EnvironmentAsia
The international journal by the Thai Society of Higher Education Institutes on Environment

EnvironmentAsia 12(2) (2019) 87-95
DOI 10.14456/ea.2019.30
ISSN 1906-1714; ONLINE ISSN: 2586-8861

Correlation between Nutrients Distribution and Location of Green Mussel Farm Areas at the Coast of Phetchaburi, Phetchaburi Province, Thailand

Urairat Rattanavijit[1*], Wit Tarnchalanukit[1], Kasem Chunkao[1,2] and Onanong Phewnil[1,2]

[1]*Department of Environment Science, Faculty of Environment, Kasetsart University, Bangkok, Thailand.*
[2]*The King's Royally Initiated Leam Phak Bia Environmental Research and Development Project at Laem Phak Bia sub-district, Ban Leam District, Phetchaburi Province(The LERD project), Chaipattana Foundation ,Thailand.*

*Corresponding author : au_2001@hotmail.com
Received: July 15, 2018; Revised: November 16, 2018; Accepted: January 5, 2019

Abstract

Many green mussel farm were located in Bang Taboon coastal area more than any other coastal area in Thailand. Therefore identifying the key factors that influence on this situation is very important in the future farm business. Then the object of this study is to investigate the correlation between nutrient distribution and mussel growth in the different distance along the coastal area of Petchaburi province in Thailand for both low and high tide during November 2017(Rainy season).The water quality had been sampled and analyzed in six different distance at 0.5,1,2,3,4 and 5 km. Six parameter have been identified as follows: calcium silicate, ammonium, phosphate, chlorophyll a, chlorophyll b and phytoplankton. The study showed that nutrients (ammonium, phosphate, calcium silicate).The correlation showed negatively related to distance(r=-0.499,-0.709,-0.789,P<0.01) but chlorophyll a ,chlorophyll b and phytoplankton do not correlate with distance (r=0.014,0.411,0.029, 0.-029, P > 0.01).The study express that the niched located for growing mussels is at 2-3 km. from the coastal. The result showed that the growth of mussels largely influence by availability of diatom, the food source of mussels, that depended on suitable concentration of nutrients as follows calcium silicate, ammonium, phosphate and suitable light for photosynthesis obsering form phytoplankton.

Keywords: Correlation; Nutrient distribution; Green mussel; Location; Phetchaburi Province

1. Introduction

The specific ecological characteristic of coastal areas connected to estuaries had influenced on estuary nutrients as primary nutrients source (Silvia *et al.*, 2005). In addition, estuaries were function as important sinks and transformation zones for nutrients transported from inlands to the sea (Jordan *et al.*, 1991). These systems were of important to coastal ecosystems especially for fish and invertebrates to nurse their offspring (Vasquez Botello *et al.*, 1996). These nutrients will be the beginning of the food chain starting by photosynthesis process of phytoplankton through cell walls to produce organic matter (Mehard *et al.*, 1974),

which will be the source of food for other animals to transfer energy along the food chain. Consequently the coastal area was suitable to be a breeding and shelter habitat for aquatic animals and was an important area to generate a lot of revenue for the country (Nelson *et al.*, 1976).

The coastal area of Phetchaburi province located the upper gulf of Thailand was abundance of nutrients. It was a shallow sea area with the coastal plain that composed of the continental shelf, that wide and long caused by the deposition of the Phetchaburi river, Maeklong river and some Thachin river (Anukorn, 2000).There were germination of the new land all the time in the areas from bang taboon to laem phak bia in ban laem district created from deposition of abundant flooding sediment along the coast and mangrove (Jamlong, 1999).This area was characterized as muddy beaches according to their ecosystems such as brackish water and lagoons. In low tide, the beach was extend from the shore for about 3-5 kilometers with plenty of organic matter and nutrients especially from the north side is bang taboon bay until the lame luang approximately 20,000 rai lagoon (Siripong, 1997).

Moreover data of nutrients and water quality were important factors to determine the growth rate and survival rate of aquatic animals in the upper coastal area from bang taboon area, ban laem, to bang khun sai canal at Phetchaburi river estuary (Department of Fisheries, 2014) correspond with Wongkhae's study (2004). In addition to nutrients. There were many other factors such as tide, salinity and fresh water flowing into the area. Study on nutrients content in coastal areas in mussel farming area. It was necessary, because it was an important factor for the growth of green mussel. The purpose of this study was (1) to study the correlation between nutrients distribution and location of green mussel farm areas at the coast of Phetchaburi province (2) to study the suitable location for mussel farms in the future.

2. Materials and Methods

2.1 Study Sites

There are 6 sampling lines in coastal areas from the bang taboon area to laem phak bia beach. Each Line is 5 km long from the coast to the sea with details as followings: Line 1 Bang Ta-boon (A), Line 2 Ban Laem (B), Line 3 Bang Kaew (C), Line 4 Klong-E-ED (D) Line 5 Wat Samut -Tharam (E), Line 6 Banpuk-Taharn (F). The locations of 5 lines are shown in Figure 1.

2.2 Sampling

Samples were collected in high tide and low tide in Rainy season of November, 2017. Each sampling line is divided in to 5 points at a distance of 500 m, 1 km, 2 km, 3 km, 4 km, and 5 km from the coast respectively. Moreover

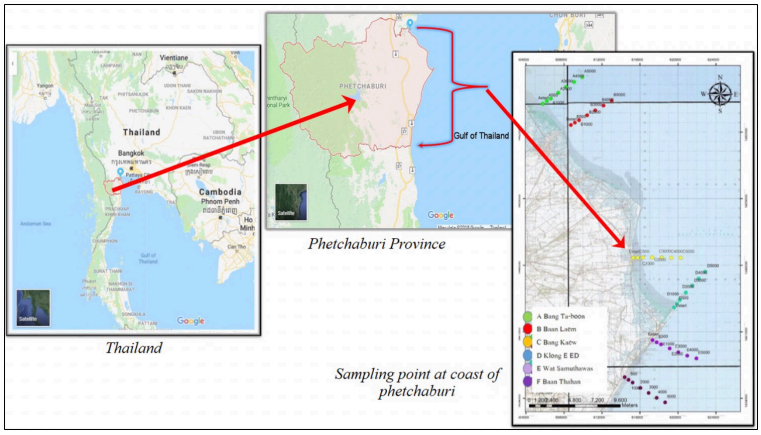

Figure 1. Sampling locations at the coast of Phetchaburi province

each sample point is divided into 3 different depth at 30 cm. from the surface, and at 0.6H, 0.8H of the total depth. Water samples have been tested according to the standard methods for the Examination of Water and Wastewater (APHA, AWWA, and WF, 2005). Moreover, 1-liter bottles of samples would be stored in a refrigerated tank at temperature lower than 4°C. Six parameters of water quality would be tested, i.e. calcium silicate, chlorophyll a, b, phosphate and ammonium (Wintermans and De Mots, 1975).

3. Results and Discussion

3.1 Distribution of nutrients and phytoplankton

3.1.1 Ammonium

The sampling data demonstrated that the average ammonium concentration in the high tide was higher than in the low tide. In Figure 2(a), in the high tide, had the highest distribution of data at a distance of 3 km, the average ammonia 0.255 mg/L and the highest was 0.389 mg/L. In Figure 3(f) in low tide was the distribution of data at a distance of 3 km the highest average of 0.155 mg/L. Ammonium had a maximum value of 0.254 mg/L.

Ammonium concentration was important for cell growth hence most phytoplankton used nitrogen in the form of ammonium (Smayda, 1983; Ladda, 1987; Sripong, 1997) while phytoplankton and bacteria was used the most nitrogenous ammonium compounds in the form of NH_4^+ in all nitrogen compounds (Valiela, 1995). Then green mussel were also commonly used in ammonia and the appropriate ammonia concentration should be less than 0.4 mg/L or NH_4^+-N less than 22.22 μm (Suksri *et al*, 2000).

3.1.2 Phosphate

The sampling data demonstrated that the distribution in the high tide was higher than in the low tide. Especially at a distance of 3 km. In Figure 2(b) the high tide had the best distribution of data, the highest average phosphate content was 0.0778 mg/L and the highest was measured at 0.1247 mg/L. In Figure 3(g) in the low tide, the distribution of data at a distance of 4 km. However, at the distance of 1 and 2 km the highest mean was 0.1371 mg/L. and the maximum amount measured was 0.1432 mg/L. Phosphorus plays an important role in the biochemical reactions within the phytoplankton cells, which are related to energy transportation within the cell resulting in cell growth and reproduction (Round, 1981).

3.1.3 Calcium silicate

From Figure 2(e), in high tide, the distribution of calcium silicate, most at a distance of 2 km. The average 29.766 mg/L. and the maximum volume was measured at 39.4 mg/L at a distance of 2 km as well. From Figure 3(j) in low tide, the highest calcium silicate distribution at 1 km measured the mean of 51.517 mg/L and the maximum amount measured was 62.5 mg/L at 0.5 km. Silicate was an important mineral in the growth of diatom phytoplankton, silicoflagellate and some phytoplankton with tentacles. Since it was used to build cells, it was used in the form of orthosilicate (SiO_3^{2-}) (Ladda, 1987). The concentration of the orthosilicic acid of the sea or river mouth depends on rainfall that leaches the ground and then flows into the sea. During the Rainy season, the amount of silicate was very different from the Summer season (Chatapong, 2002). *Skeletonema costatum* was very abundant in the Dry season with silicate and ammonia as the main food that was high in abundance (Jarumas, 1999).

3.1.4 Chlorophyll a

From Figure 2(c), in high tide, there was a distribution of chlorophyll a at a distance of 5 km over other distances. From Figure 3(h) in low tide, at a distance of 4 km of chlorophyll a was distributed over the other distances, and the average measured 2.218 mg/L of the maximum measured 3.584 mg/L.

All phytoplankton species contain chlorophyll, a major green pigment for photosynthesis. The properties of chlorophyll a are water insoluble but will dissolve in organic solvents. In general, the amount of chlorophyll a is correlated with the amount of phytoplankton

(Fogg, 1980).

3.1.5 Chlorophyll b

From Figure 2(d), in high tide, at a distance of 4 km, the distribution of chlorophyll b was greater than that of other distances. The mean was 0.282 mg/L and the maximum was 0.898 mg/L. In Figure 3(h) in low tide, at a distance of 3 km, the distribution of chlorophyll b was greater than that of other distances. The mean was 0.578 mg/L and the maximum was 1.029 mg/L.

3.1.6 Phytoplankton

In this study, Phytoplankton in high tide was higher than low tide. From Figure 4 in the high tide, distance 2 and 3 km were the distribution of phytoplankton more than any other distance. Which was different from low tide, and from this study also found that, the dominant and abundant species at all distances were *Ceratiam furca*, especially at distance 3 km.

3.2 Correlation between nutrients distribution and distance in locations of green mussels farm areas.

Correlation between distance and nutrients show in table 1. From the table shows that. Ammonium was negatively correlated with distance at significant level of 0.05, phosphate and calcium silicate were negatively correlated with distance at significant level of

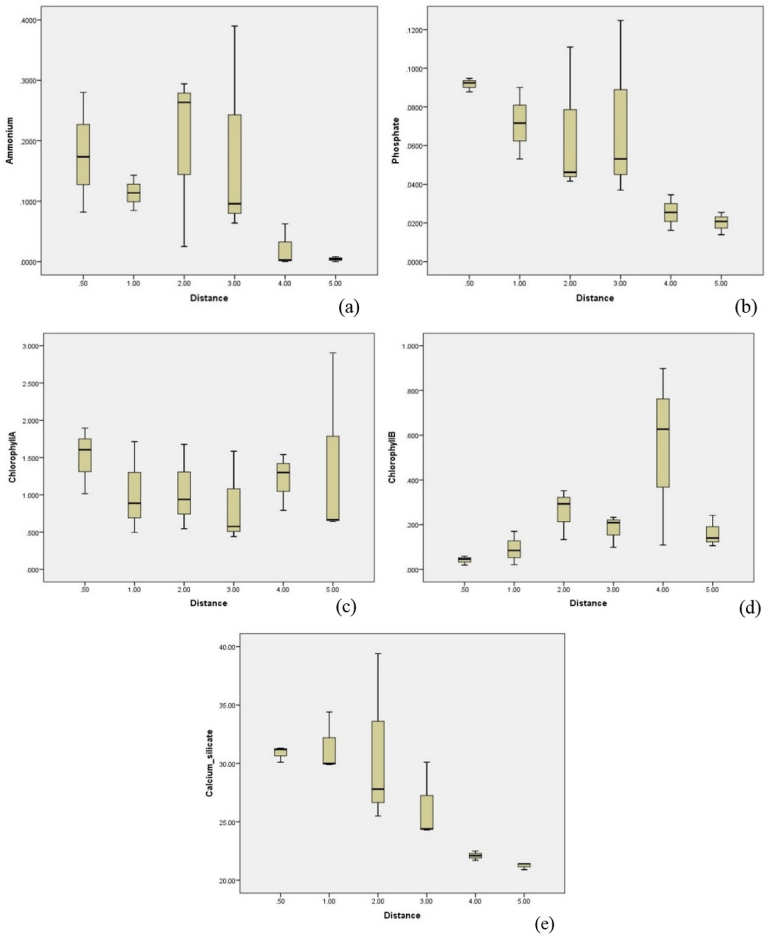

Figure 2. Distributions of nutrients/ammonium (a)/phosphate (b)/chlorophyll a(c)/Chlorophyll b (d) calcium silicate (e) in mussels farm areas at the coast of Phetchaburi province (high tide)

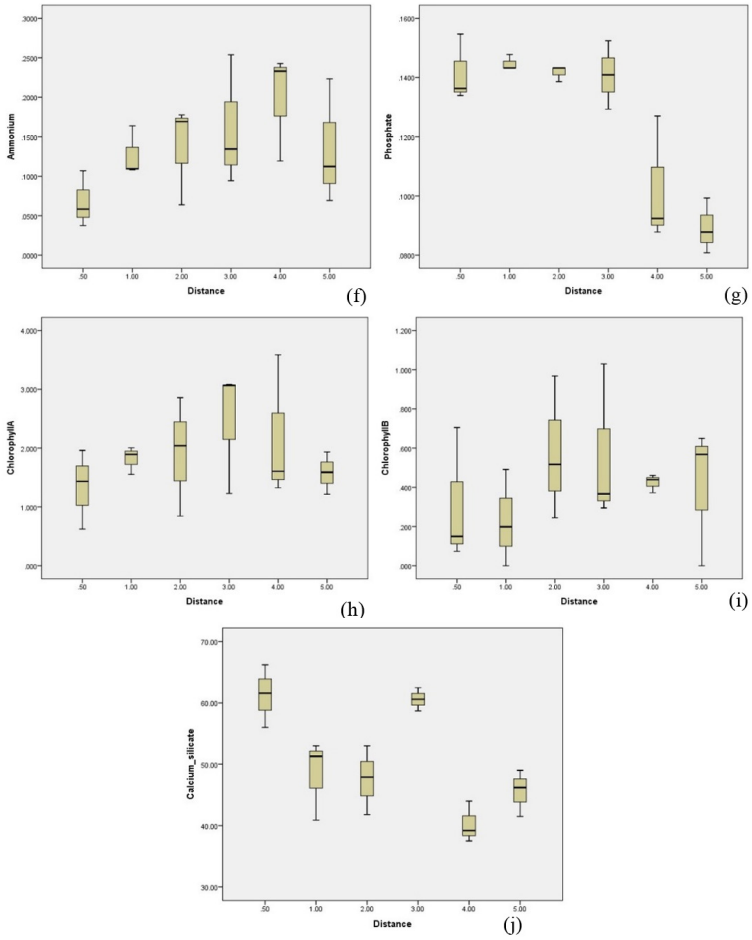

Figure 3. Distributions of nutrients/ammonium (f)/phosphate (g)/ chlorophyll a(h)/Chlorophyll b(i) calcium silicate(j)/in mussels farm areas at the coast of Phetchaburi province (low tide)

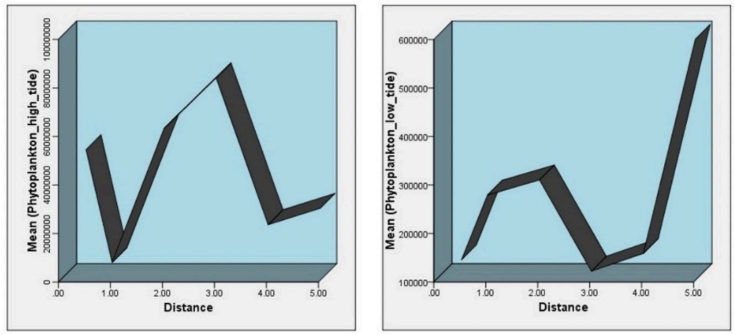

Figure 4. Distributions of phytoplankton in mussels farm areas at the coast of Phetchaburi province in low and high tide.

Table 1. Correlation between distance and nutrients

Nutrients and phytoplankton	Distance	
	Pearson correlation	Significant
Ammonium	-0.497*	0.036
Phosphate	-0.709**	0.001
Calcium silicate	-0.789**	0.000
Chlorophyll a	0.014	0.957
Chlorophyll b	0.411	0.091
Phytoplankton	-0.029	0.908

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

0.01 chlorophyll a and chlorophyll b did not correlate with distance and phytoplankton did not correlate with distance too.

3.3 Appropriate location for green mussel farms

In this study, the study area was bang taboon bay. The most green mussel farming in the petchaburi coast, the results of this study showed that from Figure 1 and 2, the distribution of nutrients (ammonium, phosphate, calcium silicate, chlorophyll a, chlorophyll b) at distances of 2 and 3 km were more than the other, and using pearson correlation between distance and nutrients content, it was found that nutrients correlated with distance significantly as shown in Table 1. In addition to nutrients found at a distance of 2-3 km, the amount of phytoplankton in this study. There were more than other distances, as well as nutrients. (Figure 3) Which consistent with the green mussel farm area based on survey data from the Department of Fisheries, Phetchaburi coast (Department of Fisheries, 2014). It can be seen that the green mussel farm area grows well. Depending on the amount of nutrients in the coast. Green Mussel can grow well in areas with abundance phytoplankton, especially diatoms (Fehling *et al.*, 2012). Green mussel was species Mytilus edulis found high concentrations of chlorophyll a (Page and Hubbard, 1987).The density of mussel farm correlated with coastal nutrients, while most of the mussel foods were phytoplankton, small animals, protozoa and organic matter suspended in the sea (Wattana,1998). Phytoplankton always found in coastal and estuarine areas.

In the coastal areas, where there were abundance green mussels, there were four groups: blue green algae, green algae, diatoms and dinoflagellates. Diatoms were the main types in all the most common areas (Selina, 1995). The nutrients correlated with phytoplankton growth, which was the food of the mussel, were (1) Silicate: silicate would be the basic structure of the diatomic valve cells of phytoplankton must received silicate to be accumulated for cell division (Eppley, 1967), to be transported for breeding process (Nelson *et al.*,1976), to formulate protein carbohydrate and chlorophyll(Werner, 1977), and to bond with other substrate in the diatom (Azam *et al.*,1974; Mehard *et al.*, 1974) (2) Ammonia: phytoplankton was able to introduce nitrogenous nutrients into various cell types to create an amino acid benefit the growth with the nitrite reductase (NiR) enzymes (Carlucci *et al.*,1970) involved. In low light areas phytoplankton would used ammonia for nitrite and nitrate removal. (3) Phosphorus: phosphorus was found in all phytoplankton cells in the form of phosphates in various vacuoles and was in the form of polyphosphates in cytoplasm or vacuole, while the phosphorus inside the cell changes with the concentration of phosphorus in the water (Dugdale, 1967). The mechanism of green mussel growth and nutrient distribution in the green mussel area and the amount of phytoplankton. Can confirm

that, nutrients and phytoplankton were related and important factor in the abundance of green mussel.

Study on the correlation between distance and nutrients on the coast of Phetchaburi province. Can be referenced to educate the community. It is also used as a guideline for the development of other green mussel farms in Thailand in the future.

4. Conclusion

The results of this study identify that the green mussel farms located in bang taboon coastal area corresponded to essential green mussel nutrients. The farms were located at the specific area that contains high calcium silicate content, which is necessary for growing phytoplankton to be the food source of green mussel. The variety of phytoplankton in term of diatom species in the area also suitable for the growth of green mussel complied with the results from Mehared *et al*. (1974) and Durbin (1977) ,who stated that contents of nutrients, calcium silicate, and diatoms are related to the growth of green mussel. Hence, during the Rainy season when nutrients were leached from inland, nitrogen, phosphate and silicate were dissolved into the coastal area then assimilate for phytoplankton growth (Jarumas, 1999) and reproduction (Raymont, 1963). Moreover, the results from the Department of Fisheries, Petchaburi Province also stated that the location of 14,016 rai green mussel farm (Department of Fisheries, 2014) also corresponding to nutrients, calcium silicate, and phytoplankton.

This study identify that the niche ecological area suitable for the growth of green mussels are (1) the coastal area that received the leached mineral from the limestone mountain area to release calcium silicate, the important source for growing of cell diatom and a major food source of green mussel with the suitable concentration in the range 7–23 mg/L., which is complied with the study of Bauer *et al*. (1995). Moreover, this study shown that the recommend depth and length are 3-10 m from the surface and 1-3 km from the coast, which is complied with the study of Ninart (1983), according to the suitable photosynthesis for diatoms. (2) suitable nutrient content as follows: ammonium concentration not more than 0.02 mg/L. in the form of un-ionized form, phosphate concentration in the range of 0.02-0.03 mg/L., which is complied with the study of Maitree and Jaruwan(1985).

Acknowledgement

This study was funded by The King's Royally Initiated Leam Phak Bia Environmental Research and Development Project at Laem Phak Bia Sub-district, Ban-Laem District, and Phetchaburi Province (the LERD project) Chaipattana Foundation, Thailand.

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