GROWTH OF MANGROVE COCKLE *(ANADARA ANTIQUATA)* CULTURED IN CAGES

Jesaja A. Pattikawa and Elizabeth Ferdinandus
Faculty of Fisheries and Marine Sciences, Pattimura University
Kampus Unpatti, Jl. Mr. Ch. Soplanit, Poka Ambon 97233
E-mail : boypattikawa@yahoo.com
Received: 25 November 2008 Revised and Accepted: 14 October 2009

ABSTRACT

Study on growth of mangrove cockle (*Anadara antiquata*) was conducted in the intertidal area of Passo, Inner Ambon Bay. Three size-classes of 25 individual cockles were cultured in $1m^3$ cage. Length increment data was collected every two weeks for seven periods of observation. Relative growth rate, length-weight relationship and condition factor were estimated using formula proposed by Effendie, Pauly and King, respectively. The results showed that the small size had the highest length increment and relative growth rates while the large size had the best condition factor. Length – weight relationship showed isometric growth for all categories.

Keywords: Growth, condition factor, mangrove cockle, *Anadara antiquata*

INTRODUCTION

Ambon Bay which lies in Ambon Island-Maluku Province is a very productive waters and is divided into two parts, Inner and Outer Ambon Bay. The Inner Ambon Bay is a semi-closed waters, with an almost round shape and shallow (Wenno, 1986 cited *in* Pattikawa and Ongkers, 2002). Passo coastal waters which is located in the Inner Ambon Bay has rather dense mangrove trees and is inhabited by various marine biota such as fishes, crabs, prawns and molluscs.

Bivalves are the second largest group (after Gastropods) in the Mollusca phylum. One of its important genus is *Anadara* which is well known as *kerang* (Indonesia and Malaysia), *mangrove cockle* (England), *hoi-kreng* (Thailand) and *siham* (Suwignyo *et al.*, 2005). *Anadara antiquata* or locally known as *kerang bulu* is the most important species of the genus *Anadara,* live in the intertidal area particularly in muddy substrates in the estuaries.

Mangrove cockle is economically important because of its tasty meat and is traded for source of income by local community. Though it has been exploited, information about mangrove cockle particularly on its growth is very limited in Indonesia. Up to now, only one study on population dynamics of the species from Saparua Island, Central Maluku has been reported (Ayal, 2003).

Therefore, study on growth of mangrove cockle which consisted of growth rate, length-weight relationship and condition factor was conducted. It is expected that the results might give more information that could be used as a basis for the management of the resource.

METHODS

Research on growth of *Anadara antiquata* was conducted in the coastal waters of Passo, Inner Ambon Bay on August to October 2005. Length increment data was measured every two weeks to study growth of mangrove cockle. Seventy five individuals of mangrove cockle were collected randomly by hand and the length of shell and weight of each individual were measured. Length was measured from most posterior to the most anterior of the shell (Setyobudianto, 1997 cited *in* Ayal, 2003) using vernier caliper to the nearest 0.1 mm while total weight or live weight of individual cockle was measured to nearest 0.1 gram. Mangrove cockles measured were grouped (according to their shell length) into three categories, i.e. small (< 30 mm), medium (30 – 39.9 mm) and large (> 40 mm). Individuals of these three categories were returned to their habitat bordered by three wire

DOI: 10.14203/mri.v34i2.514

cages (1x1x1m in size) in which each cage was loaded with 25 individuals. Cages were used so that it would be easier to handle the cockle for measurement and to prevent predation or exploitation by local communities. Data of individuals died during investigation were not included in the analysis.

Growth rate

Growth rate analysis was based on the length increment every two weeks. Because the cockles were grouped based on the length of their shell, relative growth formula proposed by Effendie (1997) with slight modification was used:

$$h = (L_t - L_{t-1}) / L_{t-1}$$

Where :

- h = relative growth
- L_t = Length of shell at period t
- L_{t-1} = Length of shell at period t-1

Comparison of average growth rates between groups were analysed by one-way ANOVA. Subsequently, Tukey test was used to analyse differences between average growth rates.

Length-weight relationship

Relationship between length and weight were calculated using formula proposed by Pauly (1984):

$$W = a L^b$$

Where:

- W = weight (gram)
- L = Length (mm)
- a and b are constants

Growth pattern was determined using interval value of b at 95 % Confidence Interval as proposed by Sparre & Venema (1992):

$$b \pm t \times sb$$

Where:

- t = t_{table} (P=0,05; df=n-2)
- sb = standard deviation of b

Condition factor

Condition factor was analysed using formula of King (1995 cited *in* Pattiasina, 2003):

$$CF = \frac{\overline{W}}{W_{pred}}$$

where:

- CF = condition factor
- $\overline{W}$ = average weight of sample
- Wpred = $a L^b$ (prediction of weight based on length-weight relationship)
- L = average length of sample

RESULTS

Substrates in the study area were muddy sand and sandy mud with small gravels. Mangrove species commonly found in this area were *Rhizopora spp*, *Sonneratia spp* and *Bruguiera spp*. Water temperature and salinity during the research showed little variation ranging from 28.1 – 29.9 °C and 30 – 33 ppt, respectively.

Eight individuals (10:67%) from 75 cockles of small and medium sizes used in this research died during the first period of the observation. The percentage of dead individual was higher (24% or six individuals) in small categories, followed by medium categories. Possibly, these individuals died because of stress during handling for measurement. All of dead individuals were excluded from the entire analysis.

Size of shells and their standard deviation during periods of research are presented in Table 1. Standard deviation in this table showed that shell length of small individuals were more varied compare to the large and medium individuals. On the contrary, the weight of large cockles was more varied than the other two groups. Variation of shell length in small group and variation of weight in large group were caused by wider range of length (15.7 – 29.9 mm) in small individuals as well as wider range of weight in large individuals (21.1 – 51.6 gram) at the beginning of experiment. Averages of sizes in Table 1 showed that the highest size increment during research was represented by the small-sized group (4.1 mm) while for the weight were those of medium-sized group. However, the highest averages of relative increment were represented by the small-size group, i.e. 15.6% for length and 54.1 % for weight.

Length-weight relationships calculated from the three size class of cockle during research were presented in Table 2. Coefficient of correlation (r) indicating relationship between length and weight of the three groups ranged from 0.741 (large group, period 1) to 0.950 (small group, period 3). These values were larger than critical values of r at P=0.01 (df 17=0.575; df 21=0.526 and df 23=0.507). In other words, there is a highly significant relationship between length and weight of the cockles. In this case, the contribution of the length of shell to its weight ranged from 54.91% to 90.25%. Table 2 also showed the values of b which were ranged from 2.828 (period 6, large group) to 3,835 (period 2, medium group) and as whole was dominated by b > 3 (80.95%). However, the range of b at 95% Confidence Interval (p=0.05) showed that b = 3 was included in ranges of all size class during periods of research. Therefore, the values of b were not significantly different from 3 (b=3).

Growth of the three size class of mangrove cockles was presented in Figure 1. During the experiments, averages of relative growth of small, medium and large groups of cockle were 2.45, 1.17 and 1.12%, respectively. Small-sized cockles had larger average of relative growth compared to other class, with the highest relative growth occurred during the fourth period, *i.e.* 3.50%. Analysis of variance showed highly significant differences (P=0.0003) between averages of relative growth of the three size class. Subsequent analysis using Tukey test revealed that significant differences (P=0.05) of averages of relative growth occurred between small size and the large one and also between small and medium categories.

The values of condition factor of the cockle during this research were fluctuated in which the minimum and maximum values were represented by medium-size group, *i.e.* 0.83 (period 1) and 1.46 (period 6) (Fig. 2). As a whole, averages condition factor for small, medium and large groups were 1.17, 1.11 and 1.00 respectively.

DISCUSSION

Distribution of *Anadara* species is likely related to their preferred habitat. *Anadara antiquata* has a tendency to be associated with mangrove and it is found over variety of substrates, but is commonly found in muddy sands or sandy mud adjacent to mangrove (Tebano and Paulay, 2001). Soft substrates enable *A. antiquate* to burrow itself easily, while mangrove area provide abundant phytoplankton for their food.

Table 1. Range, mean ($\overline{X}$) and standard deviation (S) of shell of mangrove cockle (*Anadara antiquata*) during the research

Category	Period						
	1	2	3	4	5	6	7
Small (n = 19)*							
Length (mm)							
Range	15.7 – 29.9	16.4 – 30.3	16.9 – 30.8	17.6 – 32.6	19.1 – 33.6	20.5 – 34.0	21.0 – 34.7
$\overline{X} \pm S$	26.1 ± 4.5	26.5 ± 4.4	27.1 ± 4.3	28.0 ± 4.4	28.6 ± 4.2	29.4 ± 4.1	30.2 ± 4.1
Weight (g)							
Range	1.00 – 18.1	1.4 – 18.3	2.1 – 19.2	2.4 – 19.4	2.7 – 20.2	2.8 – 21.0	3.2 – 21.7
$\overline{X} \pm S$	7.3 ± 4.2	7.6 ± 4.2	8.1 ± 43	8.7 ± 4.4	9.8 ± 4.5	10.6 ± 4.7	11.2 ± 4.8
Medium (n=23)*							
Length (mm)							
Range	33.7 – 40.0	34.2 – 40.1	34.7 – 40.7	35.2 – 41.6	35.6 – 42.7	36.2 – 43.3	36.8 – 43.5
$\overline{X} \pm S$	38.1 ± 1.9	38.4 ± 1.9	38.9 ± 1.9	39.4 ± 1.9	39.90 ± 1.9	40.4 ± 1.9	40.9 ± 1.9
Weight (g)							
Range	10.6 – 30.3	10.9 – 30.9	12.2 – 31.3	13.8 – 31.7	14.2 – 33.3	15.2 – 34.3	16.2 – 35.4
$\overline{X} \pm S$	19.2 ± 4.4	19.9 ± 4.6	20.7 ± 4.5	21.4 ± 4.4	22.7 ± 4.5	23.8 ± 4.6	24.5 ± 4.6
Large (n=25)							
Length (mm)							
Range	41.9 – 50.1	42.1 – 50.5	42.2 – 50.7	43.1 – 51.2	43.3 – 52.0	44.4 – 52.6	44.7 – 53.2
$\overline{X} \pm S$	45.2 ± 2.3	45.7 ± 2.3	46.1± 2.4	46.6± 2.4	47.3 ± 2.4	47.9± 2.5	48.4 ± 2.4
Weight (g)							
Range	21.1 – 51.6	21.8 – 51.8	22.5 – 52.1	23.2 – 53.4	24.4 – 53.9	25.7 – 54.9	25.9 – 55.3
$\overline{X} \pm S$	33.9 ± 7.4	34.4 ± 7.5	34.8 ± 7.2	35,8 ± 7.2	37.3 ± 7.2	38.5 ± 7.2	39.1 ± 7.1

* = dead individuals are excluded from the entire analysis

In general, the calculated values of b in this research were found to be within the range of b value for most species of *Anadara* cited by Sahin *et al.* (1999). These data imply that *Anadara antiquata* has a similar growth pattern to other *Anadara* species. It was also found that the values of b were not significantly different from 3. These indicate that within the range of the shell sizes, growth pattern of the three categories of the cockles are isometric, *i.e.* weight increment is equivalent to the cubic system of length (Pauly, 1984; Sparre and Venema, 1992). Length-weight relationship is often used in fishery research when there is a requirement for statistical conversion from length to weight or *vice versa*, and to obtain condition factor which describes relative fatness or well-being of an organism (Effendie, 1997). Therefore, these results should be useful for biomass evaluation of this species.

It has been demonstrated by many authors that shell length is an important tool in estimating the growth of many fresh water and marine bivalves (Bailey and Green, 1988; Garton and Haag, 1991; Smith *et al.*, 1992). Based on shell length, the results of this research showed that relative growth was faster in small-sized or young individual cockles. It is generally known that growth of individuals is affected by internal and external factors. Among those, age, maturity and density are considered as important factors (Pauly, 1984; Harvey and Vincent, 1990; Effendie, 1997).

Table 2. Length-weight relationship of shell of mangrove cockle (*Anadara antiquata*)

Period	$W = a\ L^{b}$ (range of b at P = 0,05)		
	Small	***Medium***	***Large***
1	$W = 0.00005\ L^{3.606}$ (2.998 – 4.214)	$W = 0.00004\ L^{3.557}$ (2.299 – 4.814)	$W = 0.0001\ L^{3.264}$ (1.986 – 4.542)
2	$W = 0.00009\ L^{3.416}$ (2.839 – 3.992)	$W = 0.00002\ L^{3.835}$ (2.624 – 5.045)	$W = 0.0002\ L^{3.138}$ (1.920 – 4.357)
3	$W = 0.00005\ L^{3.054}$ (2.394 – 3.714)	$W = 0.00004\ L^{3.559}$ (2.407 – 4.711)	$W = 0.0003\ L^{3.080}$ (1.933 – 4.227)
4	$W = 0.0003\ L^{2.925}$ (2.180 – 3.669)	$W = 0.00008\ L^{3.392}$ (2.238 – 4.547)	$W = 0.0004\ L^{2.983}$ (1.868 – 4.098)
5	$W = 0.0004\ L^{3.162}$ (2.571 – 3.754)	$W = 0.0001\ L^{3.243}$ (2.134 – 4.532)	$W = 0.0003\ L^{3.075}$ (2.103 – 4.047)
6	$W = 0.0002\ L^{3.241}$ (2.632 – 3.850)	$W = 0.0001\ L^{3.262}$ (2.190 – 4.334)	$W = 0.0007\ L^{2.828}$ (1.875 – 3.783)
7	$W = 0.0003\ L^{3.106}$ (2.487 – 3.724)	$W = 0.0002\ L^{3.111}$ (1.996 – 4.226)	$W = 0.0005\ L^{2.915}$ (1.947 – 3.884)

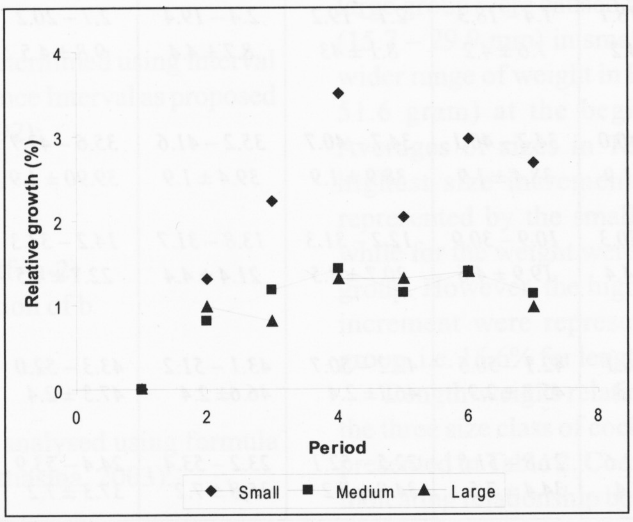

Figure 1. Relative growth of mangrove cockle (*Anadara antiquata*) during the research

According to Effendie (1997), in young individuals, almost all of the energy obtained from food is used for growth. On the other hand, in large and older individuals, only a small part of the energy is used for growth, while the rest is used for gonad development, spawning and maintenance. In addition, faster relative growth in cockles of small-sized is probably related to density. Ricker (1975) has reported that besides age as internal factor, there are also some external factors which can influence growth. Furthermore, Harvey and Vincent (1990) state that external factor which is important in determining growth is population density or number of individual that consume the available food. With lesser density of cockles in small-sized group, it is unavoidable that its relative growth is faster than medium and large groups.

Condition of an organism, i.e. its growth and survival which are represented by numbers, can be seen in the value of condition factor. During this study, the values of condition factor for the three categories of cockles were close to 1. Effendie (1997) stated that ideal condition of an organism is achieved when the value of its condition factor is 1.0, when the length increment is proportional to weight increment or weight increment is equal to the cubic of length (isometric growth). It has been described above that the values of b for all categories were not significantly different from 3 (b=3). However, analysis of condition factor revealed that only large-sized cockles have real isometric growth pattern. It is not surprising that by having ideal condition, all individual of large-sized group can survive until last period of research.

CONCLUSION

Mangrove cockles (*Anadara antiquata*) of small category have highest length and weight increment as well as relative growth. Length weight relationships of the cockles show an isometric growth pattern, while analyses of condition factors show that cockles of large group have ideal condition.

AKNOWLEDGMENT

We want to acknowledge anonymous referees for constructive criticism of the manuscript.

REFERENCES

Ayal, F. W. 2003. *Dinamika populasi kerang bulu (Anadara antiquata) pada perairan pantai Ihamahu, Kecamatan Saparua, Kabupaten Maluku Tengah*. Skripsi. Fakultas Perikanan dan Ilmu Kelautan, Universitas Pattimura, Ambon. 46 pp.

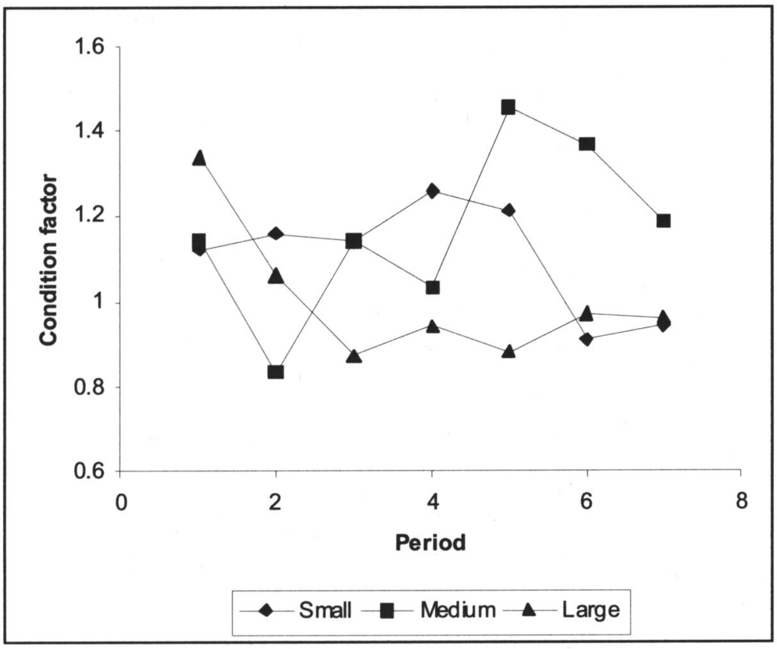

Figure 2. Condition factor of mangrove cockle (*Anadara antiquata*) during the research

Bailey, R. C. and R. H. Green. 1988. Within basin variation in the shell morphology and growth rate of a fresh water mussel. *Can. J. Zool.* 66:1704–1708.

Effendie, M. I. 1997. *Biologi Perikanan*. Pustaka Nusatama, Yogyakarta. 163 pp.

Garton, D. W. and W. R. Haag. 1991. Heterozigosity, shell length and metabolism in the European mussel, *Dreissena polymorpha*, from recently established population in Lake Eire. *Comp. Biochem. Physiol*. 99A:5–48.

Harvey, M. and B. Vincent. 1990. Density, size distribution, energy allocation and seasonal variations in shell and soft tissue growth of two tidal level of a *Macoma balthica* (L.) population. *J. Exp. Mar. Biol. Ecol*. 142:151–168.

Pattiasina B. J. 2003. Hubungan faktor fisk, kimia dan biologi perairan dengan pertumbuhan tiram mutiara *Pteria penguin* (Roeding) pada habitat mangrove, lamun dan terumbu karang. *ICHTHYOS*: *Jurnal Ilmu-Ilmu Perikanan dan Kelautan*, 2(1): 25–32

Pattikawa, J. A. and O. T. S. Ongkers. 2002. Dinamika populasi ikan puri putih (*Stolephorus indicus*) di teluk Ambon bagian dalam. *ICHTHYOS*: *Jurnal Ilmu-Ilmu Perikanan dan Kelautan*, 1(1): 42–47

Pauly, D. 1984. *Fish Population Dynamics in Tropical Waters: A Manual for Use with Programmable Calculators*. ICLARM, Manila. 322 pp.

Ricker, W. E. 1975. Computation and Interpretation of Biological Statistics of Fish Population. *Bull. Fish. Res. Board. Can.* 19: 191–382.

Sahin, C., E. Dusgunes, C. Mutlu, M. Aydin and H. Emiral. 1999. Determination of the growth parameter of the Anadara cornea R. 1844 population by the Bhattacharya method in the Eastern Black Sea. *Tr. J. of Zoology*. 23: 99–105.

Smith, H., A. Bij de Vaate and A. Fioole. 1992. Shell growth of zebra mussel *Dreissena polymorpha* (Pallas) in relation to selected physiochemical parameters in the Lower Rhine and some associated lakes. *Arc. Hydrobiol*. 124:257–280.

Sparre, P. and S. C. Venema. 1992. *Introduction to Tropical Fish Stock Assessment Part 1. Manual*. FAO Fish. Tech. Pap. 306/1. Rome. 376 pp

Suwignyo, S., D. Widigdo, Y. Wardiatno, and R. Krisanti. 2005. *Avertebrata Air*. Penebar Swadaya, Jakarta. 204 pp.

Tebano, T. and G. Paulay. 2001. Variable recruitment and change environment create a fluctuating resource: the biology of *Anadara uropigimelana* (Bivalvia:Arcidae) on Torawa Atoll. *Atoll Res. Bull*., 488:1–15.