ORIGINAL PAPER

Seasonal change of phytoplankton at Hat Pak Meng, the Andaman Sea

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Abstract. Phytoplankton is a very important food source for economically important marine organisms, particularly bivalves. However, ecological studies of phytoplankton in Thai waters are quite limited. The seasonal variation of phytoplankton in coastal areas is related to several physicochemical and biological factors. This study aimed to examine the seasonal variation on composition and abundance of phytoplankton at Hat Pak Meng beach, Trang Province, the Andaman Sea. Sampling was carried out during dry (February, March and April) and a rainy season (September, October, November), using a standard 20 μm mesh plankton net with a mouth diameter of 30 cm, equipped with a flow meter, by horizontal hauls during day time. Thirty-one different taxa of phytoplankton were recorded. The dominant phytoplankton groups in the dry season were Coscinodiscus sp., *Chaetoceros* sp. and *Protoperidinium* sp., while in the rainy season the last was replaced by *Ceratium* sp. The fluctuation in rainfall regimes induces changes in physicochemical and biological factors which lead to seasonal variation of the composition of phytoplankton taxa.

Keywords: phytoplankton, Andaman Sea, diatoms, abundance

1. Introduction

Phytoplankton are the main primary producers through all shallow water ecosystems, playing a key role in maintaining the structure and functioning of marine coastal communities (Malone et al. 2016). Abundance and composition of this group show a great spatiotemporal variation on coastal areas due to their sensitivity to seasonal variations in salinity, pluviosity, temperature and nutrient availability (Berg & Newell 1986; Varela 1996; Stolte et al. 1994, Troccoli et al. 2004). Several characteristics drive this dynamism, such as their size and rapid growth rates due to high nutrient intake (Malone 1980; Stolte et al. 1994). Thus phytoplankton are usually the first group to respond to changes in environmental conditions, especially when they affect the available nutrients (Livingston 2000; Paerl et al. 2003). As the energetic base for the marine food web, changes in phytoplankton composition is reflected in all marine faunal communities (Legendre and Le Fèvre 1995; Sokołowski et al. 2012). Therefore, understanding the dynamics of seasonal variation in phytoplankton communities is extremely important to predict the potential effects of periodic environmental changes on coastal fauna, especially to primary consumers such as zooplankton.

2. Materials and Methods

2.1 Study site and sample collection

This study was conducted at Hat Pak Meng, Trang Province. Phytoplankton sampling was carried out during dry season (February, March and April) and rainy season (September, October) in 2018. Samples were collected using a standard 20 μm mesh planktonic net with a mouth diameter of 30 cm, equipped with a flow meter, by horizontal hauls in day time. The samples were preserved in a 10% buffer formalin solution. In a laboratory, specimens were then identified to genus level and counted under a compound light microscope. The abundance of each phytoplankton group was expressed in individuals/m^3 (ind./m^3). The environmental parameters (temperature, salinity, pH, and dissolved oxygen) were recorded by using the Handheld pH and Conductivity Monitoring - YSI - Model 63 with 100-foot cables

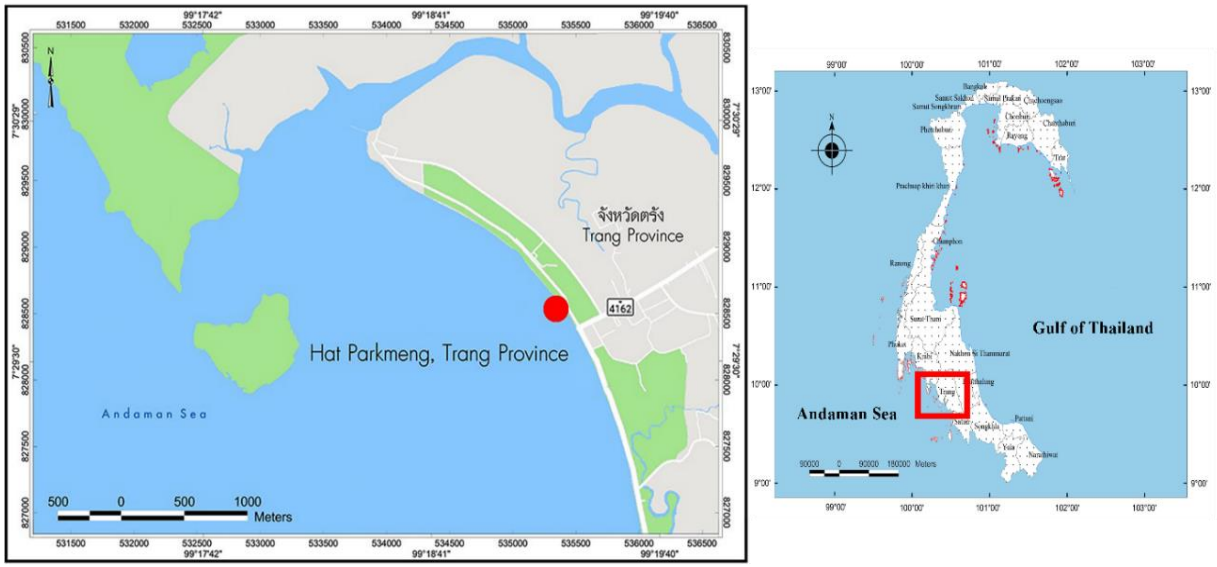

Figure 1. Location of the sampling site at Hat Pak Meng

2.2 Statistical analysis

One-way ANOVA with Fisher's LSD was performed to detect the difference of plankton density between seasons, using R program version 3.5.0 with "vegan" package. The spearman's correlations was used to identify the correlation between dominant genera and environmental parameters.

3. Results

A total of 39 phytoplankton genera were recorded in this study, belonging to six different families, consisting of one blue-green algae (Cyanophyceae), 27 genera of diatoms (Bacillariophyceae, Coscinodiscophyceae, and Mediophyceae) and 11 genera of dinoflagellates (Dinophyceae and Noctilucophyceae) (Table 1.). The richness of genera between seasons was similar, 28 phytoplankton genera were found during the rainy season while in the dry season 31 genera were recorded. The dominant phytoplankton genus was *Chaetoceros* sp. followed by *Coscinodiscus* sp. during both seasons.

The highest density of phytoplankton was recorded during the dry season (87,208.07± 8,448.29 ind./m^3), while the lowest one was found in rainy season (7,696.39± 3,855.94 ind./m3) as shown in Figure 2. However, the average abundance of phytoplankton found in the summer season (57,061.22±21,320.98 ind./m^3) was not significantly different from those found during winter season (39,607.22± 27,383.77 ind./m^3).

During the investigation period, water temperature varied between 28.94±0.13-32.17±0.09 °C (Table 2). All parameters showed a narrow range of variation. The dominant ganera Chaetoceros was positively correlated with salinity (p=0.55), while *Rhizosolenia* sp. showed a positive correlation with salinity (p=0.61), and was negatively correlated with pH value (p=0.70). The abundance of dinoflagellate Ceratium was positively correlated with pH value (p=0.60). However, the *Ceratium* spp. exhibited negatively correlation with salinity (p=0.73) (Table 3.).

4. Discussion

This study revealed the abundance of phytoplankton at Hat Pak Meng was high when compared with Similan islands and some coastal areas in Trang Province (Charoenvattanaporn et al. 2018; Iqbal et al. 2017; Tarangkoon et al. 2012). The abundant phytoplankton, Cocsinodiscus, and Ceratium have been reported as abundant species in Trang and Phangnga Provinces (Iqbal et al. 2017; Charoenvattanaporn et al. 2018). In tropical regions, phytoplankton density varies from freshwater to estuarine zones and between dry to wet seasons (Varona-Cordero et al. 2010).

Table 1. A checklist of phytoplankton at Hat Pak Meng, Trang Province

Phylum	Class	Order	Family	Species
Cyanobacteria	Cyanophyceae	Oscillatoriales	Oscillatoriaceae	*Oscillatoria* sp.
Bacillariophyta	Bacillariophyceae	Bacillariales	Bacillariaceae	*Bacillaria paxillifera*
				Cylindrotheca closterium
				Nitzchia longissima
				Pseudo-nitzschia sp.
		Naviculales	Naviculaceae	*Gyrosigma* sp.
				Navicula sp.
			Pleurosigmataceae	*Pleurosigma* sp.
		Surirellales	Entomoneidaceae	*Entomoneis* sp.
		Thalassionematales	Thalassionemataceae	*Thalassionema* sp.
	Coscinodiscophyceae	Asterolamprales	Asterolampraceae	*Asterolampra* sp.
		Coscinodiscales	Coscinodiscaceae	*Coscinodiscus* sp.
				Palmeria sp.
		Rhizosoleniales	Probosciaceae	*Proboscia* sp.
			Rhizosoleniaceae	*Guinardia* sp.
				Rhizosolenia sp.
		Triceratiales	Triceratiaceae	*Tricerratium favus*
	Mediophyceae	Chaetocerotales	Chaetocerotaceae	*Bacteriastrum* sp.
				Chaetoceros sp.
		Eupodiscales	Odontellaceae	*Odontella sinensis*
		Hemiaulales	Hemiaulaceae	*Cerataulina* sp.
				Eucampia zodiacus
				Hemiaulus sp.
		Lithodesmiales	Lithodesmiaceae	*Ditylum* sp.
		Thalassiosirales	Lauderiaceae	*Lauderia* sp.
			Skeletonemataceae	*Skeletonema* sp.
			Thalassiosiraceae	*Planktoniella* sp.
				Thalassisira sp.
Miozoa	Dinophyceae	Dinophysales	Dinophysaceae	*Dinophysis* sp.
		Gonyaulacales	Ceratiaceae	*Ceratium brevis*
				Ceratium carriensis
				Ceratium declinatum
				Ceratium macroceros
				Ceratium massiliensis
				Ceratium trichoceros
			Pyrocystaceae	*Pyrocystis lunula*
				Pyrophacus sp.
		Peridiniales	Protoperidiniaceae	*Protoperidinium* sp.
	Noctilucophyceae	Noctilucales	Noctilucaceae	*Noctiluca* sp.

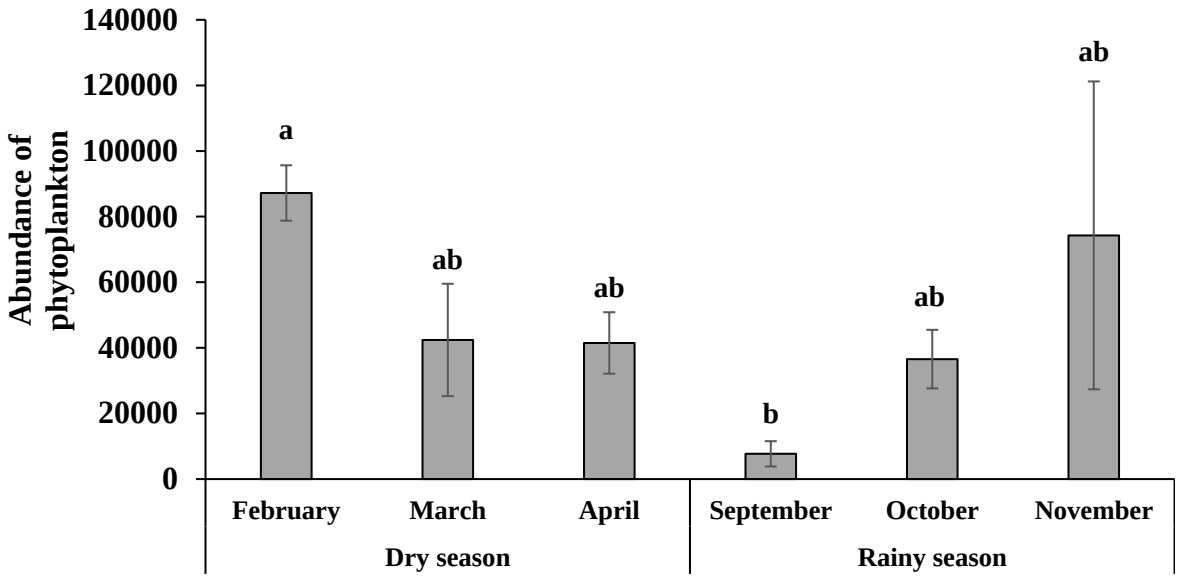

Figure 2. Abundance of phytoplankton in dry and rainy season at Hat Pak Meng

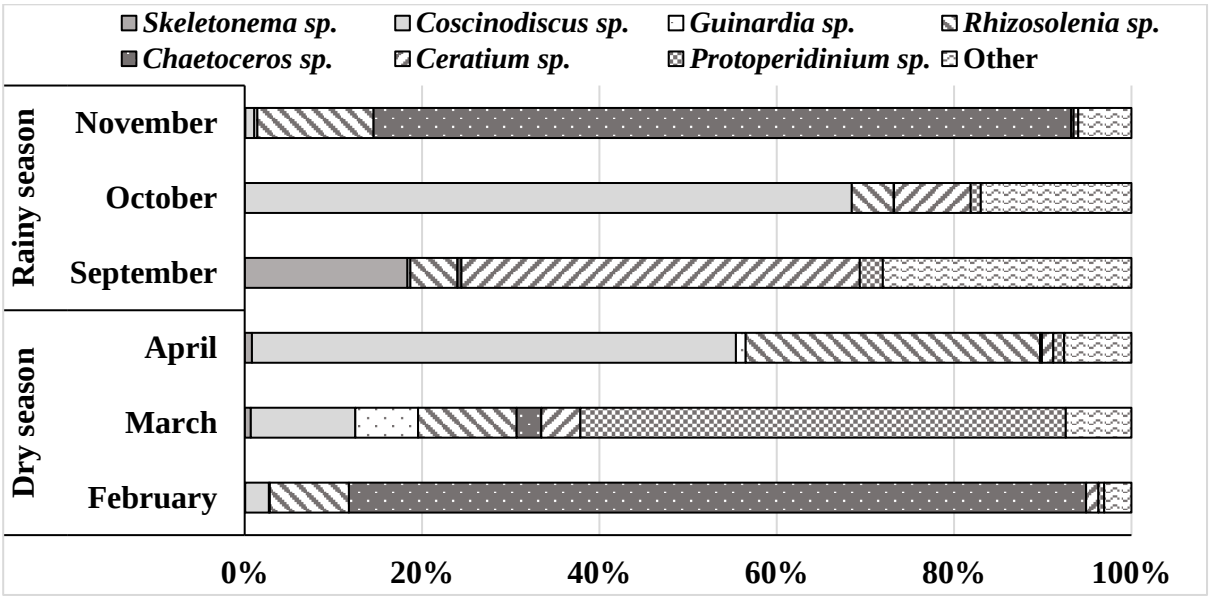

Figure 3. Proportion of phytoplankton communities at Hat Pak Meng

Table 2. Environmental parameters at sampling site

Sampling periods	Environmental parameters			
	Temperature (°C)	Salinity (psu)	pH	DO (mg/L)
Dry season				
February	29.16±0.09	31.66±0.10	7.58±0.06	5.26±0.05
March	29.46±0.09	30.94±0.09	8.01±0.09	5.13±0.08
April	29.87±0.08	31.63±0.09	7.67±0.09	5.21±0.10
Rainy season				
September	28.94±0.13	31.05±0.11	8.18±0.03	5.27±0.08
October	32.17±0.09	31.10±0.13	8.18±0.09	4.24±0.05
November	31.88±0.13	32.86±0.13	8.02±0.06	4.65±0.09

Table 3. Correlation between the abundant phytoplankton and the environmental parameters

Species	Environmental parameters			
	Temperature	**Salinity**	**pH**	**DO**
Ceratium sp.	-0.16	-0.73	0.60	-0.06
Chaetoceros sp.	-0.16	0.55	-0.44	0.22
Coscinodiscus sp.	0.18	-0.08	-0.13	-0.41
Rhizosolenia sp.	0.23	0.61	-0.70	0.12

Additionally, physical variables such as water temperature and salinity exhibit significant effects on the hydrobiology of any aquatic ecosystem, and phytoplankton distribution and composition have been reported to relate to seasonal changes in freshwater flow, salinity, and turbidity, and nutrient availability (Barber and Smith 1981; Cushing 1989; Chang et al. 1992; Smith and Kemp 2001; Pelleyi et al. 2008; Costa et al. 2009; Nirmal Kumar et al. 2009).

The dominant phytoplankton genera varied between months but not between seasons. Phytoplankton are highly sensitive to environmental changes, responding not only with shifts in total biomass but also in composition (Winder and Sommer 2012), in fact, differences in tolerance to environmental conditions between different species have been reported in previous studies (Heino and Soininen 2006; Fariñas et al. 2015). Furthermore, composition variability might be also explained by other factors not addressed in study, such as nutrients, competition, and light intensity (Litchman and Klausmeier 2008). Phytoplankton association to seasonal variations in nutrient availability in the coastal waters of Thailand is still poorly understood and further investigation should be conducted to clarify this matter. The present study serves as a baseline for future research by reporting seasonal variability in dominant phytoplankton taxa at Hat Pak Meng, the Andaman Sea coast of Thailand.

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