Jornal of Coastal Development
Vol. 1, No. 2, February 1998: 151-163

ISSN : 1410-5217

THE APPLICATION OF VON BERTALANFFY GROWTH CURVE ON THE DEMOGRAPHIC STRUCTURE OF BIVALVAE POPULATIONS AT REMBANG WATERS, CENTRAL JAVA

Muhammad Zainuri

Marine Sciences Department
Faculty of Fisheries and Marine Sciences, Diponegoro University
Kampus Ilmu Kelautan Tembalang, Semarang. 50239. Indonesia

ABSTRACT

The determination of bivalvae demographic structure were conducted in Rembang Waters, Central Java. The samples were collected and observed in situ, from February to May, 1996 and covered 3 species, which are Mactra sp., Solen sp. and Pholas sp.

The Von Bertalanffy Growth Curve allows the determination of bivalvae population growth and their evolution. This is in regard to their presence according to sampling time and their abundances. The growth model was adjusted by several approaches, using the computer program, called DATAX. It was found that, the general pattern of bivalvae demographic structure was directly related to the ecological capacity and hydrodynamic factors of sampling area.

Keywords : demographic structure, bivalvae, growth model.

I. INTRODUCTION

Bivalvae population is one of the potential marine living resources in Indonesian waters. The bivalvae populations occupy habitat as diverse as estuaries, eelgrass and sandy coast ; and show an annually successives of their abundance (Rokhmin Dahuri *et al*, 1996). This flexibility makes the bivalvae populations excellent candidates for demographic analysis as their ecological success demonstrates that they are able to adapt to a wide variety of selective pressures.

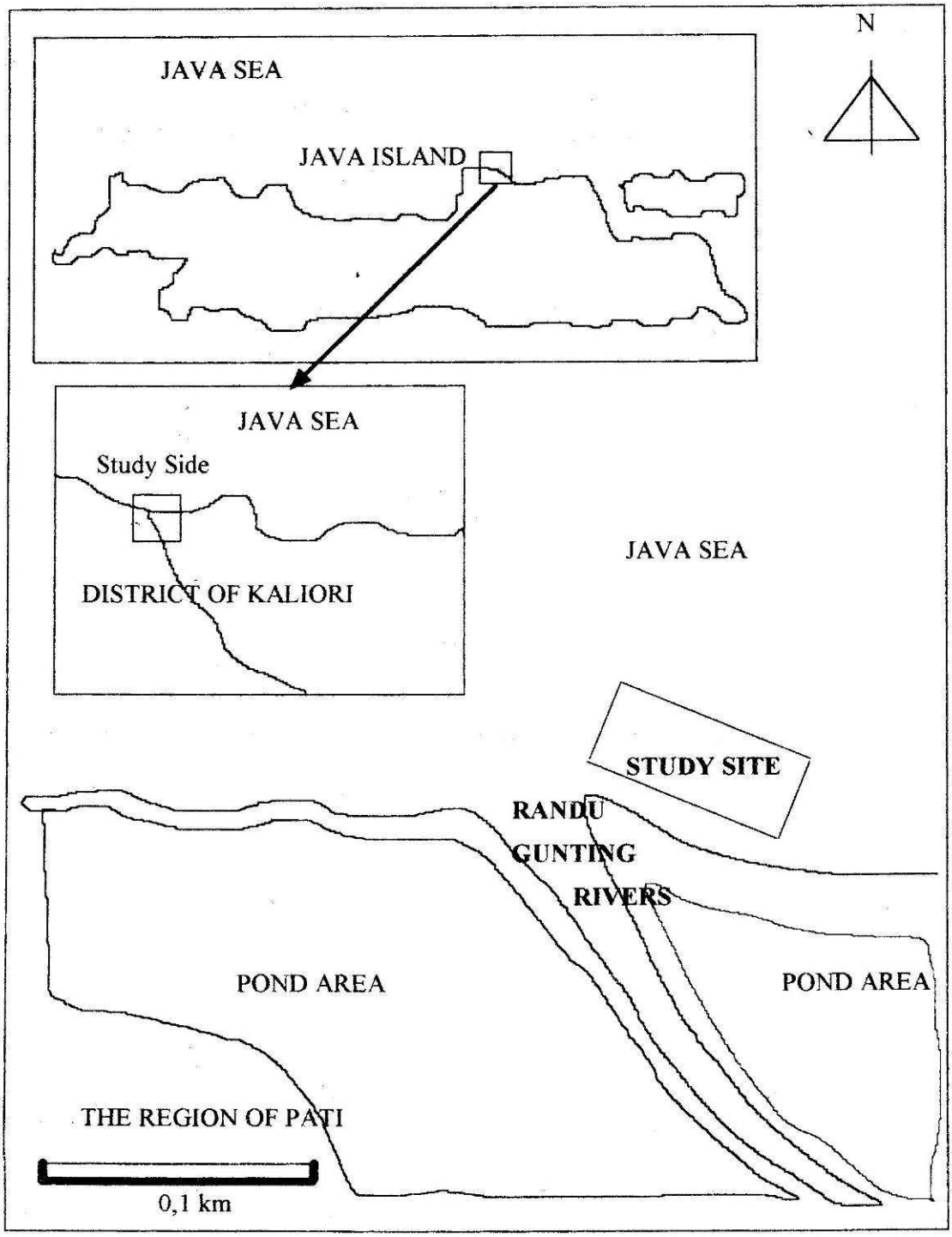


Figure 1. Location of Study Site (112° 4' E, 7° 13' S)

This study observes the aspects of the demography structure of the bivalvae populations inhabiting the Randu Gunting Estuaria, Rembang Waters, Central Java. Base on the demographic structure, the purpose of the study was to develop a general method of measuring growth increments, especially stock-assessment aplication. In this regard, the Von Bertalanffy growth equation (Ricker, 1979) is of fundamental importance. Due to its widespread usage in the assessment model, parameter estimates for this equations provide an ideal complement to many of the length-based methods that are currently in use. The ultimate goal of this study was, therefore, to develop a methodology to estimate the von Bertalanffy growth parameters K and L_∞ of the bivalvae populations growth model by natural populations and *in situ* approach. Ideally, the approach should be general in its application, easy to implement, simple in its technical requirements, and cost effective.

II. MATERIAL AND METHODS

2.1. Description of the study site

The Randu Gunting Estuaria (112° 4' E, 7° 13' S) at Rembang Waters, Central Java, covers an area of about 185 ha. The study sites were located on intertidal mudflats, exposed during tides of 0.6 height or less. Seagrass, benthic algae and several coral reefs are present in small colony. An abundant and diverse macroinvertebrate fauna is also present. The environmental parameters were observed weekly.

2.2. Sampling

Sampling was conducted during ebbtides off a set of mudflat 0.6 height or less, as long as 20 - 50 meter of water line. Three species were used in the present study i.e, *Mactra* sp., *Pholas* sp. and *Solen* sp. 100 individuals for each species were collected and their length were measured in first sampling time. They were then put it in a cage with diameter of 60 x 60 x 50 cm^3 which fixed at the study site, for an *in situ* approach. The observations were carried out from March, 22 to June, 28, 1996 for two type of populations, the bivalvae from natural population (until 100 individuals) and the bivalvae which already put in a cage for an *in situ* approach. Samplings were done at weekly intervals for the first six weeks, and continued by three weeks intervals for three time measurements.

Abundance and length-frequency data were based on the number of each bivalvae taken from the natural population and in the cage (*in situ* approach). The reason to choose this approach, were, 1) the natural population of bivalvae were completely depopulated and then repopulated by several recruitments, that make the analysis of the abundance and construction of the growth model were completely difficult, especially for single population ; 2) the possibility to obtain a successive data of the individual and single population growth were easily realized by *in situ* approach using the cage, in order to separate from the repopulation by the other recruitments. A theoritical growth curve for the bivalvae population was calculated using the Von Bertalanffy equation (Ricker, 1975) :

$$L_t = L_\infty \{ 1 - e^{-K(t-t_o)} \}$$

where L_t is length at time t, L_∞ is the theoritical maximum length reached by sample stock, K is the Von Bertalanffy growth coefficient, t is age and t_o is the age at which the bivalvae would have had zero length had it always grown in the manner described by the equation. Values for L, K and t_o, were derive by the methods suggested by Ricker (1975), Do Chi (1978), Pauly (1980), Bebars (1981) and Zainuri (1993).

III. RESULT

Abundance of three genus bivalvae *Mactra* sp., *Pholas* sp. and *Solen* sp. in the study sites fluctuated successively as the function of time. A general trend was apparent with *Mactra* sp being numerous on small size (10 - 25 mm) in the first week of the sampling time (Table 1), while *Pholas* sp. and *Solen* sp. were already bigger (20 - 35 mm) (Table 3 & 5). Examination of the length frequency indicates that the entry of the new cohort occur in the sampling period. During the period of time, it seemed that two recruitments were being apparents. The first recruitment of *Mactra* sp seemed occurent four weeks before sampling time. The appeareance of successive recruitment of the three bivalvae occured in the fifth to ninth weeks after the first week sampling period (Table 1 - 6).

Table 1.

The length frequency data of *Mactra* sp. from natural populations, observed from March, 22 to June 28, 1996.

Length (mm)	Sampling Time (weeks)								
	1	2	3	4	5	6	9	12	15
11.00 - 14.99	16	10	7	7	4		8	4	7
15.00 - 18.99	25	24	18	15	10	3	5	3	10
19.00 - 22.99	16	32	28	15	14	12	11	12	7
23.00 - 26.99	7	13	15	25	16	17	6	23	11
27.00 - 30.99	8	4	11	12	20	20	10	14	17
31.00 - 34.99	4	2	5	10	11	18	13	14	21
35.00 - 38.99	6	4	9	8	9	13	18	15	9
39.00 - 42.99	8	5	4	3	8	9	10	6	12
43.00 - 46.99	6	3	2	2	3	6	11	7	6
47.00 - 50.99	4	3	1	3	5	2	8	2	
N	100	100	100	100	100	100	100	100	100

Table 2.

The length frequency data of *Mactra* sp. from cage (*in situ* approach), observed from March, 22 to June 28, 1996.

Length (mm)	Sampling Time								
	1	2	3	4	5	6	9	12	15
11.00 - 14.99	16	3	3	3	1				
15.00 - 18.99	25	19	15	10	7	6	2		
19.00 - 22.99	16	30	29	29	25	24	14	15	10
23.00 - 26.99	7	10	15	20	28	26	18	17	14
27.00 - 30.99	8	4	4	4	5	6	16	14	10
31.00 - 34.99	4	5	3	4	5	7	13	15	13
35.00 - 38.99	6	9	10	8	6	7	9	10	16
39.00 - 42.99	8	8	9	10	11	10	10	8	12
43.00 - 46.99	6	7	7	7	7	8	9	7	5
47.00 - 50.99	4	5	5	5	5	6	4	2	2
N	100	100	100	100	100	100	95	88	82

Table 3.

The length frequency data of *Pholas* sp. from natural populations, observed from March, 22 to June 28, 1996.

Length (mm)	Sampling Time (weeks)								
	1	2	3	4	5	6	9	12	15
11.00 - 14.99	2	3	6	8	9	10	10	5	11
15.00 - 18.99	4	2	10	13	14	11	8	19	17
19.00 - 22.99	2	4	13	12	13	10	13	16	10
23.00 - 26.99	6	12	15	14	10	9	20	12	14
27.00 - 30.99	29	22	25	12	15	11	14	8	19
31.00 - 34.99	22	19	17	20	18	13	7	13	10
35.00 - 38.99	5	10	6	8	11	15	8	10	8
39.00 - 42.99	17	11	4	7	5	12	6	9	6
43.00 - 46.99	12	12	2	4	3	6	6	8	5
47.00 - 50.99	1	5	2	2	2	3	8		
N	100	100	100	100	100	100	100	100	100

Table 4.

The length frequency data of *Pholas* sp. from cage (*in situ* approach), observed from March, 22 to June 28, 1996.

Length (mm)	Sampling Time								
	1	2	3	4	5	6	9	12	15
11.00 - 14.99	2	2	1						
15.00 - 18.99	4	4	4	3	1				
19.00 - 22.99	2	2	3	5	4	4	2		
23.00 - 26.99	6	6	5	4	6	5	5	3	1
27.00 - 30.99	29	25	26	26	26	25	17	17	12
31.00 - 34.99	22	25	24	25	25	24	18	15	11
35.00 - 38.99	5	6	7	6	7	9	16	20	17
39.00 - 42.99	17	17	17	18	17	18	15	14	13
43.00 - 46.99	12	12	11	11	12	12	17	15	21
47.00 - 50.99	1	1	2	2	2	3	4	5	6
N	100	100	100	100	100	100	94	89	81

Table 5.

The length frequency data of *Solen* sp. from natural populations, observed from March, 22 to June 28, 1996.

Length (mm)	Sampling Time (weeks)								
	1	2	3	4	5	6	9	12	15
11.00 - 14.99	2	2	3	4	5	7	14	30	10
15.00 - 18.99	1	9	8	10	9	11	18	23	13
19.00 - 22.99	13	17	12	11	16	12	28	20	11
23.00 - 26.99	16	21	16	13	17	15	8	8	19
27.00 - 30.99	29	10	10	15	16	20	7	5	21
31.00 - 34.99	27	16	16	12	15	11	8	7	10
35.00 - 38.99	7	13	20	17	10	8	8	4	7
39.00 - 42.99	3	8	8	12	8	10	5	2	5
43.00 - 46.99		2	4	4	4	3	4	1	2
47.00 - 50.99	2	2	3	2		3			2
N	100	100	100	100	100	100	100	100	100

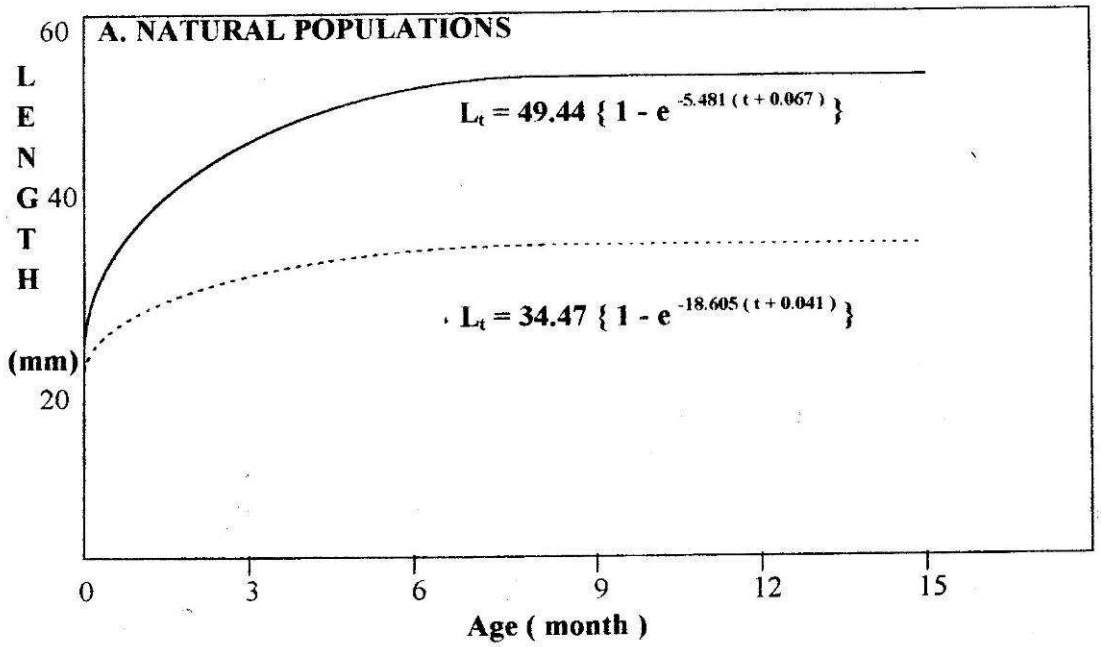
Table 6.

The length frequency data of *Solen* sp. from cage (*in situ* approach), observed from March, 22 to June 28, 1996.

Length (mm)	Sampling Time								
	1	2	3	4	5	6	9	12	15
11.00 - 14.99	1								
15.00 - 18.99	6	5	4	3	1				
19.00 - 22.99	10	12	11	12	12	13	8	4	1
23.00 - 26.99	18	16	15	14	16	16	12	8	6
27.00 - 30.99	28	27	29	28	24	21	17	14	10
31.00 - 34.99	32	29	26	26	24	25	17	13	10
35.00 - 38.99	2	4	5	5	6	6	15	19	14
39.00 - 42.99	1	2	3	4	6	7	8	10	17
43.00 - 46.99	1	3	4	4	5	6	6	3	5
47.00 - 50.99	1	2	3	4	6	6	7	2	1
N	100	100	100	100	100	100	90	73	64

Length and growth increments, Von Bertalanffy parameters and growth curve for each bivalvae populations are presented in Figure 2 to 4. The bivalvae population in Randu Gunting Estuaria was represented by three genus which greatly overlapped in length and growth. Growth appeared to increase from the first week to sixth until ninth week and relatively constant throughout the life-span. A comparison of weekly and three weekly model growth, also between natural populations and population in the cage shows almost complete concordance indicating that the Von Bertalanffy equation adequate to describes the growth pattern of the three genus of bivalvae in Randu Gunting Estuaria, Rembang Waters.

The environment parameters such as temperature, salinity, pH, transparancy and depth observed during the sampling periods are presented in table 7.



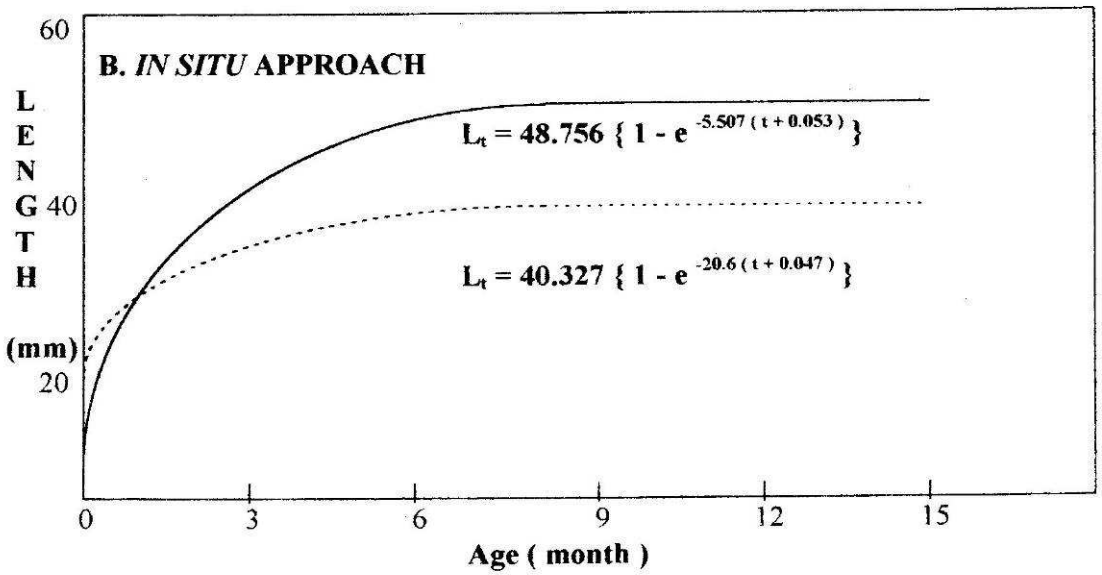
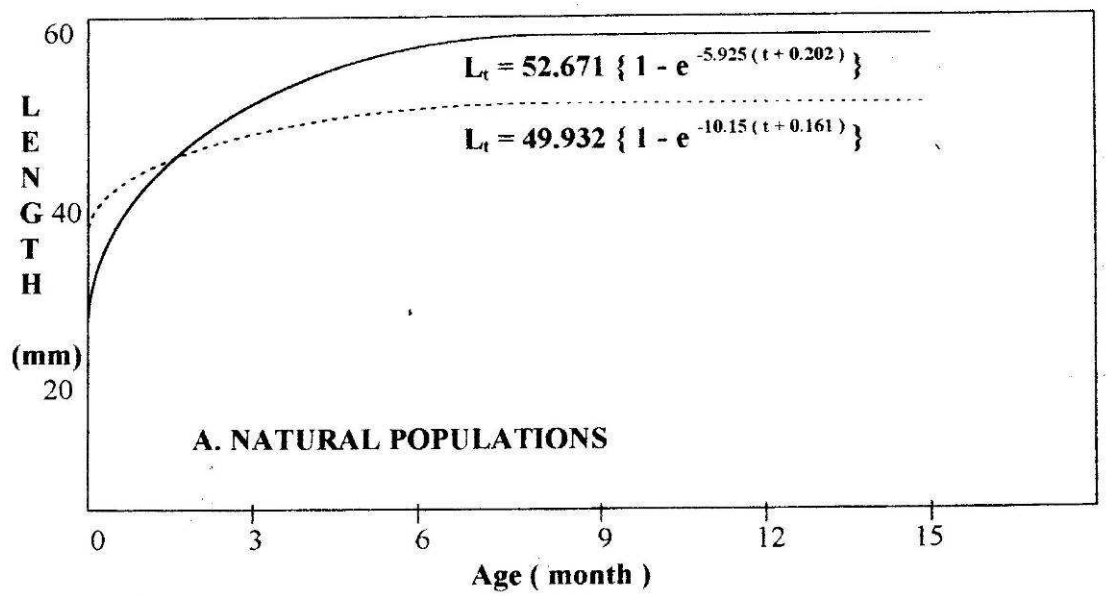


Figure 2.

The growth model of *Mactra* sp. (_____ = three week ; ------ = weekly) using Von Bertalaffy equation from natural populatios (A) and cage (B. *in situ* approach), observed from March, 22 to June 28, 1996.



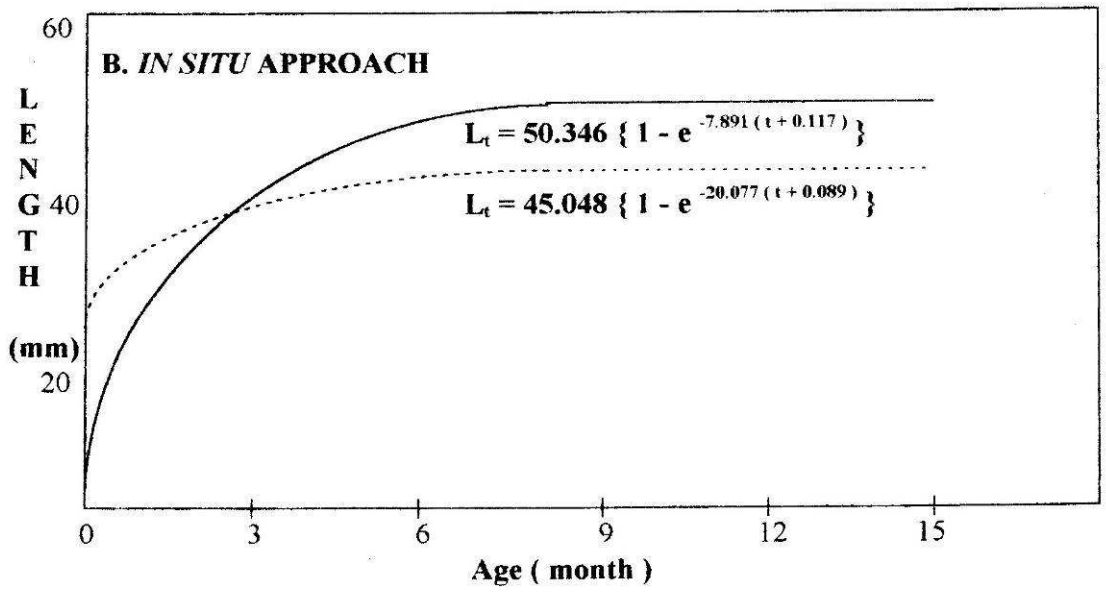


Figure 3.

The growth model of *Pholas* sp. (_____ = three week ; ------ = weekly) using Von Bertalaffy equation from natural populatios (A) and cage (B. *in situ* approach), observed from March, 22 to June 28, 1996.

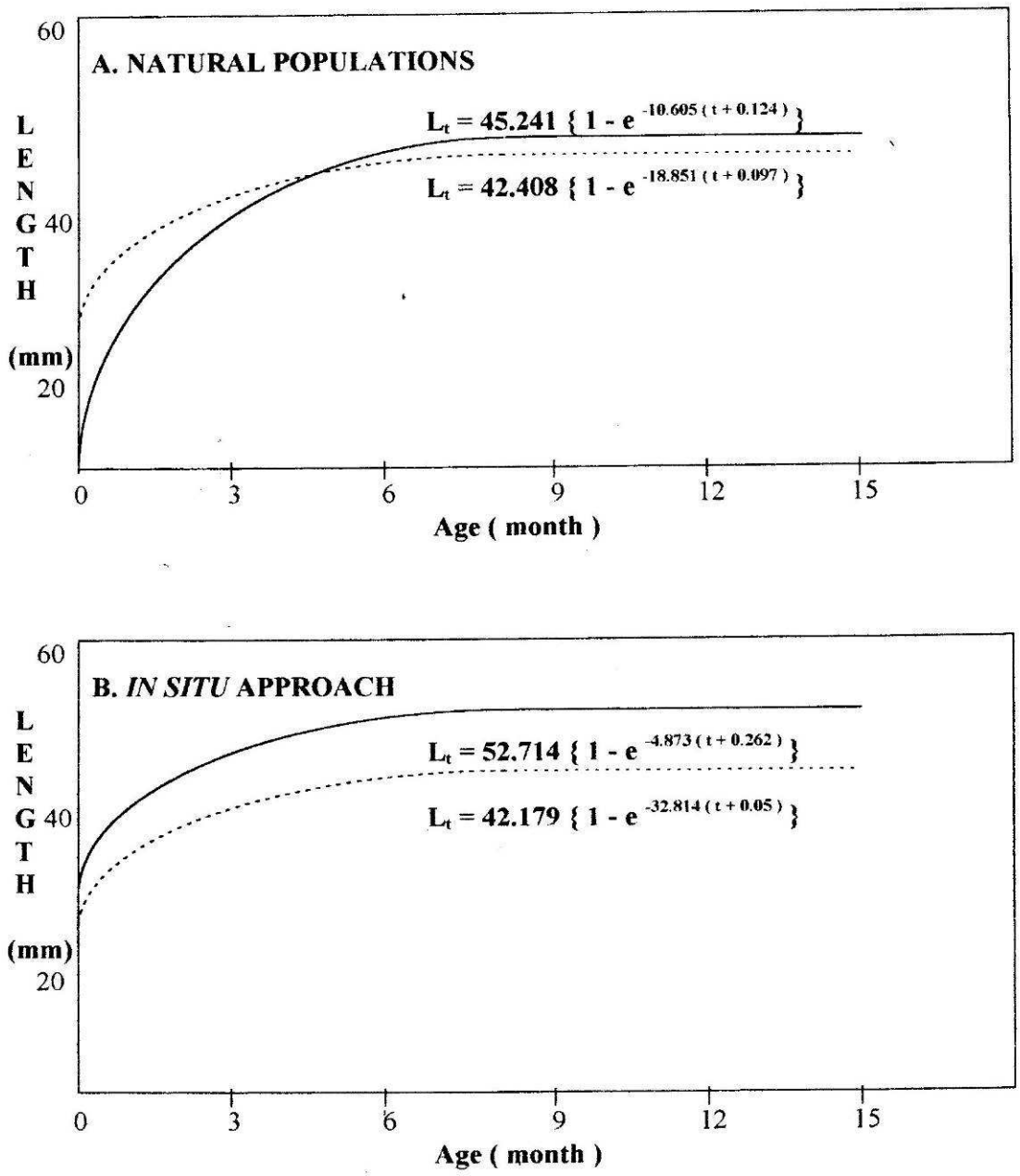


Figure 4.

The growth model of *Solen* sp. (_____ = three week ; ------ = weekly) using Von Bertalaffy equation from natural populatios (A) and cage (B. *in situ* approach), observed from March, 22 to June 28, 1996.

Table 7.

Environment parameters of Randu Gunting Estuaria, Rembang waters observed from March, 22 to June 28, 1996.

Parameters	Sampling Time								
	22/3	29/3	5/4	12/4	19/4	26/4	17/5	7/6	28/6
Temperature (°C)	28	30	29	29	30	30	26	25	26
Salinity (°/oo)	25	26	28	27	28	28	28	22	26
pH	7.6	7.6	7.8	7.8	7.8	7.7	7.8	7.5	7.7
Transparancy (cm)	3	7	8	5	10	7	4	5	6
Depth (cm)	56	65	65	60	50	70	80	70	65

IV. DISCUSSION

The abundance and growth of the three genus of bivalvae population in the sampled of Randu Gunting Estuaria, Rembang Waters exhibited seasonal cycles (Table 1 to 7, Figure 2 - 4). The environmental variables examined i.e. temperature, salinity and transparancy were the factor correlated with population size and their recruitment. Salinity was probably influenced by freshwater inflow from Randu Gunting Rivers. It was also important to note that during the end of April, the turbulence of sea water current and freshwater inflow were strongly present.

In the *Mactra* sp., the seasonal abundance remained constant. While the populations of *Pholas* sp. and *Solen* sp. were fluctuated, and caused by recruitment of new cohort. The environmental variables, especially temperature and transparancy, played important role on the primary productivity. In consequence, the avalaibility of food for the bivalvae populations stimulated their growth and the appearence of new cohort. In contrast, observation *in situ* showed an inter and intra population competition, indicated by the reduction of number survivorship for the three genus. This was also due to the surface of the cage and their mesh size. Even, if this observation was only to isolate the population observed from the influence by new cohort, but the data showed a good relation to control the natural populations.

In natural conditions, the pattern of bivalvae population recruitment in Randu Gunting Estuaria was clear, even it was limited only four month of the observation period. In tropical region, Zainuri (1994) and Rokhmin Dahuri *et al* (1996) stated that the month of March to June, were the optimal period for the recruitment of the marine living organisme, examined by their result of meroplankton.

The growth model of Von Bertalanffy applied to length frequency data of the bivalvae population in Randu Gunting Estuaria presents an effort of estimation. The three genus observed in this study had a relatively short lifespan, reaching an age of 15 month (2 years ?). At first, growth of the three genus were rapid with approximately fifty percent of the growth in length being achieved at the end of the first year. Growth rate then decreased from the second year. In case of *Mactra* sp., the model growth of three week observations was similar between natural populations and population in the cage (*in situ* approach). It could be inteprated that the populations of *Mactra* sp., could resist of the environmental influence for a relatively long period, but not in a short period as shown in the model of weekly observations.

The same phenomena was also sound for the populations of *Pholas* sp. Contrarely with *Mactra* sp., the populations of *Pholas* sp. showed an overlapped model between weekly and three week observations for both the natural populations and in the cage. The first three months of their lifespan probaly, was the critical period to remain a constant growth for the rest of their life. It was also noted that the constant growth were started at age of six month.

The population of *Solen* sp. showed an excellent growth model for the weekly observations. In general, however, this genus was the weak one, base on their survivorship. The model obtained was difficult to interprated and give some bias.

REFERENCE

Bebars, M.I. 1981. Exploitation Rationelle des Pecheries Egyptiennes : Application aux Pecheries des Sardinelles (*Sardinella aurita*, Valenciennes, 1847) de la Baie du Salloum, Egypte. These de Doct. Etat, Univ. Sci. Tech. Languedoc, Montpellier, 354p.

Do Chi, T. 1978. Modeles Cinetiques et Structuraux en Dynamiques des Populations Exploitees. Application au Squilles, *Squilla mantis* L (crustaces stomatopode) du Golfe du Lion. These de Doct. Etat, Univ. Sci. Tech. Languedoc, Montpellier, 272p.

Pauly, D. 1980. An Objective Method for Determining Fish Growth from Length-Frequency Data. *ICLARM News-letter*, 3 (3) : 13 - 15.

Ricker, W.E. 1979. Handbook of Computation for Biological Statistics of Fish Populations. *Fish. Res. Board. Can. Bull.* 191 : 1 - 132.

Rokhmin Dahuri, Jacub Rais, Sapta Putra Ginting & J. Sitepu. 1996. Pengelolaan Sumberdaya Wilayah Pesisir dan Lautan Secara Terpadu. Pradnya Paramita. 305 hlm.

Zainuri M. 1993. Structures des Peuplements Ichtyologiques D'une Zone D'herbier a *Zostera marina* de L'etang de Thau (France). Etude de la Composition Alimentaire des Juveniles du Loup (*Dicentrarchus labrax*, Linnaeus, 1758), de la Daurade (*Sparus aurata*, Linnaeus, 1758) et du Muge (*Chelon*

labrosus, Risso, 1826) par des Approches Experimentale. *These de Doctorat. Univ. Montpellier II - Scie. Tech. du Languedoc*. 315p.

Zainuri, M. 1994. Siklus Nycthemeral Kelimpahan dan Biomassa Zooplankton di Padang Lamun *Zostera marina*. *Majalah Penelitian*, Lemlit- Undip. VIII (23) : 64 - 77.