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MARINE PHYTOPLANKTON OF PHRA THONG ISLAND ON THE WESTERN COAST OF THAILAND

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ABSTRACT: A study on the diversity of marine phytoplankton at Phra Thong Island, Phangnga Province, Thailand was carried out in January 2016. Phytoplankton was sampled at 12 stations using plankton nets with mesh size of 20 micrometres. A standard bottle was used to collect water samples for vertical distributions study at 1–3 levels: subsurface, middle and 0.5 metre above the bottom. Sixty-five species were identified by light microscope. Forty-nine diatom, 12 dinoflagellate, 3 cyanophyte, and 1 silicoflagellate species were found. The most diverse dinoflagellate genus was *Ceratium*. Other diverse diatom genera were *Chaetoceros* and *Rhizosolenia*. Phytoplankton density ranged 38–1,230 cells L^{-1}. Following species were most abundant *Guinardia flaccida*, *Rhizosolenia bergonii*, and *Bacteriastrum hyalinum*. Principal component analysis suggested that the structure of the phytoplankton communities was determined by hydrology and nutrient concentrations. Multivariate analysis revealed that a total dissolved nitrogen and phosphorus concentrations were the major factors controlling phytoplankton abundance. The results of the present study give an improved understanding of the factors that structure the coastal phytoplankton communities at Phra Thong Island.

Keywords: biodiversity, marine phytoplankton, Phra Thong Island, the Andaman Sea

INTRODUCTION

Phytoplankton are important as primary producers and have numerous functions in aquatic ecosystems. They also play an important role in biogeochemical cycles as they are an integral part of the global carbon cycle (Falkowski *et al*. 1998; Gregg *et al*. 2003). Phytoplankton are important components of coastal ecosystem but rapid changes in their physical environment can influence the species composition (McLusky and Elliott 2004). Therefore, when there have been environmental changes in the region is it motivated to study the phytoplankton diversity and abundance. Mangrove habitats occur adjacent to coastal waters where freshwater inputs from land and oceanic sources are mixed by hydrodynamic processes.

Phra Thong Island is located at Khura Buri, Phangnga Province about 2 kilometres from the shore. The island is a very diverse environment for example beaches, mangrove, swamp meadows and shrubs. The coastal areas of the island have previously been studied on marine biodiversity; however, it is of course not covering all resources. In marine plankton research, Huvanon (2008) has studied the biodiversity at Ra Islands-Phra Thong Island National Park during 2004–2005, and showed that it consisted of 168 species of phytoplankton and 78 species of zooplankton during the northeast monsoon season. There was no following record of phytoplankton diversity after Huvanon (2008).

A number of authors have suggested the use of phytoplankton as bio-indicator of the change in water quality (Underwood *et al*. 1998; Bellinger and Sigee 2010). The present study attempts to understand the taxonomy and distribution of phytoplankton community in mangrove and seagrass ecosystem at the eastern side of Phra Thong Island, Phangnga Province. The main aim of the present study was to investigating the spatial variability of the physiochemical variables, phytoplankton abundances and biomass in Phra Thong Island, Phangnga Province.

MATERIALS AND METHODS

Study site

Phra Thong Island is located in Ra Islands-Phra Thong Island National Park, Khura Buri District, Phangnga Province, Thailand. It has an area of 92 km^2 and is located 1.5 km from the mainland off the western coast of Thailand in the Andaman Sea (Phuket Marine Biological Center 2008). The eastern coastline of the island is dominated by mangrove forest whilst the western shoreline primarily has narrow sandy beaches. Aquaculture development features with fish cage cultures exist on the northeast coast of the island.

This study was conducted in January 2016. On the eastern coast of Phra Thong Island, three stations (1–3) were sampled in the shallow canal with sandy bottom, station 4–9 were sampled in an area with seagrass. Three stations (10–12) were sampled west of the mainland in a mangrove area (Fig. 1). Total depth ranged 0.8 and 9.0 metres between the stations.

Methods

Seawater samples were collected during day time at 1–3 levels: subsurface, middle and 0.5 metre above the bottom depending on the total depth of the water. At each station, 20 litres of seawater were immediately filtered using standard plankton net (mesh size 20 µm) and using a brown glass bottle to store the filtrate in. The collected samples were preserved directly with a final concentration of 2–3% formalin for later laboratory analysis. The subsample of 1 mL was transferred into a Sedgewick Rafter Counting chamber slide and left to settle for at least 0.5–1 hour before placing on a Nikon Eclipse E600 light microscope for identification and enumeration. Tomas (1997), Wongrat (2001), and Round *et al*. (2007) were used for identification of marine phytoplankton

Physicochemical parameters were taken at the same time as the phytoplankton collecting. The eleven factors were: salinity, dissolved oxygen (DO), total suspended solids (TSS), pH, water temperature, dissolved inorganic nitrogen (DIN: nitrite, nitrate, ammonia), total dissolved nitrogen (TDN), orthophosphate, and total dissolved phosphorus (TDP). Some environmental parameters were *in situ* measured including salinity (refractometer), pH (digital pH meter), DO (DO meter), and temperature (thermometer). The TSS concentration was determined by filtering 1000 mL of seawater through pre-weighted 47 mm Whatman GF/C filters and dried on them. The filtered samples were dried overnight at 80ºC for 24 hours and then re-weighed. All nutrient concentrations were determined according to standard methods described in APHA (1992). Chlorophyll *a* concentration was also determined by measurements by spectrophotometer in order to estimate phytoplankton biomass, according to the method of Parsons *et al*. (1984).

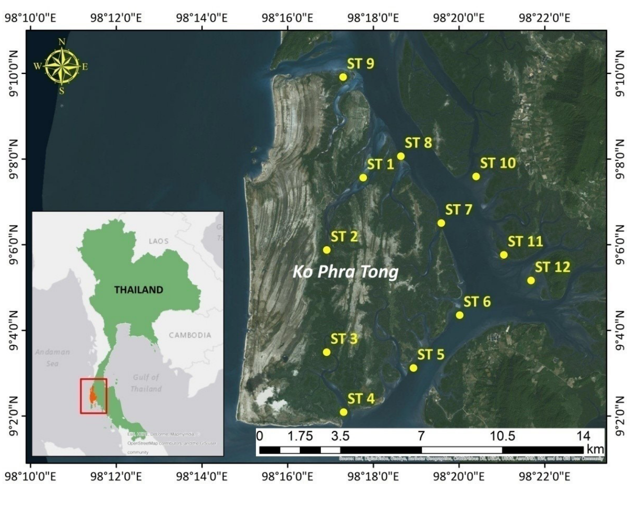

Figure 1. Map of Phra Thong Island, Phangnga Province, Thailand showing the twelve sampling stations.

Statistical analysis

Data analysis was undertaken using Microsoft Excel 2013, Sigma Plot 11, PRIMER-E 7 (Plymouth Routines In Multivariate Ecological Research), and CANOCO 4.5 software (CANOCO, Microcomputer Power, Ithaca, NY). PRIMER-E 7 was used for cluster analysis and matrix display by shade plot to resolve the complexity of the phytoplankton abundance (Clarke and Warwick 1994; Clarke *et al*. 2014). The phytoplankton abundance data were transformed to the square root before illustrating by simple shade plot and nMDS plot. CANOCO software was used in this study to analyse the effect of selected environmental parameters on the phytoplankton abundance. To assess interactions between environmental parameters and phytoplankton groups, a redundancy analysis (RDA) was carried out using the CANOCO 4.5 software package (Ter Braak and Šmilauer 2002). This analysis determines the environmental variables that best explain the distribution of the main selected taxonomic groups, by selecting the linear combination of environmental variables that yields the smallest total residual sum of squares in the taxonomic data (Peterson *et al*. 2007).

RESULTS AND DISCUSSION

Hydrographic factors

The mean environmental and chemical parameters of Phra Thong Island in January 2016 are shown in Figures 2 and 3. Salinity values varied over a wide range during the sampling period (26–31 ppt). The lowest values were recorded in mangrove areas near the mainland (stations 11 and 12). Water temperature ranged 29.5–31.0ºC. The pH varied over a narrow range (7.56–8.16). The dissolved oxygen concentrations generally reached 5 mg L^{-1} during the study period. Total suspended solid concentration (TSS) was high next to the mainland (stations 11–12) as shown in Fig. 2. The chlorophyll a concentrations were generally below 2 mg L^{-1} (Fig. 2). The lowest concentration was measured at station 11 (0.12 mg L^{-1}).

All nutrients fluctuated as shown in Fig. 3. Nitrite concentrations were generally detected as below 0.1 µM L^{-1} in all samples. Nitrate concentrations were low along the sampling sites with a range of 1.51–3.13 µM L^{-1}. Ammonia concentration fluctuated significantly (6.56–11.6 µM L^{-1}) with the highest concentration at station 9. Total dissolved nitrogen concentrations were slightly higher at stations 7–12. Orthophosphate concentrations were generally below 0.3 µM L^{-1} in the samples, reaching the highest value of 0.4 µM L^{-1} at station 1. Total dissolved phosphorus concentrations ranged between 0.37 and 0.42 µM L^{-1}. Dissolved silicate concentrations were generally below 10 µM L^{-1}, reaching the highest value of 14.52 µM L^{-1} at the subsurface depth at station 10.

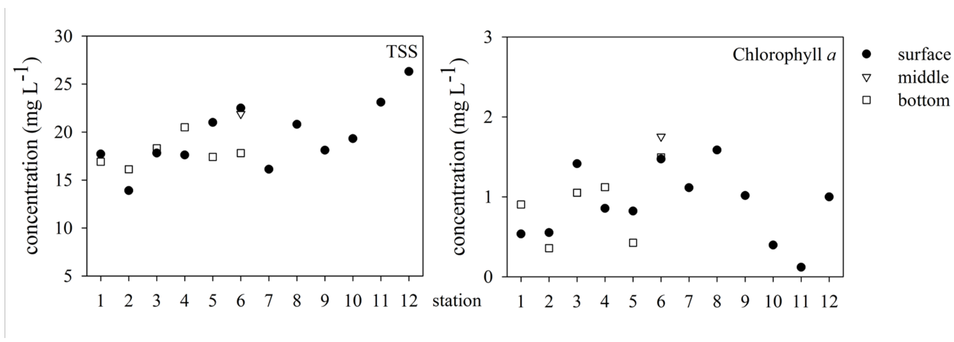

Figure 2. Distribution of total suspended solids and chlorophyll *a* concentration at Phra Thong Island, Phangnga Province in January 2016. Symbols apply to all charts.

In the study, high nutrient concentrations were observed to be proper for the growth of diatoms as observed by Underwood *et al*. (1998) and the ammonia value was high in this site. Thus, in particular at aquaculture areas (the northern part of the island, station 8 and 9), ideal high ammonia concentrations are beneficial for the growth of the diatom species.

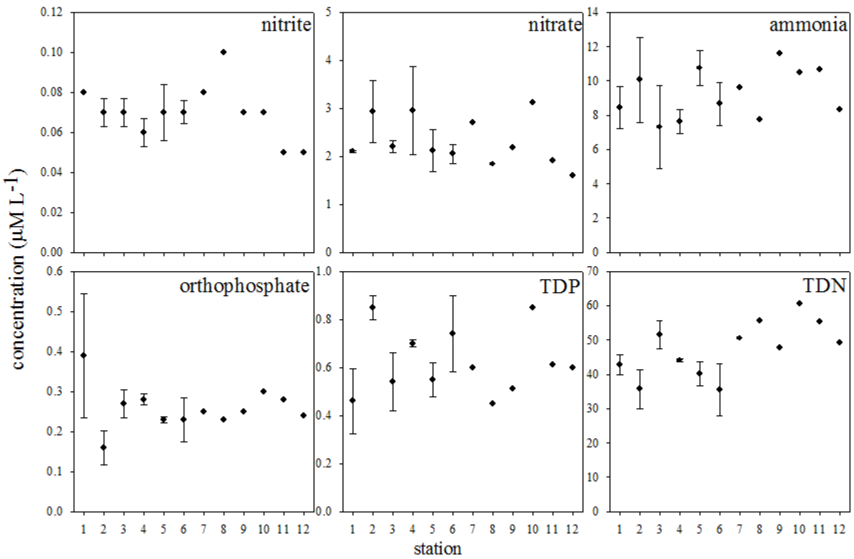

Figure 3. Mean nutrient variables measured in January 2016 at Phra Thong Island, Phangnga Province.

Phytoplankton community structure and composition

A visible change in phytoplankton community regarding abundance and species composition was evident along the study sites. At least 65 phytoplankton species were quantified through the analysis of all samples collected at Phra Thong Island as shown in Table 1. Diatoms were diverse (49 species), whilst dinoflagellates, cyanophytes, and silicoflagellates were represented by 12, 3 and 1 species, respectively. The genus *Ceratium* was most diverse (6 species) followed by the genera *Chaetoceros* and *Rhizosolenia* with 7 and 4 species, respectively.

This study recorded 49 diatom species belonging to 31 genera in 13 families and 2 orders. The most diverse genera were *Chaetoceros* followed by *Rhizosolenia* and *Hemiaulus*. The most frequent diatoms species were *Cyclotella* sp., *Lauderia annulata*, *Coscinodiscus* sp., *Guinardia flaccida*, *Pseudosolenia calcaravis*, *Chaetoceros* spp., *Bacteriastrum* spp., and *Amphora* sp. These dominant diatoms have previously also been reported by Huvanon (2008). The abundances of diatoms in this study ranged 64–1,103 cells L^{-1} and the highest mean abundance of diatom species occurred at the station 9.

At least 14 species belonging to 7 genera in 5 families and 4 orders of coastal dinoflagellates were identified. The most diverse genus was *Ceratium* (8 species). The most frequent dinoflagellate genera were *Peridinium* and *Protoperidinium*. The density range of dinoflagellates was 9–96 cells L^{-1} and the highest dinoflagellate abundance occurred at station 10 where *Peridinium* spp. were most abundant (85 cells L^{-1}) followed by *Dinophysis caudata* (7 cells L^{-1}). The dominant dinoflagellate species in this study consisted of *Dinophysis caudata*, *Ceratium furca*, *C. fusus*, *Peridinium* spp., and *Protoperidinium* spp. Huvanon (2008) also observed that this group grow to high biomass in this area.

The cyanophyte species, *Trichodesmium* spp. and *Pseudo-anabaena* sp., were present in almost all stations throughout the study site. The abundance of *Trichodesmium* spp. between the stations 1 and 9 ranged 1–28 cells L^{-1}, whereas *Pseudo-anabaena* sp. was 1–50 cells L^{-1}. In this study, *Richelia intracellularis* was only found at the station 1 and 2 with a range of 2–25 cells L^{-1}.

We describe the phytoplankton community based on microscopic analysis. The diatoms were present in highest abundance followed by dinoflagellates, cyanophytes, and silicoflagellates. Similar observations, highest biomass of diatoms along with dinoflagellates, have previously been recorded in this area (Huvanon 2008). We found that the total number of phytoplankton species was significantly lower than in the 2004–2005 survey by Huvanon (2008) at Ra Islands-Phra Thong Island National Park. The previous study recorded 168 species and 77 genera. The reasons are probably different water quality and that the samples were collected in a different monsoon season. Additionally, our phytoplankton collection consisted of 20-litres of filtered sea water while Huvanon (2008) filtered 100-litres per sample. This may explain the difference in phytoplankton diversity.

Table 1. Taxonomic list and abundance of coastal phytoplankton (in unit cells L^{-1}) at the Phra Thong Island, Phangnga Province, Thailand in January 2016.

no.	List station	1	2	3	4	5	6	7	8	9	10	11	12
	Division Cyanophyta												
	Class Cyanophyceae												
	Order Oscillatoriales												
	Family Oscillatoriaceae												
1	*Trichodesmium* sp.	15	11	2	5	8	4	4	-	21	-	-	-
2	*Pseudo-anabaena* sp.	2	-	3	3	6	7	11	50	25	-	11	-
	Family Nostocaceae												
3	*Richelia intracellularis* Schmidt	14	5	-	-	-	-	-	-	-	-	-	-
	Division Chromophyta												
	Class Bacillariophyceae												
	Order Biddulphiales												
	Suborder Coscinodiscineae												
	Family Thalassiosiraceae												
4	*Cyclotella* sp.	2	2	5	9	5	19	60	74	64	46	18	35
5	*Lauderia annulata* Cleve	4	-	6	19	4	15	28	35	71	7	25	-
6	*Skeletonema costatum* (Greville) Cleve	-	-	1	4	-	-	7	-	-	-	-	-
	Family Melosiraceae												
7	*Paralia sulcata* (Ehrenberg) Cleve	-	-	-	2	-	1	-	-	-	-	-	-
8	*Stephanopyxis* sp.	-	-	-	-	-	-	4	-	4	-	-	-
	Family Leptocylindraceae												
9	*Leptocylindrus* sp.	-	-	-	-	-	7	-	7	-	-	4	-
	Family Coscinodiscaceae												
10	*Coscinodiscus* sp.	14	6	35	5	1	11	43	78	78	32	7	25
	Suborder Rhizosoleniineae												
	Family Rhizosoleniaceae												
11	*Dactyliosolen* sp.	4	-	6	3	9	18	39	35	60	11	11	32
12	*Guinardia flaccida* (Castracane) H. Peragallo	8	1	8	15	15	8	43	113	117	-	35	11

no.	List station	1	2	3	4	5	6	7	8	9	10	11	12
13	*Proboscia alata* (Brightwell) Sundström	-	-	-	-	5	1	4	-	-	-	-	-
14	*P. indica* (H. Peragallo) Hernández-Becerril	2	-	4	-	-	1	-	-	11	-	-	-
15	*Pseudosolenia calcaravis* (Schultze) Sundström	4	2	6	11	18	8	21	32	39	-	39	39
16	*Rhizosolenia bergonii* H. Peragallo	8	-	1	-	-	41	64	110	110	18	14	82
17	*R. hyaline* Ostenfeld	-	-	-	-	-	-	-	-	11	-	-	-
18	*R. robusta* Normann	-	-	-	-	4	1	-	-	-	-	-	-
19	*Rhizosolenia* spp.	2	9	27	40	70	4	-	4	7	-	-	-
	Family Hemiaulaceae												
20	*Eucampia cornuta* (Cleve) Grunow	-	-	2	-	-	-	-	-	-	-	-	-
21	*E. zodiacus* Ehrenberg	-	-	-	-	-	1	-	-	14	-	7	-
22	*Hemiaulus hauckii* Grunow	-	-	-	-	-	1	-	-	-	-	-	-
23	*H. indicus* Karsten	-	-	-	-	-	1	18	-	-	-	-	-
24	*H. membranaceus* Cleve	-	-	-	-	-	1	-	-	7	-	-	-
25	*H. sinensis* Greville	-	-	-	-	-	-	-	-	18	-	-	-
	Suborder Biddulphiineae												
	Family Chaetoceraceae												
26	*Bacteriastrum furcatum* Shadbolt	2	2	2	33	22	-	-	43	-	-	-	-
27	*B. hyalinum* Lauder	5	-	5	3	2	6	28	-	113	-	21	25
28	*Chaetoceros coarctatus* Lauder	-	-	-	1	-	1	-	-	-	-	-	-
29	*C. compressus* Lauder	-	2	4	3	11	4	-	21	28	4	7	-
30	*C. diversus* Cleve	-	-	1	1	1	1	-	4	7	-	-	-
31	*C. lorenzianus* Grunow	4	1	15	12	21	12	18	53	39	-	25	21
32	*C. peruvianus* Brightwell	-	-	1	8	2	1	4	7	-	-	7	-
33	*C. pseudocurvisetus* Mangin	2	-	-	2	1	1	32	11	7	-	-	7
34	*Chaetoceros* spp.	8	5	50	36	18	32	43	82	82	25	28	39
	Family Lithodesmaceae												
35	*Bellerochea malleus* (Brightwell) Van Heurck	-	-	-	-	-	-	7	-	-	-	-	-
36	*Ditylum brightwellii* (West) Grunow	-	-	-	-	-	-	-	-	4	-	-	-
37	*D. sol* Grunow	2	-	2	3	4	1	32	18	14	-	-	4
	Family Eupodiscaceae												
38	*Odontella aurita* (Lyngbye) C.A Agardh	-	-	-	-	-	1	-	-	-	-	-	-
39	*O. sinensis* (Greville) Grunow	6	-	5	6	8	5	11	32	7	-	-	-
	Order Bacillariales												
	Suborder Fragilariineae												
	Family Thalassionemataceae												
40	*Thalassionema frauenfeldii* (Grunow) Hallegraef	-	-	1	2	26	4	18	21	43	-	4	-
41	*T. nitzschioides* (Grunow) Mereschkowsky	4	-	1	1	1	-	-	-	7	-	-	-

no.	List station	1	2	3	4	5	6	7	8	9	10	11	12
	Suborder Bacillariineae												
	Family Naviculaceae												
42	*Amphora* sp.	11	11	4	3	6	2	7	-	21	35	21	35
43	*Diploneis* sp.	-	2	2	2	-	2	39	7	14	11	11	-
44	*Gyrosigma* sp.	4	4	2	4	4	6	25	18	28	46	21	25
45	*Meuniera membranacea* (Cleve) P.C. Silva	4	-	1	3	2	6	-	14	28	-	-	7
46	*Navicula* sp.	11	1	-	2	2	1	18	-	18	-	7	25
47	*Trachyneis* sp.	-	1	2	1	2	1	-	-	-	4	-	4
	Family Bacillariaceae												
48	*Cylindrotheca closterium* (Ehrenberg) Reimann et Lewin	-	-	-	2	-	1	-	-	-	-	-	-
49	*Nitzschia* sp.	3	14	-	1	4	3	14	11	25	21	14	46
50	*Pseudo-nitzschia pungens* (Grunow& Cleve) Hasle	2	-	7	2	6	-	-	-	-	-	-	-
	Family Surirellaceae												
51	*Entomoneis robusta* (Mc Call) Reimer	-	-	-	-	1	1	7	-	7	-	14	28
52	*Surirella* sp.	-	-	-	-	-	1	14	7	-	4	4	14
	Class Dictyochophyceae												
	Order Dictyochales												
	Family Dictyochophyceae												
53	*Dictyocha fibula* Ehrenberg var. - *stapedia*(Haeckel) Lemmermann	-	-	-	-	2	-	-	-	-	-	-	-
	Class Dinophyceae												
	Order Prorocentrales												
	Family Prorocentraceae												
54	*Prorocentrum micans* Ehrenberg	-	-	-	2	-	2	-	-	-	-	-	-
	Order Dinophysiales												
	Family Dinophysiaceae												
55	*Dinophysis caudata* Saville–Kent	2	-	-	-	-	-	18	4	4	7	-	-
56	*Ornithocercus* sp.	-	-	-	-	-	-	11	-	-	-	-	-
	Order Gonyaulacales												
	Family Ceratiaceae												
57	*Ceratium furca* (Ehrenberg) Claparède & Lachmann	-	-	-	-	21	4	-	11	14	-	7	-
58	*C. fusus* (Ehrenberg) Dujardin	-	-	-	1	-	1	11	11	14	-	-	4
59	*C. longirostrum* Gourret	-	-	-	-	-	1	-	-	-	-	-	-
60	*C. massiliense* (Gourret) Jörgensen	-	-	-	-	-	1	-	-	-	-	-	-
61	*C. porrectum* (Karsten) Jörgensen	-	-	-	-	-	1	-	-	-	-	-	-
62	*C. trichoceros* (Ehrenberg) Kofoid	-	-	-	-	-	1	-	-	-	-	-	-
	Family Pyrophacaceae												
63	*Pyrophacus horologium* Stein	-	-	-	-	2	5	-	4	-	4	-	4
	Order Peridiniales												

no.	List	station	1	2	3	4	5	6	7	8	9	10	11	12
	Family Peridiniaceae													
64	*Peridinium* spp.		2	9	7	1	2	14	11	25	14	85	14	11
	Family Protoperidiniaceae													
65	*Protoperidinium* spp.		6	-	2	16	11	3	-	11	35	-	4	18
	total		**154**	**89**	**220**	**266**	**323**	**269**	**709**	**950**	**1,230**	**358**	**379**	**539**

Phytoplankton diversity

The dominance of phytoplankton species (cells L^{-1}) is illustrated by shade plot (Fig. 4). Bray-Curtis similarity was performed between each pair of samples, with depth, and by clustering this matrix to demonstrate the similarity associations in the plots (Fig. 5).

The amount of phytoplankton along the Phra Thong Islands is represented by the grey shades with black bands that indicate high abundance and grey bands that show low abundance. Fig. 4 is a shade plot for the most important species of diatoms. Cluster analysis of phytoplankton abundance resulted in three major clusters with a similarity level range of about 50%. The diatom species were most abundant at stations 8 and 9, whilst the dinoflagellates peaked at station 10. Diatoms were the dominant taxon in our study, as they also were in the previous investigation by Huvanon (2008). The most abundant diatom species was *Rhizosolenia bergonii* followed by *Guinardia flaccida* and *Chaetoceros* spp. at stations 8 and 9, respectively. The centric diatom, *Bacteriastrum hyalinum*, was also common in station 9.

The biomass of the coastal dinoflagellate, *Peridinium* spp., was highest at station 10 close to the mangrove and near a mainland village (Fig. 4). Cluster analysis of phytoplankton abundance resulted in three major clusters with a similarity level range of 50% (Fig. 5). Station 1 (bottom) had lowest abundance as it also was in station 2 (both sampling depths). *Peridinium* spp. was abundant at station 10.

Correlation analysis

The statistical relationships between the composition of phytoplankton and physicochemical environmental variables during two monsoons were analysed and shown in Fig. 6. The ordination diagram shows associations between each taxon and the corresponding explanatory variables. Proximity of taxa to the environmental variables (arrows) in the same or opposite direction suggests negative or positive correlations, whereas no proximity suggest a weak or no correlation and the longer the arrow the stronger the correlation.

The associations in the ordination diagram (Fig. 6) show that the abundance of cyanophytes and silicoflagellates were inversely correlated with several chemical factors (TDN, TDP, dissolved silicate, and nitrate). Diatoms and dinoflagellates dominated in water where ammonia and nitrite concentrations were high. Moreover, these groups were inversely correlated with cyanophytes and silicoflagellates. Orthophosphate concentration was inversely correlated with diatoms and dinoflagellates. It indicates that these nutrients were not related to their abundance during the sampling period. Forward selection indicated that only two of the seven chemical factors explained the variance in the phytoplankton group when analysed together. When all the forward selected variables were analysed together (conditional effects, referred as λ a), the TDP values was the most significant explanatory variable (λ a = 0.21, P = 0.082), followed by the TDN (λ a = 0.16, P = 0.048). Other chemical parameters (nitrite, nitrate, ammonia, orthophosphate, and dissolved silicate) were not significant and possibly did not influence the phytoplankton abundance pattern

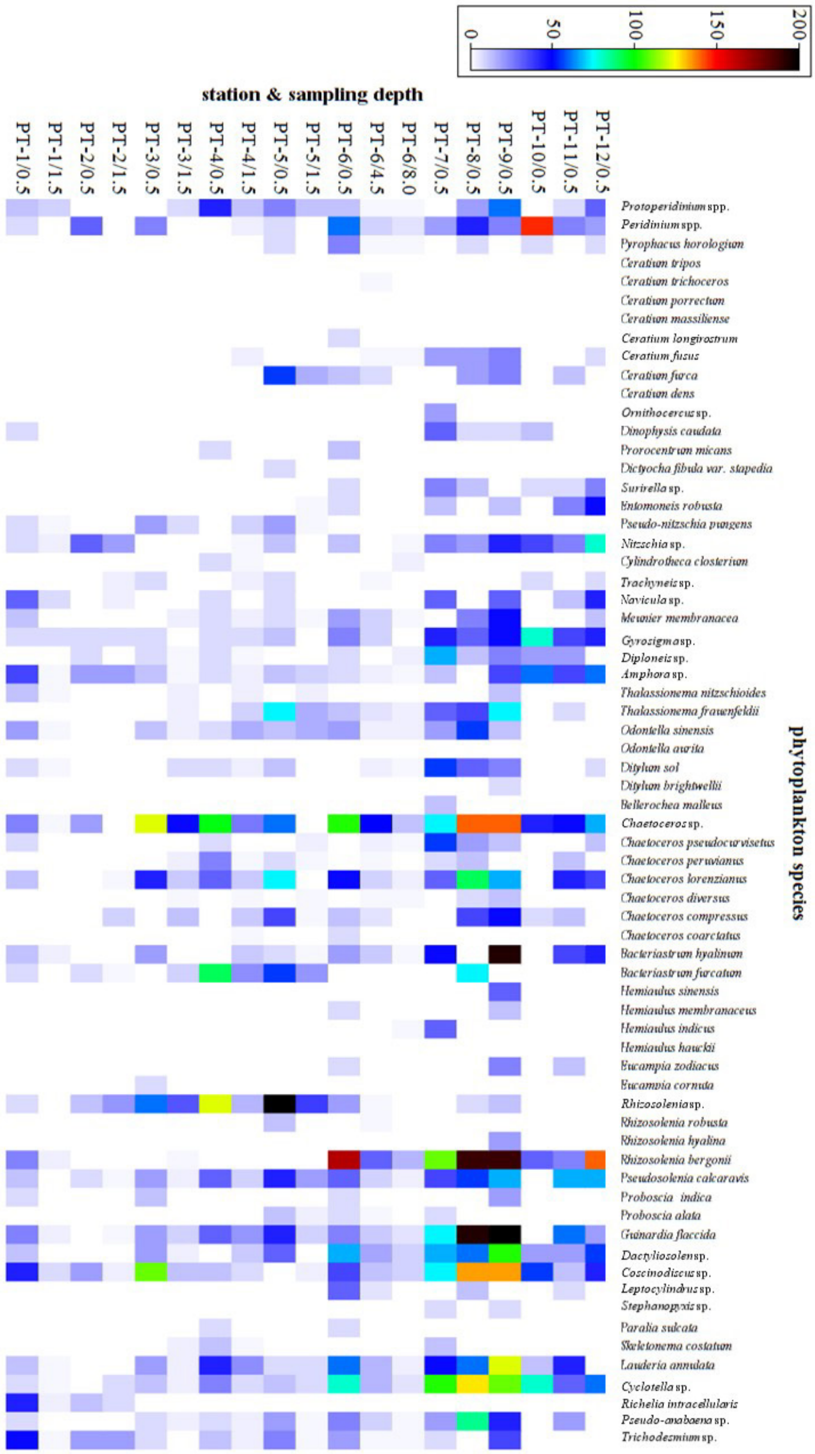

Figure 4. Shade plot indicating abundance of each phytoplankton species (cells L^{-1}) for the Phra Thong samples. Letters and numbers indicate the station and sampling depths.

Increased availability of sufficient nutrient concentrations particularly ammonia, led to faster growth rates of diatoms and dinoflagellates during the sampling period. Along the sampling stations, diatoms were dominant at stations 7–9 that were rich in ammonia, a relation reported by Kaiser *et al*. (2011). Several studies indicate that seasonal variation in phytoplankton species composition and abundance depend on interactions between chemical and physical parameters, as well as climate factors (Reynolds 1984; Türkoğlu and Koray 2002).

In fact, coastal developments and aquaculture have different influence on the environment because of their location between land and coast. Dense human populations and a high aquaculture activity probably results in much nutrient availability in the coastal waters, and consequently in high primary productivity. In this study, the high nutrient contents near the village and aquaculture areas are greatly evident, and phytoplankton abundance is strongly correlated with such nutrients, both nitrogen and phosphorus compounds.

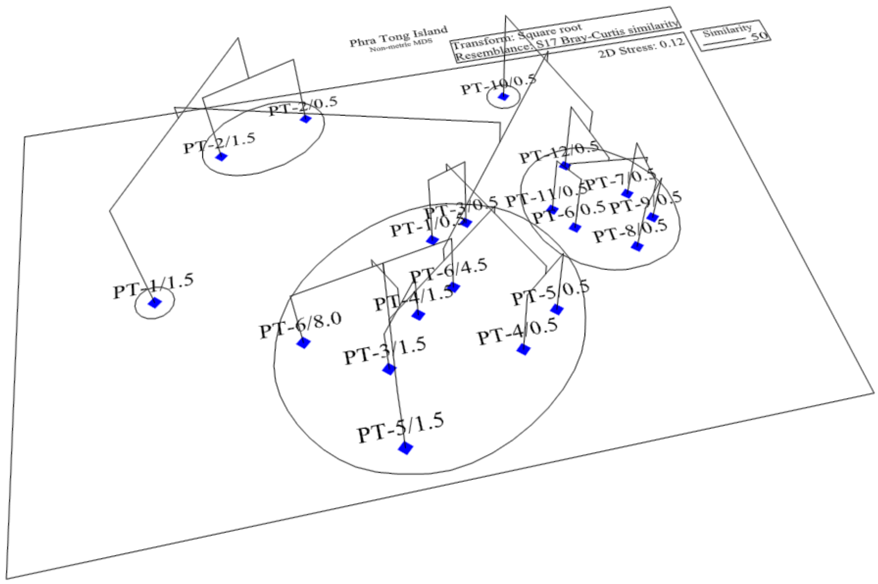

Figure 5. nMDS plot representing the phytoplankton density mean at Phra Thong Island. The cluster represents the abundance of phytoplankton species and the slices represent the resemblance level at the similarity of 50%.

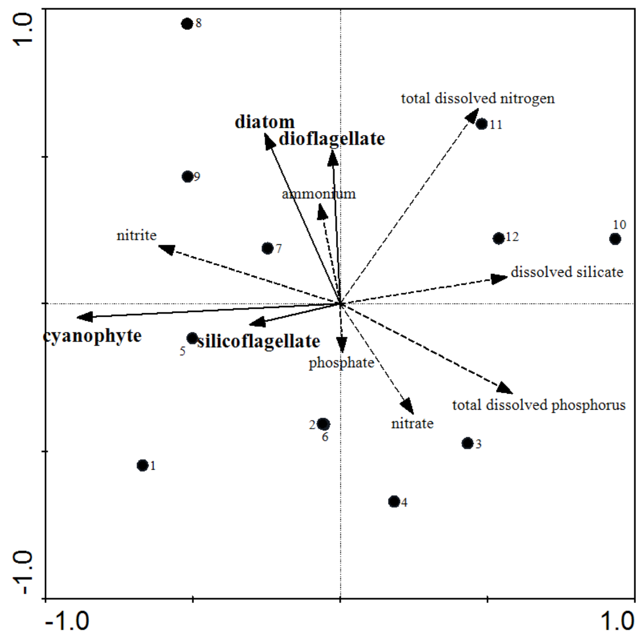

Figure 6. Ordination diagram generated from redundancy analysis (RDA) in Phra Thong Island, Phangnga Province in January 2016. Triplot represents phytoplankton taxa (blacklines), the significant explanatory variables (dashed lines) and sampling sites (black circle symbols).

CONCLUSIONS

The present study highlights the coastal phytoplankton composition and distribution, and the relationship between the phytoplankton community and environmental factors. Dominant phytoplankton groups were diatoms, while dinoflagellates and cyanophytes were prevalent in some locations. Nutrient availability and other chemical variables were correlated with phytoplankton abundance during the sampling period. Most of the dominant species of phytoplankton were not considered as harmful and dangerous for human health. However, certain species of *Trichodesmium* are known to be harmful for pelagic organisms that clog fish gills and then lead to mortality in fish and shrimp larvae. These have to be viewed as a threat to aquaculture food safety. Monitoring of toxic microalgae, especially bloom forming in the water and its effect on the trophic levels, would help to give a better understanding of the problem.

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