

# **Proceedings of International Seminar on Biological Sciences**

***“The Role of Biological Research in the  
Development of Science, Technology and Sustainability of Natural  
Resource Management”***

**17<sup>th</sup> October 2015  
North Sumatera, Medan  
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## Preface

The Biology Department at the University of Sumatera Utara sponsored an International Seminar on Biological Sciences on 17 October 2015. The one-day conference entitled, “The Role of Biological Research in the Development of Science, Technology and Sustainability of Natural Resource Management” was held at the luxurious SantikaDyandra Hotel and Convention Center in the heart of downtown Medan, Sumatera. The conference included 5 keynote addresses from speakers throughout the world including the USA, UK, Indonesia, and Germany. In the afternoon, there were concurrent sessions with speakers from throughout Indonesia and Thailand.

North Sumatera is the ideal location to hold an international scientific conference focused on the biological sciences. Some of the world’s most diverse rain forests are located on Sumatra, which is the world’s third largest island and home to thousands of unique species. I think one of the key highlights for me was hearing from Dr. Ian Singleton and Matt Novak of the Sumatran Orangutan Conservation Programme. They specialize in the protection of primates in Sumatra and they are the world’s leading authorities on Orangutans and other primates on the island. We all learned that much of Sumatra’s biodiversity is threatened by habitat destruction (particularly for palm oil and pulp or paper concession), and human persecution and this needs to stop immediately to protect the region’s biodiversity.

This is an unfortunate situation that the international community is watching and that could be rectified with assistance and pressure from the scientific community. There is an urgent need to stop the decline of loss of critical native forested regions on Sumatera. This is a key educational issue for young biologists in Sumatera, thus there is a pressing need for scientific community to gather to learn about issues facing biodiversity in North Sumatera and other regions of Indonesia. This recent international conference was an important gathering to continue the education of the nation’s biological community. It was a chance for biologists from around the world to interact with young scientists from North Sumatera.

There were a number of highlights of the conference for me. First, I was amazed by the grandeur of the opening ceremonies. I have never been to a meeting where the conference was initiated by such spectacular, graceful dancers in exquisite, colorful costumes – it was pomp and circumstances that I will never again experience at that level in my lifetime. Second, the members of the audience were attentive and seemed to be extremely interested in all the talks. Third, all the students in the audience were excited about the chance to take a photo with all the speakers – I do not think I have ever had my photo taken so many times as I did with students from North Sumatera.

There were 22 papers that were submitted as written proceedings for this conference. One of my roles as an active participant in the conference was to critically evaluate some of these papers. This is standard practice at international conferences to have the proceeding peer-reviewed. All papers were written in

English. I can only imagine the challenges of trying to write an article in another language, but for the papers I read the author's did an excellent job. The authors were articulate, and wrote about some interesting research they were conducting. The range of topics was covered by the talk was immense – ranging from studies of the distribution and abundance of mosquito larvae in villages near Medan to a summary of local wisdom for the managing mangroves. Thus, the conference represented a broad spectrum of biologists and topic areas from throughout the region.

Overall, the conference was a grand experience and something that I will never forget. It was a chance for biologists from throughout the region to interact, a chance for young scientists to learn about pressing issues facing Indonesia and the planet, a chance for biologists to gain experience presenting in front of an international audience in English – so that in the future they can present at other international conferences outside of Sumatera. The citizens of Indonesia are fortunate to live in such a beautiful country with such a unique biological heritage. Few places in the world have Orangutans living in nearby forests. I hope that the local scientific community continues to understand and protect their unique biodiversity – generations in the future will applaud your efforts.

***Dr. Peter Paton***

*Chief Editor*

*Professor*

*Department of Natural Resources Science*

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## Preface

*Assallamuailaikum warahmatullahi wabarakatu*, peace for all of us.

I am grateful to God, the Almighty God for allowing us to attend the this very noble meeting. Then, to the Dean of Faculty and their representatives, the Chairman of the Department in Faculty of Mathematics and sciences and also the Committee of International Seminar of Biological Sciences 2015 at Medan, I congratulate you all for the implementation of this seminar. It will carry the name USU not only in Indonesia but also worldwide level, to exchange experiences among researchers and practitioners in the relevant field of sciences.

Further, to all the keynote speakers, Prof. Dr. Peter Paton and Dr. Jason Kolbe from the University of Rhode Island, USA, we are very appreciate for your readiness to be a keynote speaker in this seminar. They came in the framework of the follow-up cooperation between USU and URI. Then, to Dr. Ian Singleton and Mathew G. Nowak of Sumatran Orangutan Conservation Programme, PAN Eco-YEL, North Sumatra, Indonesia, I also say thank you very much for your cooperation. Finally, to Prof. Anja Meryandini from Bogor Agricultural Institute (IPB) Bogor, we are very glade for sharing experiences with us. Whole elements of USU highly expressed our gratitude for your willingness to come to the field to share the experience of biology that gives freshness to the knowledge to all participants of the seminar. Welcome to the city of Medan, may be you able to enjoy all the good things here.

Furthermore, to all seminar participants I welcome all of you in this seminar held at Medan. Without a strong desire from all of you, this event would not be a realization. This one-day seminar was organized to exchange experiences among researchers and practitioners from around the world in the field of biology and related fields. About 180 participants in which most of them were came from different province of Indonesia beside having other participants from Malaysia and Thailand.

Finally, our hope to all participants, can take the valuable benefits of this and eager to join future agenda of this kind of activity. We hope that this event can be held back with better preparation and structured in the future.

***Prof. Ir. Zulkifli Nasution, M.Sc., Ph.D.***

Vice Rector for Academic Affairs

University of Sumatera Utara

Medan Indonesia 20155

## Foreword

This volume of seminar proceedings contains a collection of research papers presented at the International Seminar on Biological Sciences 2015 with themed **The role of Biological Research on Development of Sciences and Technology and Sustainable Management of Natural Resources**. This international seminar organized by Department of Biology, Faculty of Mathematics and Natural Sciences, University of Sumatera Utara (USU), Medan - Indonesia, held in Medan on 17<sup>th</sup> October 2015.

A special thanks to our keynote speakers and also to all our speakers, authors and delegates for making the seminar successful. We sincerely hope you find the conference proceedings enriching and thought-provoking.

***Prof. Dr. Ing. Ternala Alexander Barus***  
*Chairman of Committee*  
*Department of Biology*  
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*University of Sumatera Utara*  
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# **The Spawning Period of *Anadara granosa* (Bivalvia: Arcidae) Population in the Lhokseumawe Mudflat**

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## **ABSTRACT**

This study determined the spawning period of blood cockle *Anadara granosa* and correlation to environmental condition. The condition index (CI) analysis was conducted to evaluating the spawning period of the cockle population. Samples were collected from July 2009 until September 2010 at Lhokseumawe tidal mudflat, whereas environmental parameters were measured periodically. The highest CI was observed in September 2010 (CI:  $14.15 \pm 3.14$ ), while the lowest CI was found in January 2010 (CI:  $6.76 \pm 1.13$ ). The results indicated that the spawning period and recruitment in the cockle population at Lhokseumawe are dependent on local environment conditions. *A. granosa* spawned was dribble or throughout the year (peaked from November 2009 to January 2010). The released gamete in *A. granosa* was coincided with drastic fluctuations in environmental condition. This research found that the water temperature and salinities were the leading triggers of reproductive events.

**Keywords:** Reproductive biology, Blood cockle, Water quality

## **INTRODUCTION**

In ecosystems, intertidal species such as bivalvia, exhibit a number of important roles that affect diversity, abundance and productivity of biotas of numerous trophic levels (DFO, 2006). Bivalves affect ecosystem energy flow and nutrient cycling and may affect benthic and pelagic community dynamics and structure. Bivalves play an important role in the ecosystem, both in terms of biomass as well as productivity. Northern Strait of Malacca is an important nursery area for many intertidal organisms, and a feeding area for migrating species. One intertidal species of cockle *Anadara granosa* predicting to be a keystone species within mangroves in several areas in northern straits of Malacca.

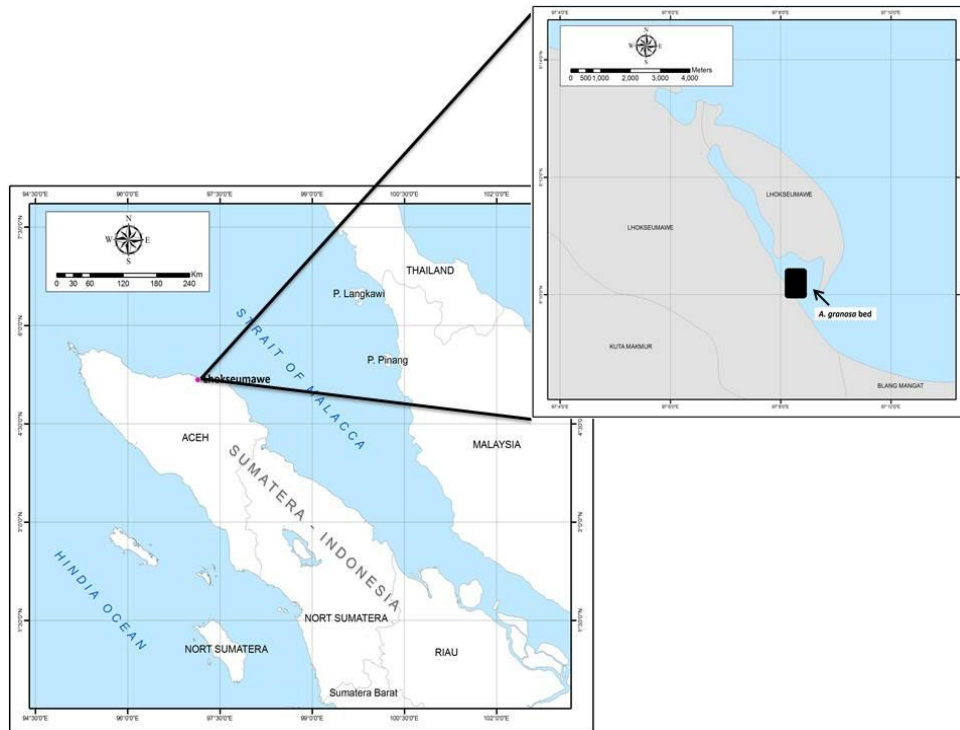
Several studies have investigated the ecological relationships of *Anadara* in different habitats (Broom, 1985; Suwanjarat and Pamrong, 1990). However, no data are available on the physical, chemical and biological parameters that affecting the population dynamics of *Anadara granosa* in northern straits of Malacca. Regardless of the geographical area or species under study, population growth and reproduction of most intertidal species is regulated by similar environmental factors such as temperature, salinity and food availability (Bayne 1985, MacDonald & Thompson 1985, Baqueiro-Cardenas & Aldana-Aranda 2000). This study evaluated environment conditions that affected the intertidal population dynamics of cockle *Anadara granosa*. In particular, few data are available on seasonal variation in spawning, which is correlated with the recruitment process and determines temporal changes in the gross condition of animals. This information can use to help develop management protocols for this species that plays a key ecological role in intertidal habitat.

## **MATERIALS AND METHODS**

### **Collection of samples**

A total of 30 samples of adult *A. granosa* (size range: 38–71 mm) were collected monthly from July 2009 until September 2010 from the natural grounds in Lhokseumawe (Figure 1) at the

East coast of Sumatera Indonesia (05° 9' 38.1"N, 95°08'32.3"E). The sampling area was characterized by muddy areas, relatively no wave action and the mangroves were sheltered and exhibited high salinity. After collecting, the specimens were stored in isotherm containers and immediately transported to the laboratory. The samples were fully removed from bio fouling and other adherences.



**Figure 1.** Sampling area of *Anadara granosa* from Lhokseumawe, East Coast Sumatera Indonesia.

### Measurement of environmental parameters and collection of water samples

The environmental parameters were recorded *in situ* and *ex situ*. Water temperature, salinity, pH, turbidity, and dissolved oxygen were recorded *in situ* while minimum and maximum water temperature and salinity were recorded daily. Water temperatures were collected at sampling areas daily at the bottom of sea beds during the sampling period. Temperature was measured with a handheld maximum minimum thermometer, and salinity was measured with a hand refractometer. The salinity of the seawater was collected daily at the bottom of sea bed depth. Hydrogen ion concentration (pH) was measured using portable pH meter periodically during the sampling period.

Turbidity consists of organic and inorganic matters held in suspension by turbulence in seawater. The turbidity was measured using a turbidity meter model HACH *turbidimeter* 2100 AN, while the dissolved oxygen was measured using dissolved oxygen meter model YSI 52. Chemical parameters such as nitrate, nitrite, ammonia, and orthophosphate were measured using spectrophotometry. Phytoplankton density was monitored monthly to determine food ability at the cockle habitat.

### Condition index (CI)

A condition index (C) can be used to determine ecophysiological factors that affect the physiological changes of carbohydrate, glycogen and protein fractions under environment influences. A CI is a reflection of the reproductive biology of bivalves. When the gonad mass increases during maturation, the CI will also increase, whereas the CI will decrease progressively after spawning has occurred (Angell, 1986). The water displacement method was used to determine the condition index. A total of 30 specimens were measured monthly

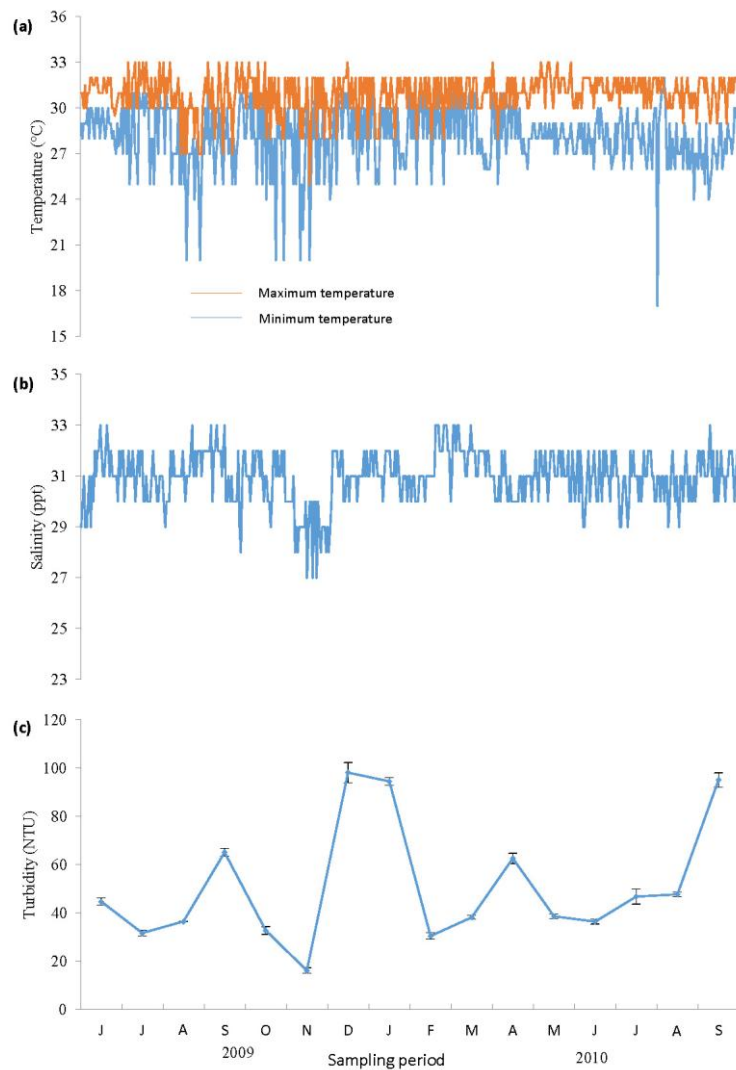
including the: dry flesh weight, wet weight of shell in grams (g) and internal cavity volume (ml). To measure dry flesh weight, the flesh was dried at 105<sup>0</sup>C for 72 hours until it became a constant weight. These data were used to calculate the condition index using the formula described by Scott & Lawrence (1982):

$$\text{Condition index} = \text{dry flesh weight (gram)} \times 100 / \text{shell internal cavity volume (cm}^3\text{)}$$

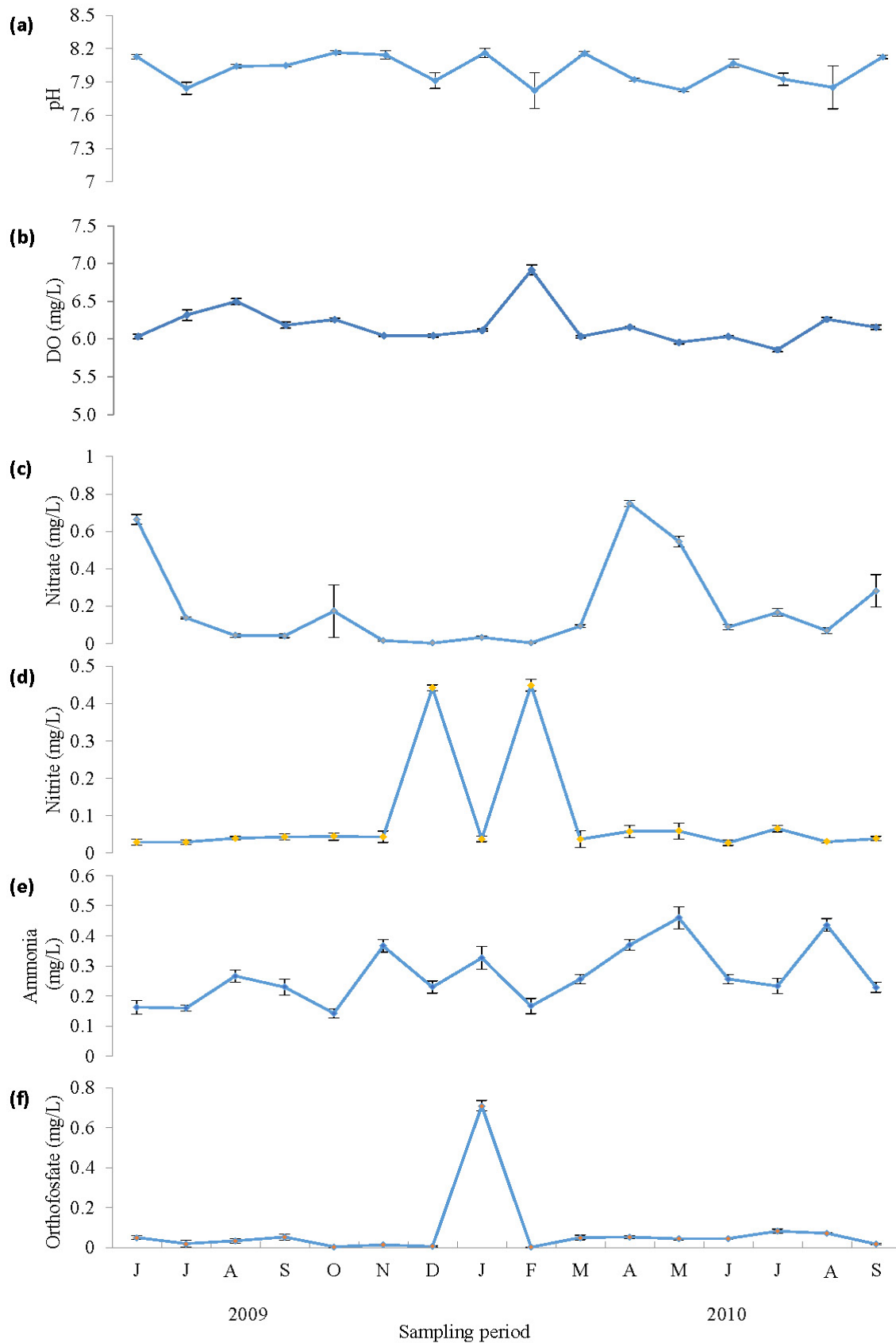
## **RESULTS AND DISCUSSION**

### **Water quality parameters**

During the study period, the variation in the daily temperature recorded did not show any significance differences. The highest temperature recorded was 34 °C and the lowest was 17<sup>0</sup>C (Figure 2). There was a drastic fluctuation in temperature in middle of June 2009 until early October 2009, thereafter remaining stable through March 2010 and continuously dropped on August 2010. The variation of turbidity unit shown fluctuation during the sampling period. Turbidity ranged from a high during December 2009 (98.23 NTU) to January 2009 (94.54 NTU) and was lowest in November 2009 (16.14 NTU) when dry season occurred. Salinity fluctuated between 27-33ppt, with highest levels observed in October 2009 until end November 2009, February 2014 to April 2014 and June 2014 to August 2014. The lowest salinities were recorded during the month of October to December 2009 during the highest intensity of rain. The variation of pH, dissolved oxygen, phytoplankton density and other chemical compounds at Lhokseumawe from June 2009 to September 2010 were shown in Figure 3.



**Figure 2.** Seasonal variation in maximum-minimum temperature, salinity, and turbidity at Lhokseumawe from June 2009 to September 2010.



**Figure 3.** Seasonal variation in environmental parameters including pH, turbidity, dissolved oxygen, phytoplankton density, nitrate, nitrite, ammonia and orthophosphate, from June 2009 to September 2010 at Lhokseumawe.

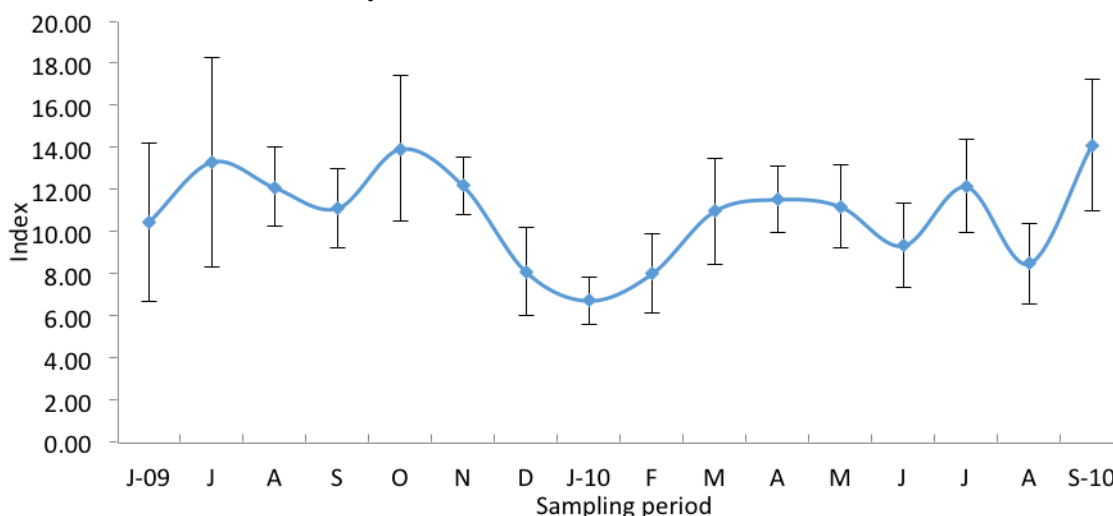
The mean value of pH recorded during the study period was  $8.03 \pm 0.12$  with the lowest value recorded in May 2010 (pH=7.84), and the highest in January 2010 (pH=8.21) (Figure 3). The mean turbidity recorded during the study period was  $51.33 \pm 26.62$  NTU, with a range from 15.18 NTU and 103 NTU. The lowest turbidity was recorded in November 2009, while the lowest was in December 2010. The mean value of dissolved oxygen recorded during the study period was  $6.18 \pm 0.26$  mg/L (Figure 3). The lowest dissolved oxygen was recorded in May 2010 with value of 5.98 mg/L, while the highest value of dissolved oxygen recorded in February 2010 with value of 6.97 mg/L. Phytoplankton density showed a high variability throughout the year. The mean values of phytoplankton density recorded during the study period was  $2059.90 \pm 884.86$  cells/L. Phytoplankton density with values more than 3000 cells/L occurred in October 2009 and December 2009, with a peak in December (4001.67  $\pm$  20.43 cells/L). Minimum values occurred in August 2009 ( $711.67 \pm 5.77$  cells/L).

The chemical compounds (i.e. nitrate, nitrite, ammonia and orthophosphate) were below the tolerance level for intertidal benthic species. The mean value of nitrate was  $0.24 \pm 0.32$  mg/L. The highest peak of nitrate was recorded in September 2010 with the value of 0.981 mg/L, while the lowest peak was in December 2009 with value of 0.002 mg/L. The range between the lowest and the highest values for nitrate was 0.979 mg/L. The mean value of nitrite during the study period was  $0.09 \pm 0.14$  mg/L. The highest peak of nitrite was recorded in December 2010 with value of 0.442 mg/L, while the lowest peak was in March 2010 with value of 0.024 mg/L. The nitrite ranges between the lowest and the highest values was 0.418 mg/L.

The mean value of ammonia from June 2009 to May 2010 was  $0.27 \pm 0.10$  mg/L. The highest peak of ammonia was in May 2010 with value of 0.49 mg/L, while the lowest value was in October 2009 with value of 0.14 mg/L. The range value between the highest and the lowest values was 0.35 mg/L. The mean value of orthophosphate during the sampling period was  $0.08 \pm 0.17$  mg/L. The highest value was recorded in January 2010 (0.700 mg/L), while the lowest value was recorded in February 2010 (0.001 mg/L). The range between the highest and the lowest values of orthophosphate was 0.699 mg/L.

#### Condition index (CI)

The Condition Index is correlated with maturity period. The high values of CI showed that the cockles had reached the ripe stages while the low values of CI shown the cockles were on spawning process (Figure 4). The highest condition index of the cockle population from Lhokseuwawe was observed in September 2010 ( $14.15 \pm 3.14$ ), whereas the lowest CI occurred in January 2010 ( $6.76 \pm 1.13$ ). *A. granosa* spawned throughout the year, with peak spawning from October 2009 until January 2010.



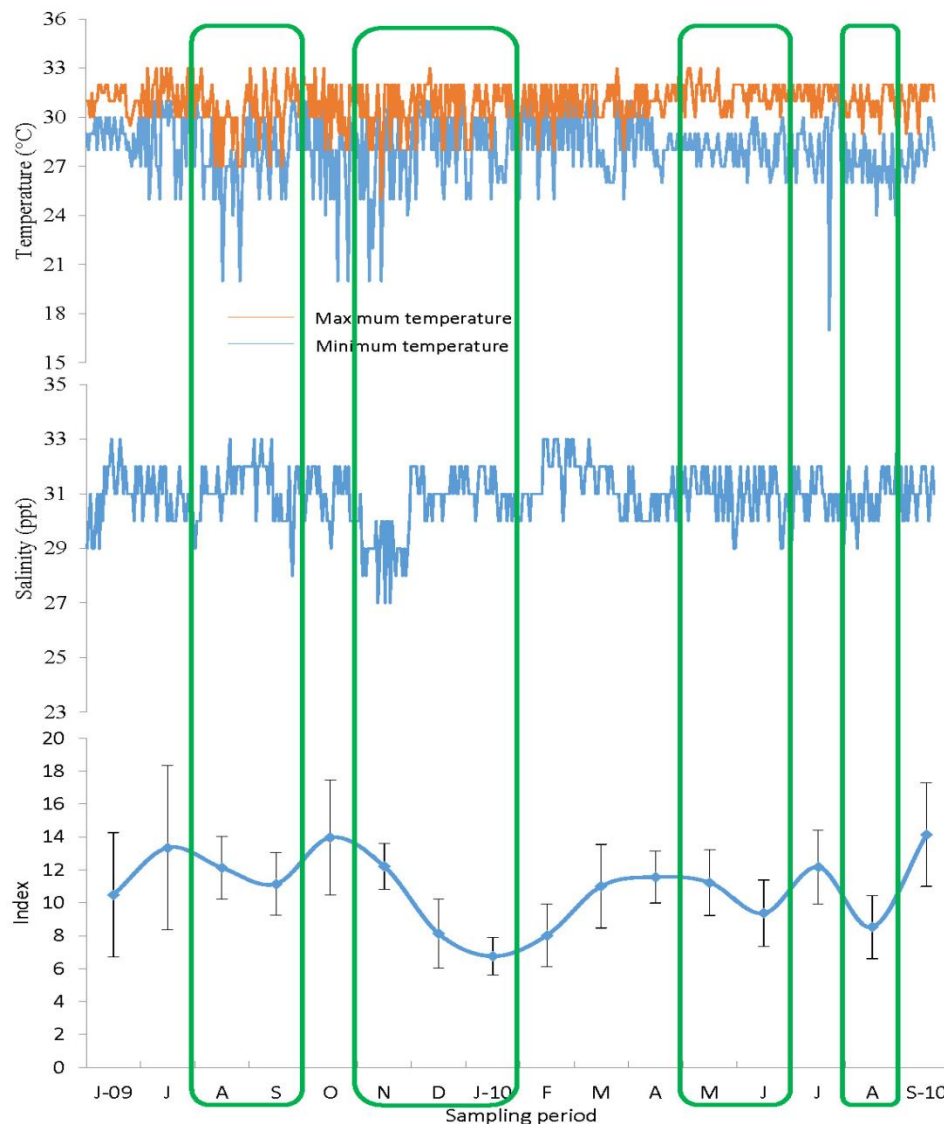
**Figure 4.** Condition index of *Anadara granosa* from Lhokseumawe from June 2009 to September 2010).

In this study, condition index (CI) was used to evaluate the tissue quality in the intertidal species *A. granosa* in Lhokseumawe, Indonesia. The condition index was known to be influenced by many environmental factors, such as temperature (Chipman, 1947; Freitas et al., 2010), salinity (Engle, 1957; Haven, 1947), seasonal variations (Rebelo et al., 2005; Sahin et al., 2006), chemical characteristics of the water and sediment (Engel, 1957), crowding and availability of food (Korringa, 1952; Galtsoft, 1964). In this study, temperature and salinity were the main environmental regulating factors of habitual performance of spawning period in *A. granosa* in Lhokseumawe, Indonesia. In addition, gonad development proceeded more actively during the periods of drastic fluctuating of temperatures and salinities, from October 2009 through January 2010 (24–34°C and 27–32 ppt). This suggests an inverse relation between water temperature, salinities and gametogenesis. The release of gametes by the natural population of *A. granosa* at Lhokseumawe coincided with the drastic daily fluctuations in temperature and salinity as indicated by rectangle boxes in figure 5.

Spawning periods of the cockle population in Lhokseumawe were highly influenced by the fluctuation of abiotic factors such as temperature and salinity, where in August 2009 until September 2009, maximum and minimum temperatures were actively fluctuating. Similar condition was recorded in salinity, where fluctuation had occurred in August 2009 until December 2009. Both these fluctuations were suggested as factors which have positive correlation in the spawning of bivalve *A. granosa* in Lhokseumawe.

Based on this study, the condition index of the cockle population in Lhokseumawe was a combination result of the fluctuations on two main environment factors, namely temperature and salinity. Fluctuations in temperature and salinity appear to stimulate the spawning activities of the cockle population. From observations of Condition Index of *A. granosa* (16 months), high fluctuations in daily temperature were followed by an onset of high fluctuations in salinity that resulted in four spawning periods. The first spawning period occurred from August 2009 to September 2009, the second cycle from November 2009 to January 2010, with a higher interval compared to first cycle, the third occurred from May 2010 to June 2010 and the fourth was in April 2010. Fluctuations in temperature and salinity appear to act as the main trigger and an active response for cockles to initiate their reproductive cycle. High fluctuations of daily temperature and salinity apparently induce gonad development. Once the gonads matured, highest fluctuations in temperature and salinity trigger the spawning process in *A. granosa* at Lhokseumawe, Indonesia. Salinity is important in determining the distribution of bivalves and able to influence the physiological rates of bivalve including reproductive process (Dame, 1996).





**Figure 5.** Correlation between spawning period of *Anadara granosa* with changes of temperatures and salinities from June 2009-September 2010 in Lhokseumawe.

### Acknowledgement

We would like to thanks Marine Sciences Laboratory Universiti Sains Malaysia, Aquaculture Department, Malikussaleh University Indonesia, Muhammad Rusdi for preparing sampling location map. Indonesian Fisheries Quarantine Service for their continuous support in making this project a success.

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