Seasonal Influences Size-Fractionated Chlorophyll *a* in Aquaculture Area at Bandon Bay, Thailand

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Abstract**—**Phytoplankton normally distributes in surface layer of water resources and obtains energy through the process of photosynthesis. Growth and abundance of phytoplankton mostly depends on variation of light, salinity, temperature, and nutrients. The influence of season on size-fractionated Chlorophyll a was investigated. Phytoplankton samples were collected from 12 stations in aquaculture area at Bandon Bay during summer (March, 2014) and rainy season (June 2014). The results showed that chlorophyll a produced by microplankton (filtered through filter pore size 20 μm) was presented in the range of 0.040-0.325 and 0.016-0.776 mg/l while the amount of total chlorophyll (filtered through GF/F) was 0.079-0.459 and 0.087-1.310 mg/l. in summer and rainy season, respectively. In summer, the proportion of chlorophyll a from microplankton in the bay acted the high amount compared to those in nano and picoplankton, while nano and picoplankton showed the high content of chlorophyll a in rainy season.

Keywords**—** chlorophyll a, size fraction, Bandon Bay

I. Introduction

BANDON Bay, representing an area of 477 square kilometers, is located in Surat Thani Province, southeast of Thailand. It is known a fertility area having vast beach stretching to the sea lanes around 1-2 km from the coast. The climate is influenced by the northeast monsoon swept through the Gulf of Thailand and the southwest monsoon from the Indian Ocean resulted a long rainy season in this region [1]. The abundant location makes this place become economic area for coastal fishery and aquaculture, fish farming, shellfish culture, shrimp farming and inland aquaculture supported the peoples settled around the bay. For success of coastal aquaculture, many factors are contributed including topography, climate, water quality, breeding, food, minerals, and management [2]. Food is identified the most important and necessary matter which determines the growth, survival rate, coloration and characteristics of the animals.

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Phytoplankton, photosynthesizing microscopic organisms, dwell in surface layers (euphotic zone) of water both marine and fresh water. It is considered a natural basic food of life in the water and marked the beginning of a flow of energy in the food chain which controls the flow of life in the ecosystem [3]. They convert organic matter into organic compounds via the process of photosynthesis and act as the agents for primary production. They are directly associated with the flow of nutrients in the water, especially nitrogen and carbon cycles, have an important impact on productivity and also important to develop the new water resources into the complex system [4]. They mostly appeared in green color due to the presence of chlorophyll within their cells (they may have variety of accessary pigments due to their groups, but chlorophyll is the main pigment for photosynthesis). Growth of phytoplankton is limited by nutrients in water such as nitrate, phosphate or silicate.

Plankton are normally divided by size into 7 groups; femtoplankton, picoplankton, nanoplankton, microplankton, mesoplankton, macroplankton and megaloplankton [5] and the groups have different their habitual functions. Phytoplankton mainly belongs to the group of picoplankton (0.2-2.0 microns; phytoplankton with tentacle and protozoa), nanoplankton (2-20 micron; mainly diatoms, green algae and dinoflagellate) and microplankton (20-60 micron; diatoms, green algae and cyanobacteria). Size distribution of phytoplankton in the water resources was influenced by environmental factor and area condition [6]. In oligotrophic zone, along the middle of the ocean, there was a plenty of nanoplankton and picoplankton which may affect the elongation time in each stage of the food chain and the mainly organisms found in this area was crustacean zooplankton. In the coast of temperate zone (temperate coastal waters), the large size groups of phytoplankton were found. And the region of upwelling, large or adult fish could consume a large phytoplankton directly (by filter feeding) which also found in the euphotic zone [7].

There are several methods to estimate the biomass and primary productivity of water resources. Standard stock refers to the number of organisms in the unit area or volume of water. Biomass represents the overall weight of all living species found in any area or volume. Chlorophyll is another method used to estimate the biological mass of phytoplankton

by measurement the amount of Chlorophyll a in water resources (since Chlorophyll a was found in all types of phytoplankton) [8]. It is an extremely vital biomolecule necessary in photosynthesis and can absorb light mostly in blue portion followed by the red and poorly in green of the spectrum.

It was needed many factors to support aquaculture in the coastal area such as topography, climate, nutrients, minerals and food. Food is determined the vital and necessary factor that controlled growth rate and survival rate of aquatic animals. Phytoplankton is considered a basic natural food of life and the beginning of the flow of energy in the food chain. Determination of chlorophyll a demonstrated an evaluation of primary production. Size-fractionated Chlorophyll a could enable us the proportional distribution of chlorophyll a according to the size of phytoplankton found in the water resources. Since phytoplankton mainly nano and pico-plankton showed the density and biomass in the form of chlorophyll about 20-90% of total phytoplankton [8] and acted as the producer which composed of traditional food chain and also passed through the microbial loop. Knowing of natural primary food would enable us the information of phytoplankton distribution in Bandon Bay in seasons.

II. Materials And Methods

A. Sampling sites and samples collection

To study the size-fractionated Chlorophyll *a* in culture area at Bandon Bay, 12 sampling stations along the coast were determined using GPS for the position. Station 1, 2 and 3 represented the east coast of the Tapi river (Kanchanadit district), station 4, 5 and 6 set at the Tapi estuary (Mueang Surat District) and station 7, 8, 9, 10, 11 and 12 were located on the west coast of Tapi river (Chaiya and Tha Chang District). The investigation was done in 2 seasons; summer (March, 2014) and rainy season (June 2014).

B. Measurement of Chlorophyll a and nutrients

Physical parameters of water such as salinity, dissolved oxygen, temperature, transparency and conductivity were measured using multivariate devices (YSI Model Pro 2030). Water samples at the surface layer were collected for determination of nutrients and chlorophyll a. For determination of chlorophyll a in micro-plankton, sample of 50 ml was filtered through filter paper pore size 20 µm, and the same volume was filtered through filter paper GF/F representation of the amount of chlorophyll a from nano- and pico-phytoplankton. The procedure was done triplicates for each site and type of plankton. Chlorophyll a was analyzed spectrophotometric method according to [9]. Nutrients in water were analyzed for nitrite, nitrate, ammonia, orthophosphate and silicate according to [9].

Fig. 1 Location of study site and sampling stations in aquaculture area at Bandon Bay, Surat Thani Province, Thailand

III. Results And Discussion

Chlorophyll a content in aquaculture area total 12 stations around Bandon Bay was studied. It was found that in summer, the average of chlorophyll a content was 0.266 mg/l which was lower than those in rainy season (0.348 mg/l). The average of total chlorophyll a at the mouth of Tapi river showed the higher amount than stations in the east and the west coast of the bay in both seasons (Fig. 2).

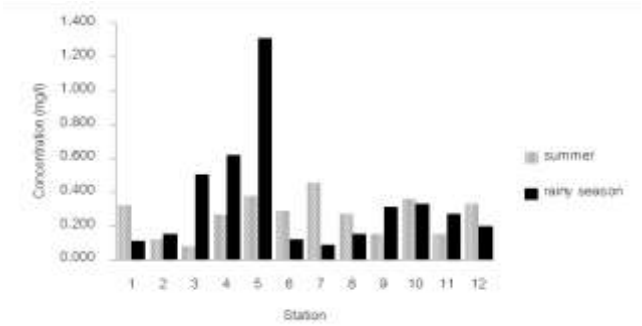

Fig. 2 Chlorophyll a content in summer and rainy season at 12 stations around Bandon Bay, Surat Thani Province, Thailand

Comparison of size fractionated Chlorophyll a between the proportion of micro-phytoplankton and nano and pico-phytoplankton showed that in the summer stations at the mouth of Tapi river and stations at the east coast of the bay had the average of micro-phytoplankton Chlorophyll much more than nano and pico-phytoplankton Chlorophyll a. But the stations in the west coast of the bay appeared the average of nano and pico-phytoplankton Chlorophyll a greater than the average of micro-phytoplankton Chlorophyll a (Fig. 3). While in rainy season, stations in the east coast, the west coast and the estuary of Tapi river clearly shown the average of nano and pico-phytoplankton Chlorophyll a higher than average micro-phytoplankton Chlorophyll a.

Our results corresponded to [10] which reported that at the mangrove area near Pak-Poon canal, Nakhon Sri Thumrat Province, the density of nano-phytoplankton was high in rainy season, while the density of micro-phytoplankton was high in summer. However, it was different from [11] which found that the average of nano and pico-phytoplankton

Chlorophyll a was higher than those of micro-phytoplankton Chlorophyll a at the mouth of Tapi river and Bandon Bay in summer. And at the mouth of the Tapi river during the rainy season, appeared the lower content of nano and pico-phytoplankton chlorophyll a than the micro-phytoplankton chlorophyll a, while nano and pico-phytoplankton chlorophyll a was greater than the average of micro-phytoplankton chlorophyll a at Bandon Bay.

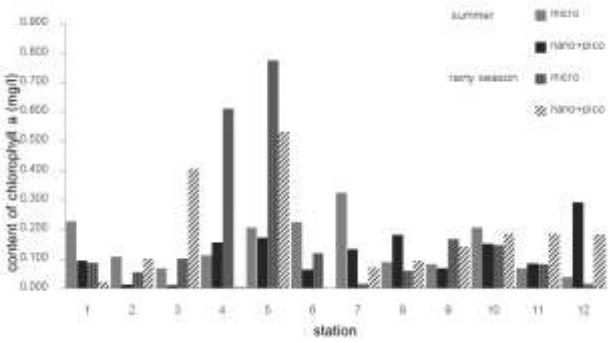

Fig. 3 Variation of biomass in the form of chlorophyll a in pico and nano-phytoplankton comparing to micro-phytoplankton at aquaculture area in Bandon bay, Thailand

Comparison of micro-phytoplankton chlorophyll a and nano and pico-phytoplankton chlorophyll a with the area was found that in summer the proportion of stations composed of micro-phytoplankton chlorophyll a higher than nano and pico-phytoplankton chlorophyll a was estimated 67 % (Fig. 4). While in rainy season, the proportion of stations consisted of nano and pico-phytoplankton chlorophyll a greater than micro-phytoplankton chlorophyll a was 58 % (Fig. 5).

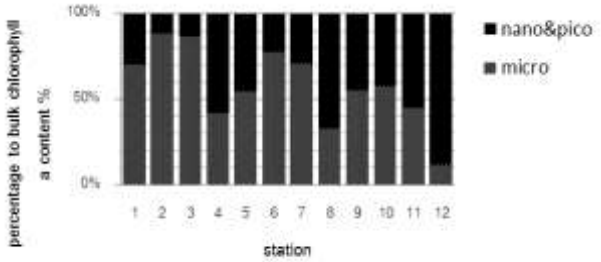

Fig. 4 Size-fractionated chlorophyll a in summer at Bandon Bay, Thailand

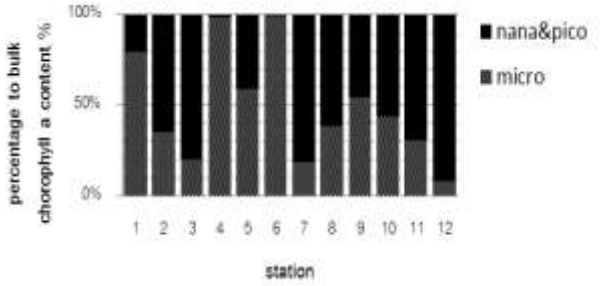

Fig. 5 Size-fractionated chlorophyll a in rainy season at Bandon Bay, Thailand

Our results corresponded to the study of [8] which reported that phytoplankton in the size smaller than 20 micron like nano and pico-phytoplankton would compose of biomass in the range of 20-90% of the total phytoplankton, and biomass of nano- and pico-phytoplankton may relate to the habitat. Pico-phytoplankton took a greater role in the ecosystem of coastal areas with low nutrients and the water character was quite clear.

Considering the water quality in Bandon Bay, it was found that in rainy season, the content of ammonia, orthophosphate and silicate was slightly higher than those in summer in all area of the east coast, west coast and estuary of Tapi river. While only at the west coast was shown the high content of nitrite and nitrate in summer than the rainy season.

In rainy season, it was found the highest content of ammonia, nitrite and nitrate at the estuary of Tapi river, while the highest content of phosphate was shown in the west coast. It clearly indicated that the mouth of Tapi river had a plenty of nutrients much more than the other area and well consistent to the high content of total chlorophyll a found there. The stations located near the estury of Tapi river appeared the highest content of chlorophyll a and stations near the shore showed the high amount rather than the far side. It caused that during rainy season sediments and nutrients from communities, agricultural areas and water inland had flowed into the bay via Tapi river and mixed between freshwater and seawater resulting in physical and biological changes in a wide range. Nutrients and mineral would accumulate near the mouth of the river much more than the far area from the coast, making this area was fertility. Including salinity occurred in the wide range which was suitable for growth of phytoplankton and small organisms, as a result of high amount of chlorophyll content.

The proportion of biomass derived from micro-phytoplankton chlorophyll a and nano and pico-phytoplankton may affect from the other factor, predator. The predator of small phytoplankton was zooplankton, mainly mucus net feeder; larvaceans, which was predominantly observed in the mouth of Tapi river and Bandon Bay [12], thus resulting the distribution of the biomass proportion of micro-phytoplankton and nano and pico-phytoplankton chlorophyll a in different of the area. Finally, it was concluded that not only season but also area, influenced size-fractionated Chlorophyll a in aquaculture area at Bandon Bay, Thailand.

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