam

### 3.3.1 Size

To change size of seed hard clam to adult hard clam (a period is 12 months)

+ **OTN area** (Figure 10)

- To change average length of hard clam from seed ones (2.18cm) to adult one (3.78cm). Growth rate is 73%.
- With width, from 1.78 cm to 3.08cm, growth rate 73%.
- With height, from 1.1cm to 2.02cm, growth rate 88%.

+ **AD area** (Figure 11)

- To change average length of hard clam from seed ones (2.18cm) to adult one (4.32cm). Growth rate is 98%.
- With width, from 1.78cm to 3.51cm, growth rate 97%.
- With height, from 1.1cm to 2.3cm, growth rate 115%.

However, it is difficult to determine distribution of hard clam whether they live in high tidal flat or in low tidal flat so to calculate average size of hard clam to represent growth rate of hard clam at Bach Dang estuary (Table 2).

### 3.3.2 Growth rate

Relationship between whole weight of whole and length of average individual hard clam shows figure 12 and figure 13. Correlation of hard clam at OTN area is 0.96 and at AD area is 0.95. Correlation of hard clam is higher than 0.8 show relationship between average length of shell and whole weight is close (Figure 12 & Figure 13).

Use software Sigma Plot 11.0 to determine relationship between average length and ages of hard clam (Figure 14).

$$L = -28.6455 + 35.5797 * \ln(T) - 13.3596 * (\ln T)^2 + 1.7179 * (\ln T)^3$$

With:

- L: length (cm).

- T: age of hard clam (months).

Error was ranged from 0.17% to 7.54 %, all value is lower 5%, and except error of No.2 is 7.54% (Table 3).

### 3.3.3 Formula to determine age of hard clam

Analysis of variance of size (length, width or height) of hard clam at Bach Dang estuary shows that it is different from rule of length, width or height. So there are three functions to access change of growth rate and size (length, width and height) (Figure 15).

Use software Sigma Plot 11.0 to determine the functions between size and age of hard clam. Optimal kind of function was exponential growth (single, 3 parameters).

With: T is age of hard clam (month); L is length (cm); W is width (cm); H is height (cm).

To access error of 3 functions to choose the optimal function:

Error of function 1.3 between height of shell and age of month is 3.4 %, the lowest term, so this function determines growth rate following width of shell of hard clam (*Meretrix lyrata*) (Table 4).

This formula was applied for hard clam (*Meretrix lyrata*) at Nam Dinh province (Table 5). If age of hard clam is over 6 months then error of result is under 12.3 %.

With hard clam at Bach Dang estuary in 2009 and 2011, error of function 1.3 is under 9.1% (Table 6). The result shows that function 1.3 can apply to determine age of hard clam which was hatchery at Bach Dang estuary.

## 4. Discussion

### 4.1 Rule of development of hard clam at two areas (OTN and AD)

Growth rate of hard clam in two areas is different, hard clam's growth in AD area has grown faster than that in OTN. Maximize of shell at AD area is 1.14 times higher than the size of hard clam in OTN. Hard clam at AD area can develop and reach bigger size (Figure 11). Hard clam at OTN have threshold stably, if to bring additionally up then hard clam can not grow (Figure 10). Because tidal regime at two areas are different so hard clam was affect time of feed. Hard clam at AD area spends 19 hours to filter food and one at OTN is only 16 hours.

It is important to choose tidal flat of hatchery of hard clam that: low flat or tide fill with 18-19hours. That is recommendation of Hatchery hard clam (*Meretrix Lyrata*) manual (MCD, 2009).

### 4.2 Rule of development of hard clam

The result shows that there are 3 stages of development of hard clam. Stage 1 was from June, 2010 to Sept, 2010 which hard clam grows very fast. Stage 2 was from Oct, 2010 to Jan, 2011 which hard clam was stable and grew slowly. Stage 3 was from Feb, 2011 to May, 2011 which size of hard clam was faster than stage 2 and grew slowly.

#### 4.2.1 Stage 1

The size of hard clam was measured after one month brought up from seed shown that growth's rate is different in serial data (Figure 10, 11). This is a period to seed of hard clam to harvest them in the living environment at Bach Dang estuary. In this stage, hard clam grows quickly. It is remarked by growth line on the shell (Figure 16).

This period is the raining season with nutrient's resource plenty from continent. Average content of TSS in the months (July, August and Sept) was ranged of 731- 875 mg/l, maximum value of 1382 mg/l (Figure 9).

#### 4.2.2 Stage 2

The stage 2 shows that hard clam was affected by the changing of water quality like flow, nutrient. Pink gland was detected when internal anatomy (Figure 17). Pink gland is ox's horn of shape, transparency and 1cm long. Probability of pink gland in the internal anatomy of hard clam (*Meretrix lyrata*) is 98%. This is signed to indicate slow exchange of current when at the top of flood-tide (Truong Quoc Phu, 1999).

A period in stage 2 is dry season. Nutrient transported by the flow is so poor at the water quality. Content of TSS at (Nov, Dec) is range 255 -392 mg/l, lower the mean value of all times to survey.

The solution for hard clam adapt to circumstance like that:

- To decrease density of hard clam where ones distribute crowded.
- To transport hard clam from high side to low side in hatchery of tidal flat.

### 4.2.3 Stage 3

This stage was from Feb, 2011 to May, 2011 that hard clam was collected for food. Hard clam developed faster than ones in stage 2, weight of hard clam was about 52-68 individuals per kg. Especially in March (Feb in lunar calendar) and April (March in lunar calendar) hard clam was dead by suddenly exchange of habitat or other reasons (MCD, 2009). In this stage, it is dizzy weather so hard clam was steeped in freshwater to be dead. Temperature, pH and Salinity in day wavered strongly (Figure 6, 7 and 8).

MCD recommends fishery that do not start hatchery of hard clam in this period. So the moment of hatchery of seed hard clam at Bach Dang estuary is from end of May to the beginning June (April – May in lunar calendar) annually.

### 4.3 Growth rate

The result of article shows that significant positive relationship between size and age of hard clam ( $R^2 = 0.95$  or  $0.96$ ). Hard clam develops very fast in stage 1 and slowly in adult growth. While length don't develop at all then weight of whole hard clam increase regularly. *'a to determine age of hard clam*

Formula is easy to determine age of hard clam at Bach Dang estuary. This formula applies for hard clam at age over 5 months old. We review the formula with hard clam at Nam Dinh province (Table 5) show that formula is suitable with age of hard clam at age after 6 months old. Review of formula with hard clam at Bach Dang estuary in 2009 and 2011, error is 2.9% and 9.1% respectively (Table 6). So this formula can be applied to determine ages of hard clam living in Bach Dang estuary.

## 5. Conclusions

Growth rate of hard clam at Bach Dang estuary distinguished from other estuaries as unique local properties of seasons, flow, nutrient regime and altitude of tidal flat. Rule of growth rate was divided into several stages with logarithm rule.

Hard clam living in high tidal flat grows slower than ones in low tidal flat. Relationship between length and ages is formulated:  $y = -28.6455 + 35.5797 * \ln(x) - 13.3596 * (\ln(x))^2 + 1.7179 * (\ln(x))^3$ . The rule is suitable with previous research.

To determine ages of hard clam at Bach Dang estuary based on size of shell (length, width or height) that formula:  $T = 5.2681 + 0.0307e^{1.4882L}$  (1.1) =  $5.6824 + 0.0167e^{1.9971W}$  (1.2) =  $5.5676 + 0.0386e^{2.6636H}$  (1.3). Of which formula 1.3 is the most correct.

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Table 1. Development stage of hard clam from embryonic stage to seed

STT	Stage	Size	Time of hatchery	Ages (months old)
1	Embryonic stage to kind of seed 1 <sup>(1)</sup>	Size of kind of seed 1 is 5.10 <sup>5</sup> -6. 10 <sup>5</sup> individual per kg.	1 month	1
2	Stage of Cultivate sampling 1: Kind of seed 1 to kind of seed 2 <sup>(2)</sup>	Size of kind of seed 2 is 2.10 <sup>4</sup> -3. 10 <sup>4</sup> individual per kg.	1 month	2
3	Stage of Cultivate sampling 2: Kind of seed 2 to kind of seed 3 <sup>(2)</sup>	Size of kind of seed 3 is 2.10 <sup>3</sup> -3. 10 <sup>3</sup> individual per kg.	2 months	4
4	Stage of Cultivate sampling 3: Kind of seed 3 to kind of seed 4 <sup>(2)</sup>	Size of kind of seed 4 is 400-500 individual per kg.	2 months	6

(1): Chu Chi Thiet and Martin S Kumar (2008).

(2): MCD (2009).

Table 2. Average size of hard clam at Bach Dang estuary

Age (months old)	Average length (cm)	Average width (cm)	Average height (cm)	Average whole weigh (g)
6.0	2.2	1.8	1.1	2.5
6.9	2.4	1.9	1.2	5.0
7.9	3.1	2.5	1.6	7.5
9.0	3.3	2.7	1.7	9.4
9.9	3.4	2.8	1.8	10.2
11.0	3.6	3.0	1.9	13.0
12.1	3.7	3.0	2.0	13.9
13.2	3.7	3.0	2.0	13.9
13.9	3.7	3.0	2.0	14.6
15.1	3.9	3.2	2.1	15.8
16.3	3.9	3.2	2.1	15.9
17.2	4.0	3.3	2.2	17.3

Table 3. Error length of hard clam of between practical size and calculable size

Error	No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10	No.11	No.12
%	4.00	7.54	2.67	1.11	0.51	1.01	0.49	1.52	1.06	0.17	0.56	1.08

Table 4. Error age of hard clam of between practical size and calculable size

STT	Error following (1.1) (%)	Error following (1.2) (%)	Error following (1.3) (%)
1	0.9	4.4	4.0
2	7.4	6.5	7.2
3	4.1	0.3	1.3
4	4.3	1.6	2.3
5	3.9	1.9	1.4
6	5.0	8.5	3.8
7	2.3	4.4	4.9
8	5.3	5.3	2.9
9	4.8	6.2	4.2
10	1.3	0.4	3.0
11	3.6	3.4	2.3
12	4.4	2.8	3.4
Average	4.0	3.8	3.4

Table 5. Ages of hard clam (*Meretrix lyrata*) at Nam Dinh province

Ages (months) <sup>(1)</sup>	Height (cm) <sup>(1)</sup>	Ages*(month)	Error (%)
3	0.08	5.6	87.2
4	0.55	5.7	43.4
5	0.69	5.8	16.2
6	0.98	6.1	1.6
7	1.11	6.3	9.7
8	1.36	7.0	12.3
9	1.63	8.5	5.3

Table 6. Review of formula 1.3 with hard clam in 2009 and 2011 at Bach Dang estuary

Time	Height (cm)	Ages (months)	Ages* (month)	Error (%)	Note
August, 2009	2.07	15.6	15.14	2.9	Le Xuan Sinh et al, 2010
May, 2011	1.03	5.7	6.17	9.1	Seed hard clam of crop (2011 -2012)
July, 2011	1.20	7.0	6.51	7.0	After seed clam of crop 2 months (2011 -2012)

Age\* was calculated by  $T = 5.5676 + 0.0386e^{2.6636H}$

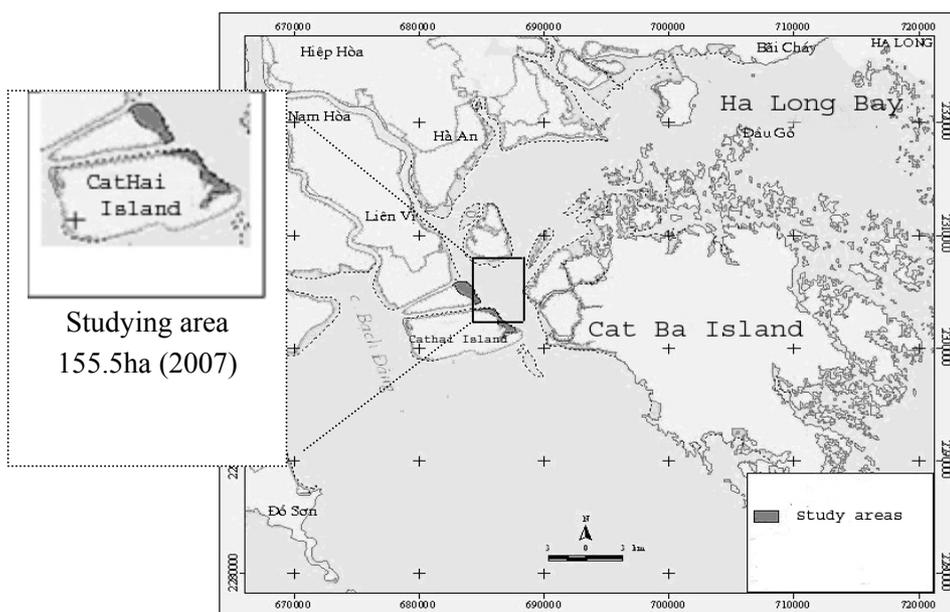


Figure 1. Area of hatchery of hard clam at Bach Dang estuary

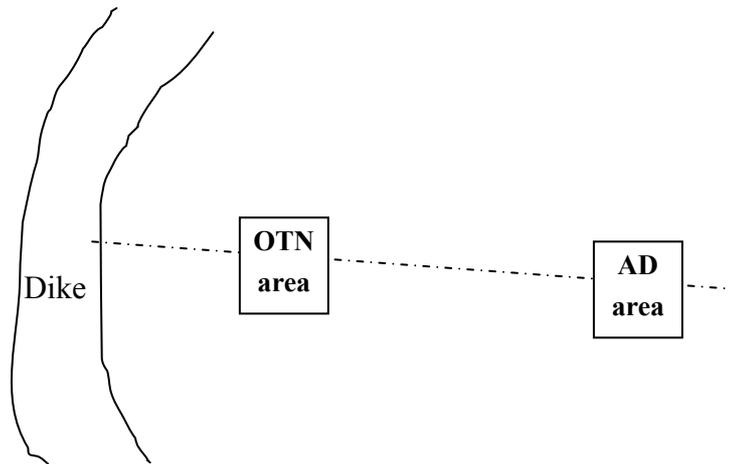


Figure 2. Setting up areas of experiment at Bach Dang estuary



Figure 3. The Palmer meter

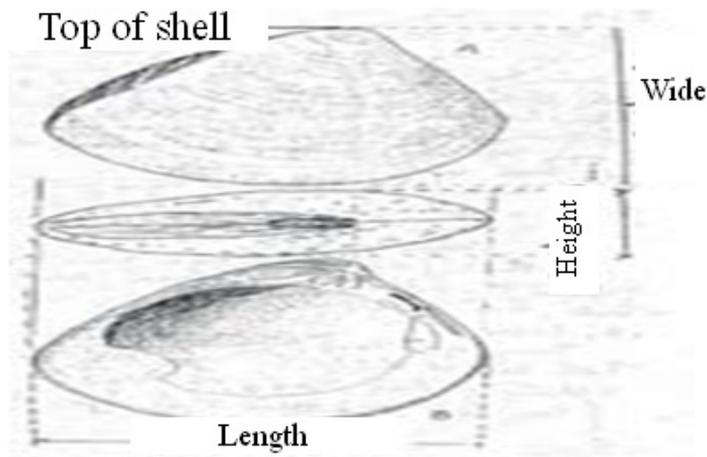


Figure 4. Size of hard clam (*Meretrix Lyrata*)

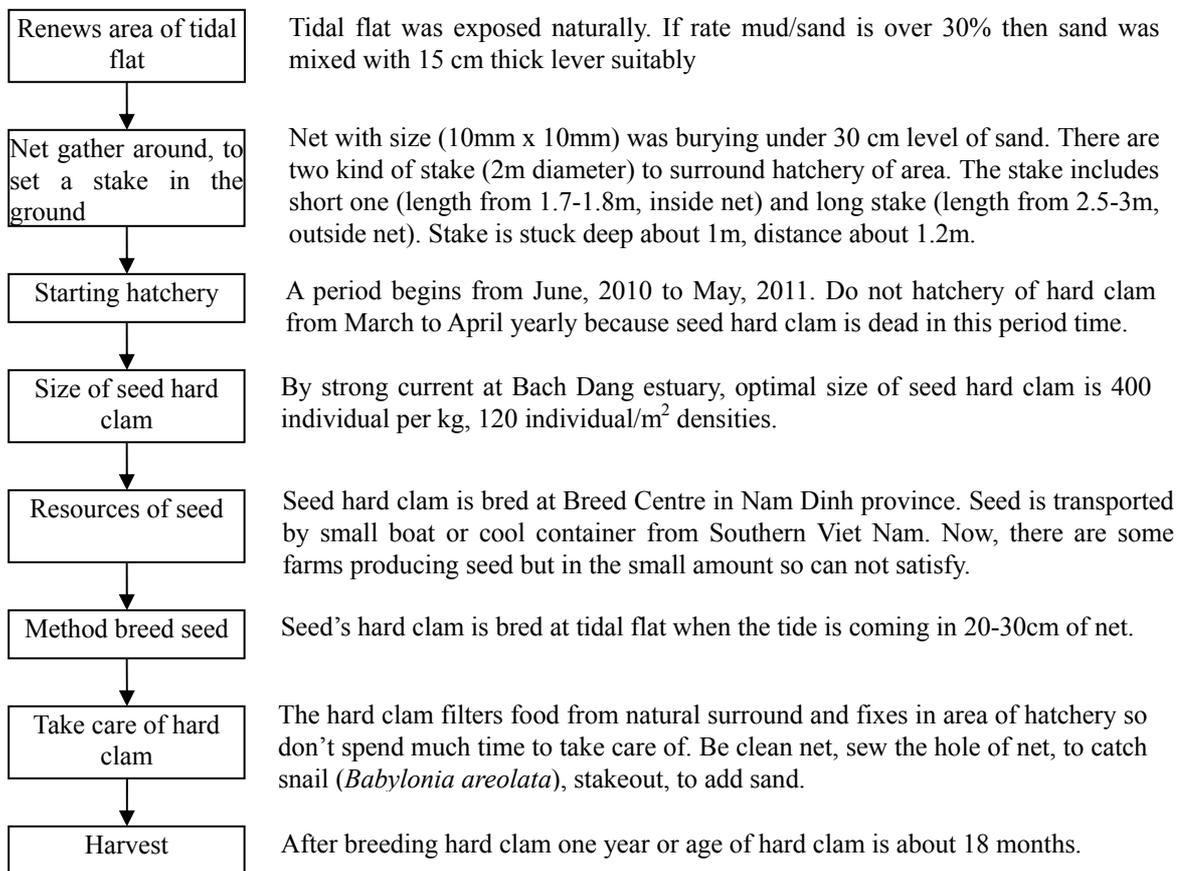


Figure 5. Steps hatchery of hard clam at Bach Dang estuary (Chu Chi Thiet and Martin S Kumar, 2008)

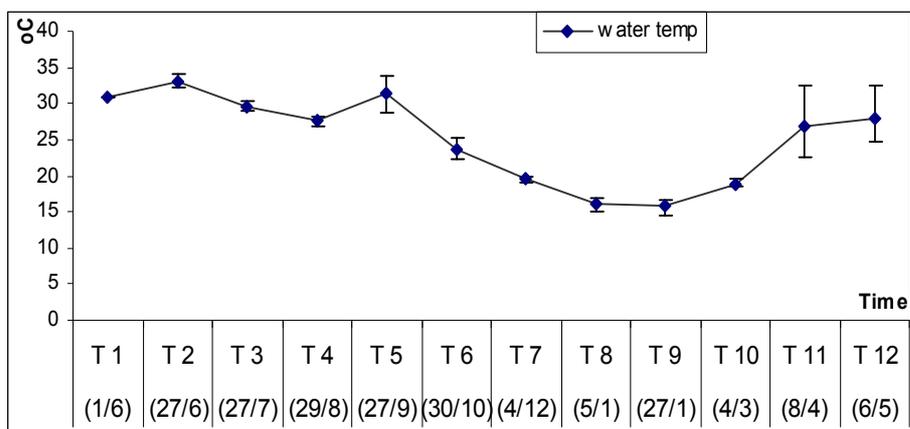


Figure 6. Variation of water temperature at Bach Dang estuary

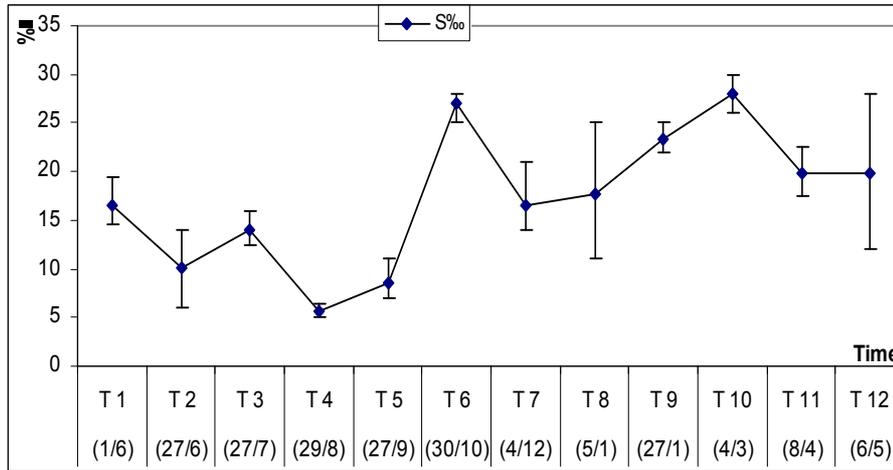


Figure 7. Variation of salinity at Bach Dang estuary

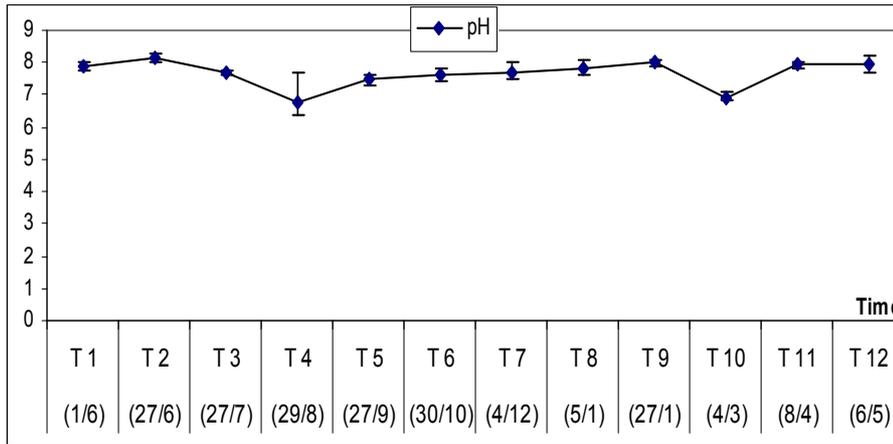


Figure 8. Variation of pH in water at Bach Dang estuary

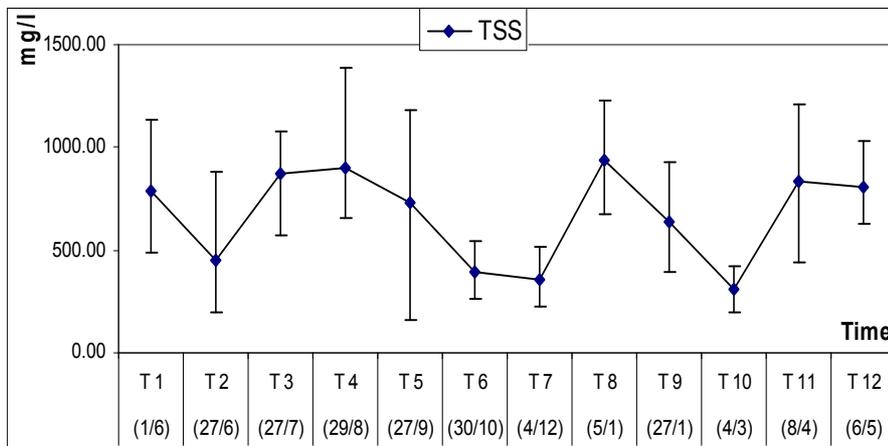


Figure 9. Variation of TSS in water at Bach Dang estuary

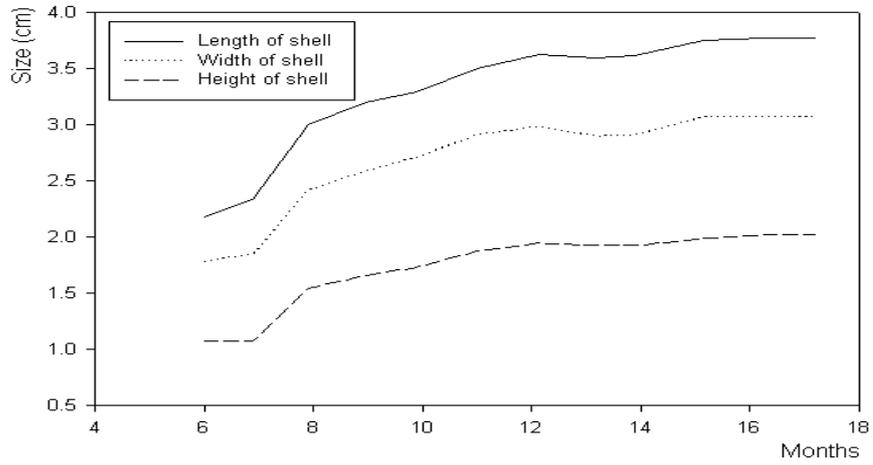


Figure 10. Variation of hard clam size at OTN area

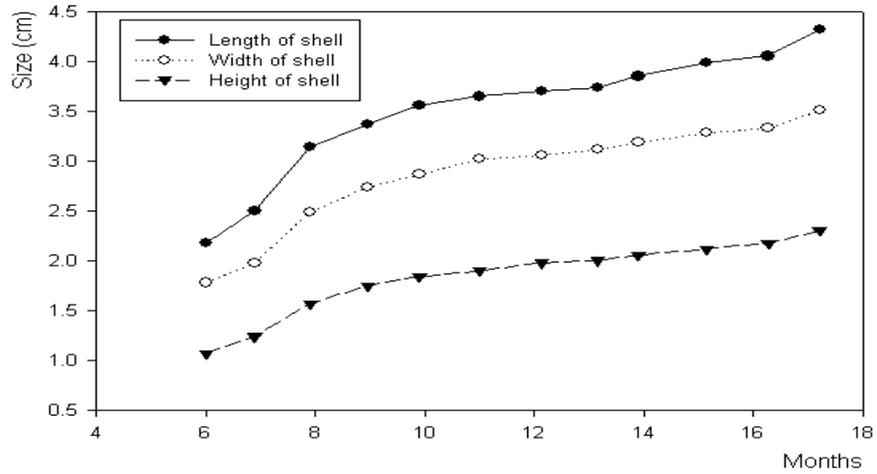


Figure 11. Variation of hard clam size at AD area

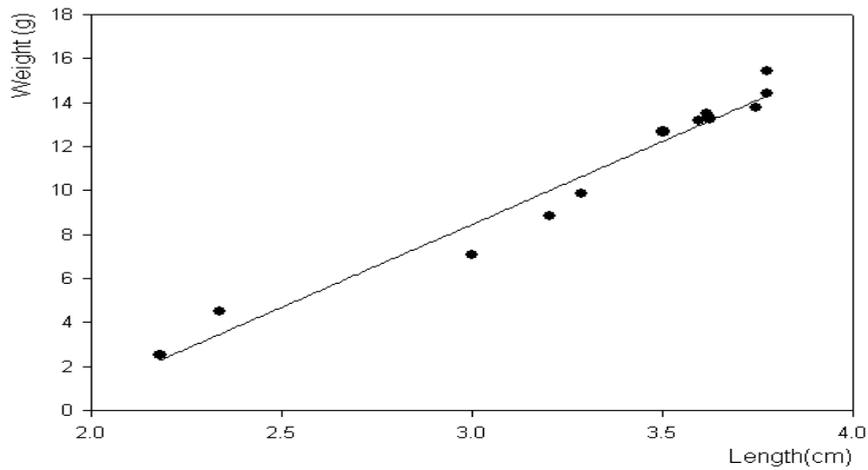


Figure 12. Relationship between length of shell and weight (g) at OTN area

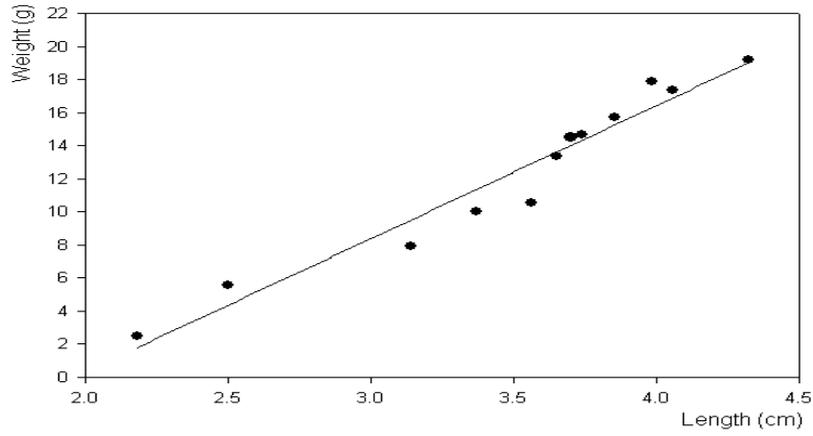


Figure 13. Relationship between length of shell and weight (g) at AD area

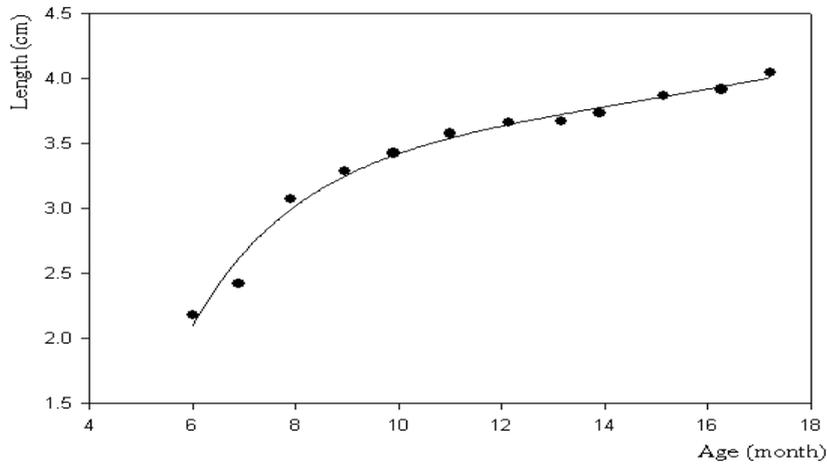
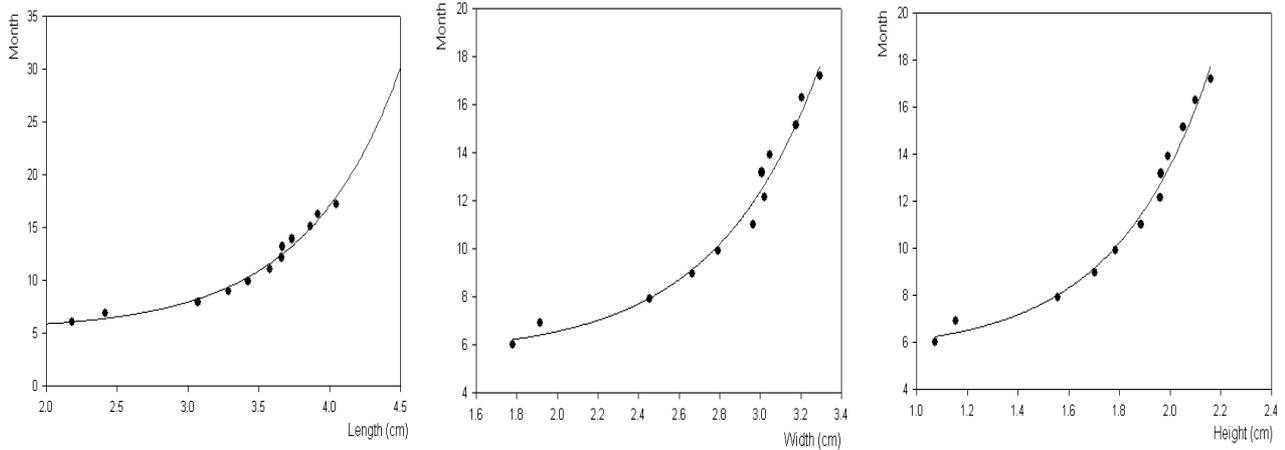


Figure 14. Relationship between length and age of hard clam



$$T = 5.2681 + 0.0307e^{1.4882L} \tag{1.1}$$

$$T = 5.6824 + 0.0167e^{1.9971W} \tag{1.2}$$

$$T = 5.5676 + 0.0386e^{2.6636H} \tag{1.3}$$

Figure 15. Formula between age and size of hard clam

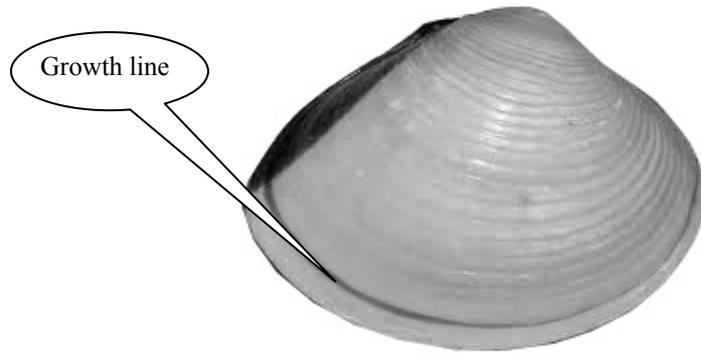


Figure 16. Growth line at shell of hard clam



Figure 17. Plink gland in internal anatomy of hard clam