Phytoplankton in Tram Chim National Park: A change in Habitat and Season

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Abstract

This study aims to build a database and to assess the current status of phytoplankton biodiversity in Tram Chim National Park, contributing to information for resource management. Phytoplankton samples were collected in the rainy season of 2018 (October) and the dry season of 2019 (March), in 5 habitats namely core canal, buffer canal, lotus pond, Eleocharis marshes and Melaleuca forest, 3 locations were collected for each habitat. At each location, qualitative samples were collected by pulling net method and a quantitative sample was collected by deposition method. These samples were collected and handed according to the methods described by Sournia[24], Hötzel and Croome[12]. 60 phytoplankton samples were collected. The study identified 349 phytoplankton taxa belonging to 7 phyla, 11 classes, in which class Zygnematophyceae had the highest number of taxa.

The number of taxa in the rainy season was higher than in the dry season with 305 taxa in the rainy season and 205 taxa in the dry season. The similarity of phytoplankton composition among the sampling sites was low. Phytoplankton recorded were high in core canals, buffer canals and Melaleuca forests. The density of phytoplankton in the dry season was higher than that of in the rainy season. The diversity of the phytoplankton was relatively high (except for core canal). Comparing to the study on phytoplankton in Tram Chim National Park conducted in 1994, the number of taxa in this study increased markedly, but the proportion of classes did not change. Comparing to 2002, the number of taxa in this study did not changes but there was a change in the proportion of classes.

Keywords: Tram Chim, phytoplankton, diversity, density.

Introduction

Phytoplanktons include microalgae and cyanobacteria that live in aquatic environments. Their diversity and species composition structure change rapidly in response to the changing environmental conditions. So phytoplankton are bioindicators for water quality. Phytoplankton are primary producers in the aquatic food chain, providing food for higher groups organisms[5]. They are a food source for zooplankton and small animals. They play an important role in the process of converting materials inorganic and organic form, so they keep the balance of the aquatic ecosystem.

Tram Chim National Park is located in the center of Dong Thap province, with an area of 7,313 hectares. Previous studies on phytoplankton in Tram Chim show that they are diverse with 583 taxa belonging to 5 phyla and 10 classes. The number species in class Zygnematophyceae changes over time. For example, they were recorded the most with 148 taxa, accounting for 74% in 1994, 130 taxa were recorded in 2006, while 80 taxa were only recorded accounting for 23% in 2002. In contrast, the Euglenophyceae are recorded in 1994 with only 18 taxa, accounting for 9 %, while in 2002 this group was recorded with 80 taxa, accounting for 23 %[16,17]. This study aims to build a database and to assess the current status of phytoplankton biodiversity in Tram Chim National Park.

Material and Methods

Phytoplankton samples were collected in October 2018 (rainy season) and March 2019 (dry season) at five habitats in Tram Chim national park such as the Core canal, buffer canal, Lotus pond, *Melaleuca* forest, *Eleocharis* marsh. In every habitat, there are three sites chosen to collect samples (Figure 1).

Phytoplankton was collected by towing plankton net with 25 µm meshed with a mouth area of 0.3 m horizontally. The catch was preserved immediately in 4% formaldehyde. In the laboratory, phytoplankton samples were identified to species level whenever possible by following Bourrely[1-3], Prescott[19], Scott and Prescott[21], Wehr and Sheath[25], Dillard[6-11], John et al[13] and Komárek et al[15].

Counting phytoplankton with Sedgwick Rafter chamber: A pipette was used to take 1 mL of the concentrated sample and run it into the chamber at the corner with the coverslip lying at an angle across the chamber. Once the chamber was filled, the coverslip is moved to cover the whole chamber and the sample was left to settle for 30 minutes. The cells are counted at the bottom of the chamber.

The abundance of phytoplankton was counted following the formula:

$$N=A*v/V,$$

where N is the number of phytoplankton in 1 L, A is the number of phytoplankton in 1 mL concentrated sample, v is

the concentrated sample and V is the filtered sample in the sites.

The Shannon-Wiener diversity index (H') calculated using natural logarithms was used to describe species diversity and species richness within phytoplankton during the study period as follows:

$$H' = -\sum_{1}^{s} \quad pi * lnpi$$

where *pi* is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N) and *s* is the number of species. H' < 2 is described as an unsteady community while, H' 2 <H'< 3 is a fair community and H' > 3 is described as a steady community

The Evenness index (J') in the phytoplankton community is the degree to which individuals are split among species. The values can be determined by using the formula:

$J' = H' / lnS$

where J' (Evenness index) is constrained between 0-1, H' is the number derived from the Shannon diversity index and S is the total number of species.

Results and Discussion

Phytoplankton composition: There were 349 taxa of phytoplankton found at all stations, belonging to 5 phyla, 8 classes (Figure 2). There were 3 classes in Ochrophyta: Bacillariophyceae, Chrysophyceae and Xanthophyceae; 2 classes in Chlorophyta: Chlorophyceae and Zygnematophyceae, one class in each remaining phylum. The number of taxa in Zygnematophyceae was the highest (46%) followed by Chlorophyceae (16%), Bacillariophyceae (15%), Euglenophyceae (13%). Some genera had a high number of taxa. *Oscillatoria* (Cyanophyceae), *Trachelomonas*, *Phacus and Euglena* (Euglenophyceae) had 15 taxa, *Eunotia* and *Navicula* (Bacillariophyceae) had 11 taxa. The number of taxa of *Staurastrum*, *Cosmarium*, *Closterium*, *Euastrum and Micrasterias* (Zygnematophyceae) was 40, 33, 16, 12 and 10 respectively.

Many species had a high frequency of occurrence. *Microcystis aeruginosa* (Cyanobacteria) was recorded at 12 sites in the rainy season but was not present in the dry season. The species Cyanobacteria has many forms and changes in season. They are usually present in eutrophic water all over the world and sometimes they make toxic blooms. They also make toxic microcystin[4,15].

In the dry season, *Oscillatoria perornata* và *Oscillatoria princeps* (Cyanobacteria) were recorded at 12 and 10 sites respectively. *Aulacoseira granulata (Melosira granulata)* (Bacillariophyceae) was recorded at 13 sites in the rainy season and 10 sites in the dry seasons.

This freshwater diatom indicates moderate to high nutrient water[14]. A diatom *Synedra ulna* had a high frequency in both seasons. *Eunotia lunaris*, *Gomphonema manubrium and Navicula* sp.2. were only present in the dry season.

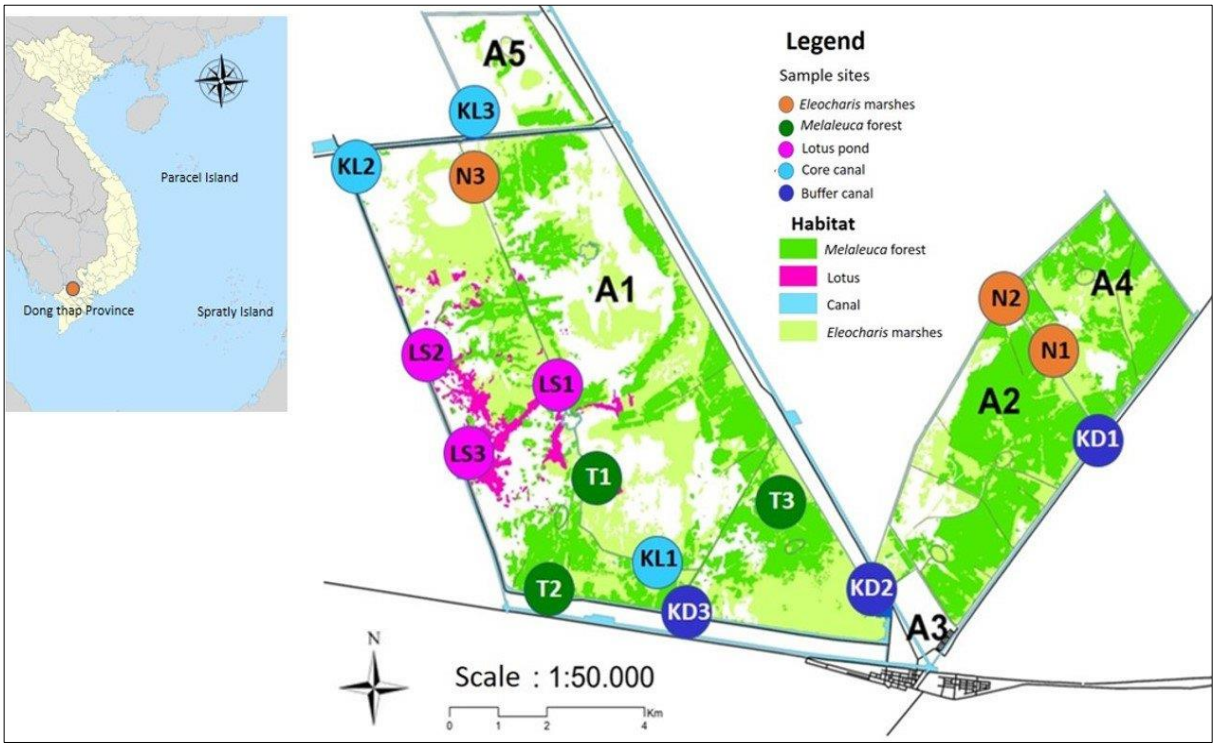

Figure 1: Map of sampling sites in Tram Chim national park

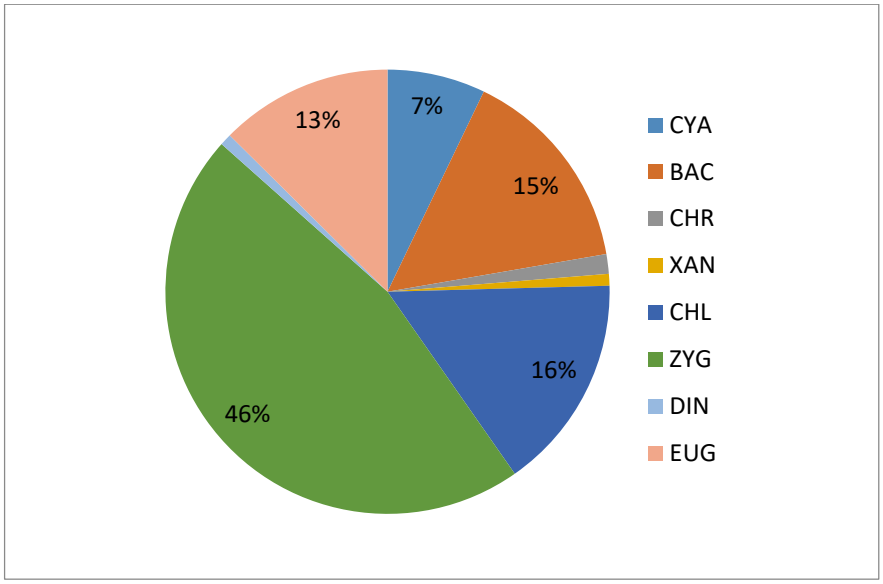

Figure 2: Composition of phytoplankton in Tram Chim National park (CYA - Cyanophyceae, BAC- Bacillariophyceae, CHR- Chrysophyceae, XAN- Xanthophyceae, CHL- Chlorophyceae, ZYG- Zygnematophyceae, DIN- Dinophyceae, EUG- Euglenophyceae)

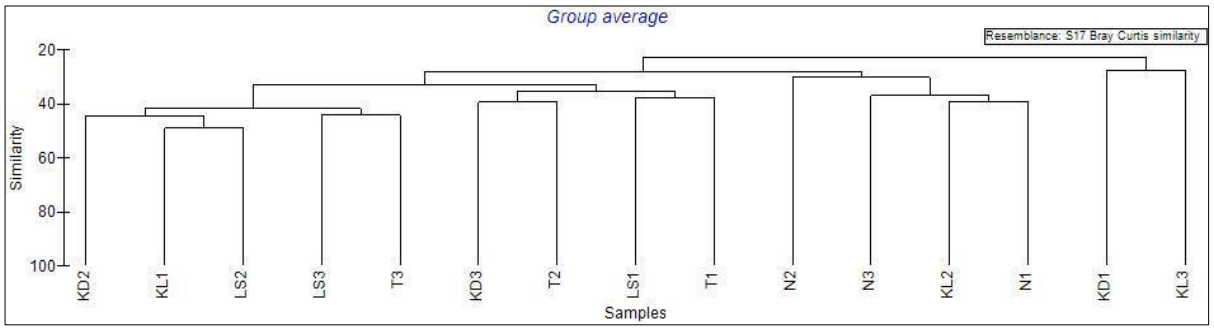

Figure 3a: The similarity of phytoplankton species composition in the rainy season

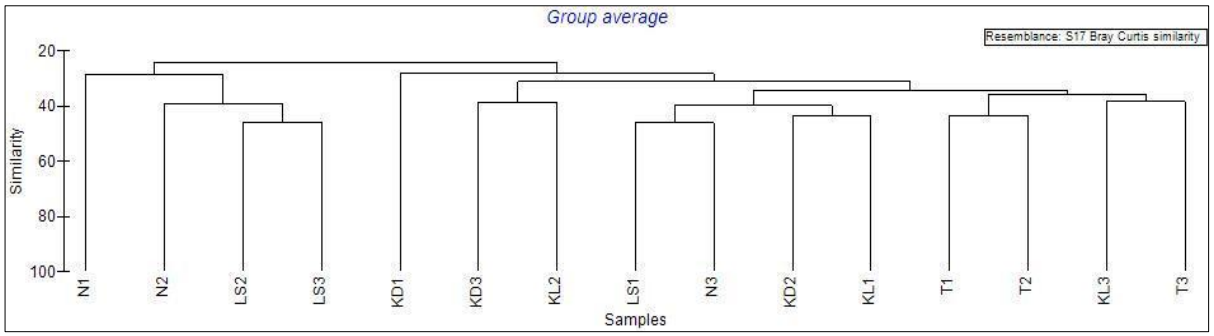

Figure 3b: The similarity of phytoplankton species composition in the dry season

About ten species in Chlorophyceae had a high frequency in the rainy season, but species in Zygnematophyceae had a high frequency in the dry season. *Euglena gracilis* (Euglenophyta) was present in 7 sites in the dry season, but not present in the rainy season. This is a unicell, flagellate, motile euglenophyte, commonly found in freshwater, especially in shallow and high-nutrient ponds. This species is used in the ecological toxicology test because of their physiological and biochemical characteristics.

The similarity of phytoplankton species composition: Cluster analysis showed that the similarity of species composition between sites was not high, only 3-46% in the dry season and 8-59% in the rainy season. Sampling sites with the same habitat did not have high similarity (Figure 3). This figured that phytoplankton species composition between sampling sites was different, even those in the same habitat. For example, in the rainy season, two sites in the buffer zone are KD2 and KD3 which have different species compositions, KD2 had many Euglenophyceae.

KD3 had many Zygnematophyceae. Similarly, both KL2 and KL3 are the core canal, but KL3 had 85 taxa including 62 Desmid taxa, while KL2 had only 23 taxa without

Desmid. The differences in the number of taxa and composition of Desmid were also found in sampling sites at Lotus pond and *Eleocharis* marsh. Sampling sites at *Eleocharis* marsh were different in the number of taxa diatom (Bacillariophyceae).

Number of taxa: The total number of phytoplankton was rather different between seasons. In the rainy season, it is higher than in the dry season, with 302 taxa in the rainy season and 205 taxa in the dry season. This difference is in most classes, except Bacillariophyceae have the same number of taxa in two seasons. The number of taxa Zygnematophyceae in the rainy season is double in the dry season (Figure 4). In the buffer canal (KD), the core canal (KL) and Lotus pond (LS), the number of taxa in the wet season was higher than in the dry season, especially in KD, the number of taxa in the wet season was 144 taxa, while the number of taxa in the dry season was 69 taxa. On the contrary, in the Leonaris marsh and Melaleuca forest, the number of taxa in the dry season was higher than in the rainy season (Figure 5). There were 10 sampling sites with a higher number of taxa in the rainy season than in the dry season because the class Zygnematophyceae had a very high number of taxa. The remaining 5 sites had a higher number of taxa in the dry season than in the rainy season. These sites have the number of taxa in Zygnematophyceae as low but the number of taxa in Bacillariophyceae and Chlorophyceae was high (Figures 6-8).

Density of phytoplankton in Tram Chim National Park: Analyzing the quantitative samples showed that the density of phytoplankton ranged from 5,640 to 986,680 (individual/L) (Table 1). The maximum abundance appeared at KL3 while minimum abundance was recorded at KL1 in the dry season. KL3 had the highest density because of the presence of Euglenoid (Euglenophyceae) *Euglena gracilis* (>700,000 individual/L) and green algae (Chlorophyceae) *Ankistrodesmus spiralis* (>200,000 individual/L).

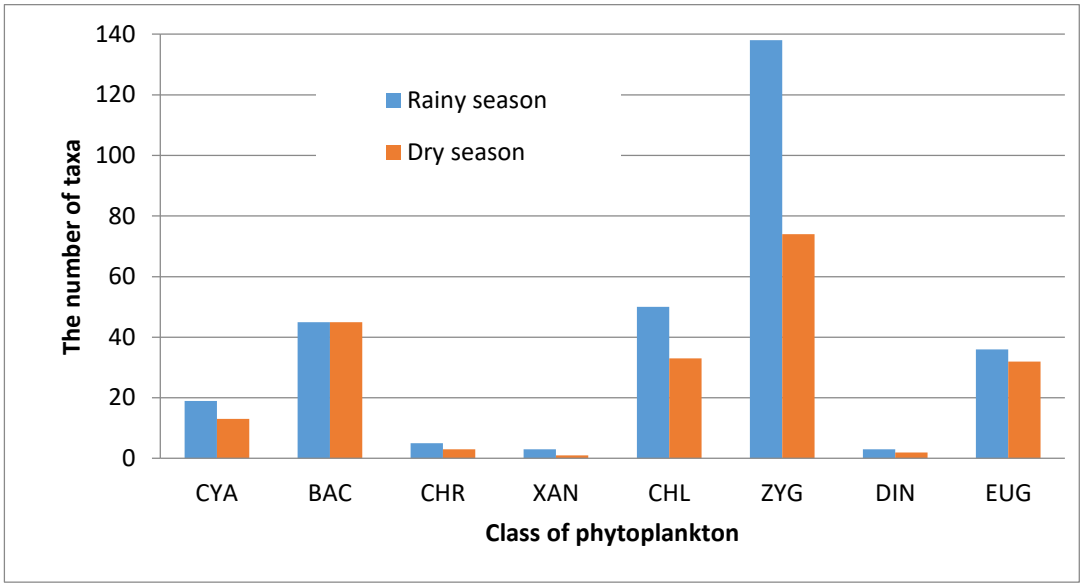

Figure 4: The number of taxa according to class of phytoplankton in two seasons

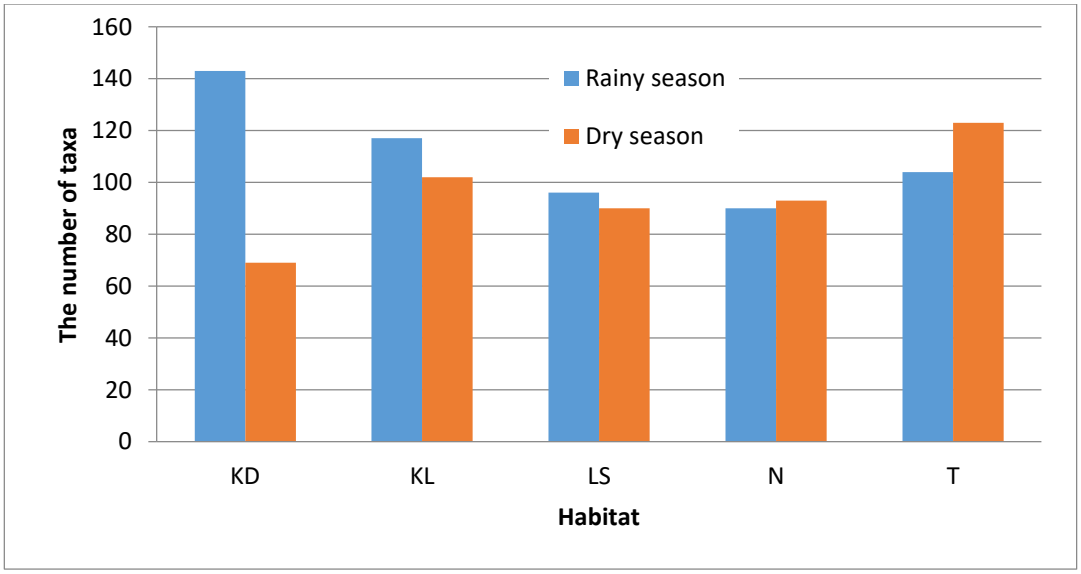

Figure 5: The number of taxa in the habitats in two seasons

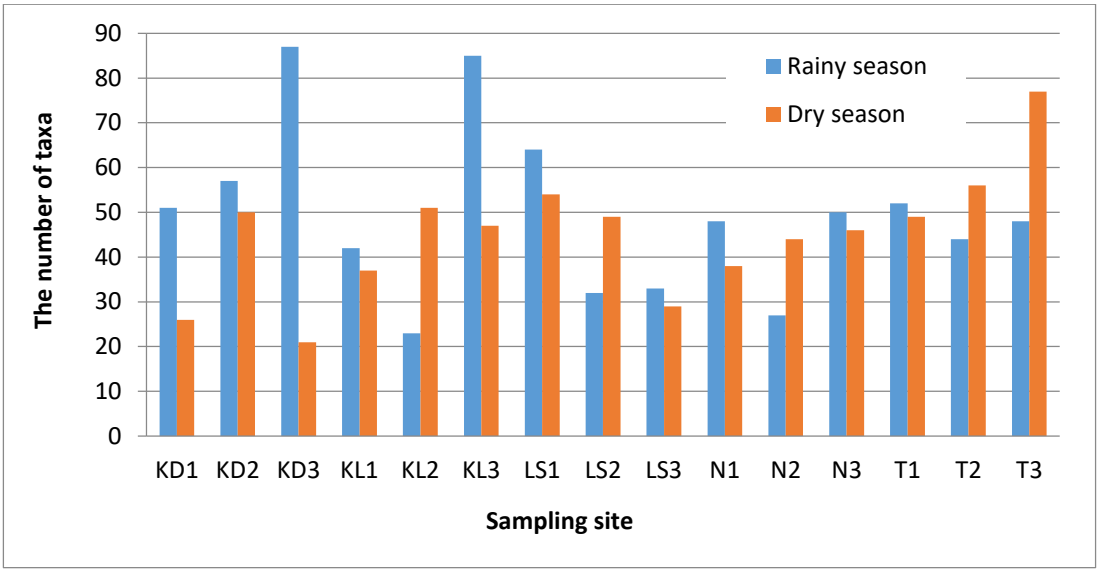

Figure 6: The number of taxa in the sampling sites in two seasons

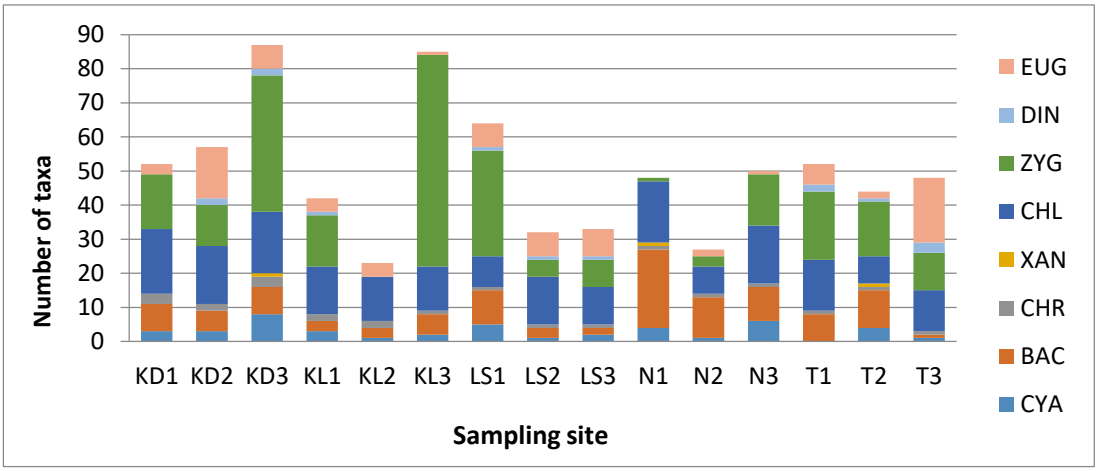

Figure 7: The number of taxa in the classes in the wet season

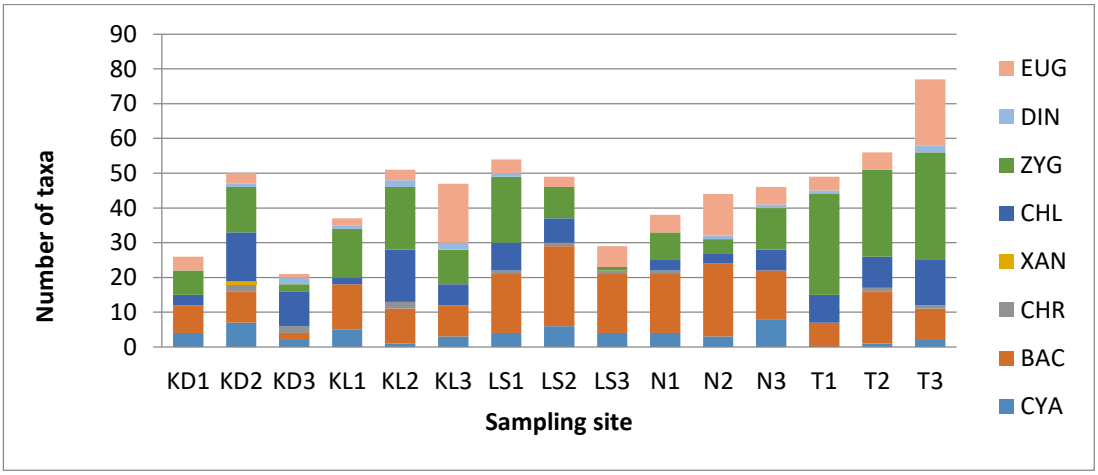

Figure 8: The number of taxa in the classes in the dry season
CYA – Cyanophyceae, BAC- Bacillariophyceae, CHR- Chrysophyceae, XAN- Xanthophyceae, CHL- Chlorophyceae, ZYG- Zygnematophyceae, DIN- Dinophyceae, EUG- Euglenophyceae
Sampling sites: KD: buffer canal, KL: core canal, LS: Lotus pond, N: Neocharis marsh, T: Melaleuca forest

These species prefer a rich nutrient environment. In addition, the two sampling sites in Lotus pond (LS1 and LS2) also had relatively high densities in both seasons, due to the presence of *Dinobryon sertularia* (class Chrysophyceae-CHR) in the rainy season and many other species in the dry season such as *Oscillatoria tenuis* (Cyanophyaceae-CYN) and *Navicula*

spp. (Bacillariophyceae-BAC) in LS1 and two diatoms *Gomphonema* sp. and *Pinnularia braunii* in LS2. In *Eleocharis* marshes (N), diatom always dominated in the rainy season, many species contributed the number of individuals to the water bodies, in contrast, in the dry season there were two dominant species: *Nitzschia filiformis* in N1 and *Navicula* in N2 (Figures 9-11). Particularly, Desmid did not appear in the rainy season, there were only some individuals of *Closterium* spp. and *Cosmarium* spp. in the dry season. In this habitat, there were a few individuals of green algae. *Melaleuca* forests was a habitat where all classes of algae were present, in which Euglenophyceae dominated.

Diversity and Evenness of phytoplankton: The diversity Shanon-Wiener index (H') varied from 0.7 – 3.5 (Table 1) with ⅝ sampling sites having H' more than 2 and ⅛ less than 2.0. There are 12/15 sampling sites having H' more than 2 in rainy season and 13/15 sampling sites with H' more than 2 in the dry season. It showed that phytoplankton diversity in Tram Chim National Park was high. The evenees index varied from 0.288 – 0.919, the highest is in KL1 and the lowest is in KL3. Site KL3 in the dry season has very low diversity and evenness because there are two species with very high densities, making the community unbalanced.

Comparison with studies in the past: Previous studies of phytoplankton in Tram Chim national park showed that the total number of phytoplankton taxa in Tram Chim national park did not change and the classes recorded were similar (except that class Raphidiophyceae was not recorded). However, the number of taxa in each class varied (Table 2). Nguyen[16] found 201 taxa phytoplankton mainly belonging to 3 classes Zygnematophyceae, Chlorophyceae and Euglenophyceae. Nguyen[17] found 349 taxa, with an increase in Chlorophyceae and Euglenophyceae species, but a sharp decrease in Zygnematophyceae. It means the water bodies in 2002 were more organic polluted. The present study had a high number of Zygnematophyceae and a low of Euglenophyceae, which indicated that the water quality in the water bodies had improved.

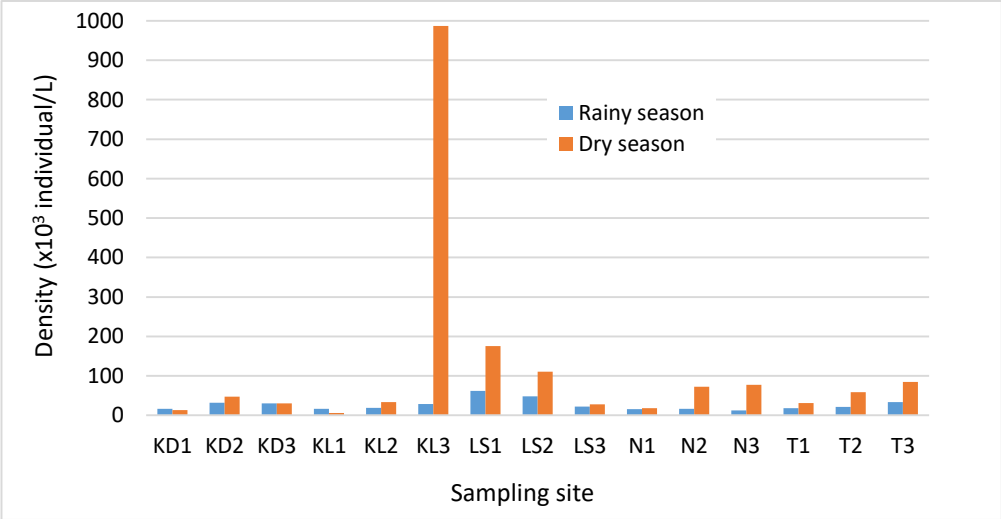

Figure 9: Density of phytoplankton in two seasons

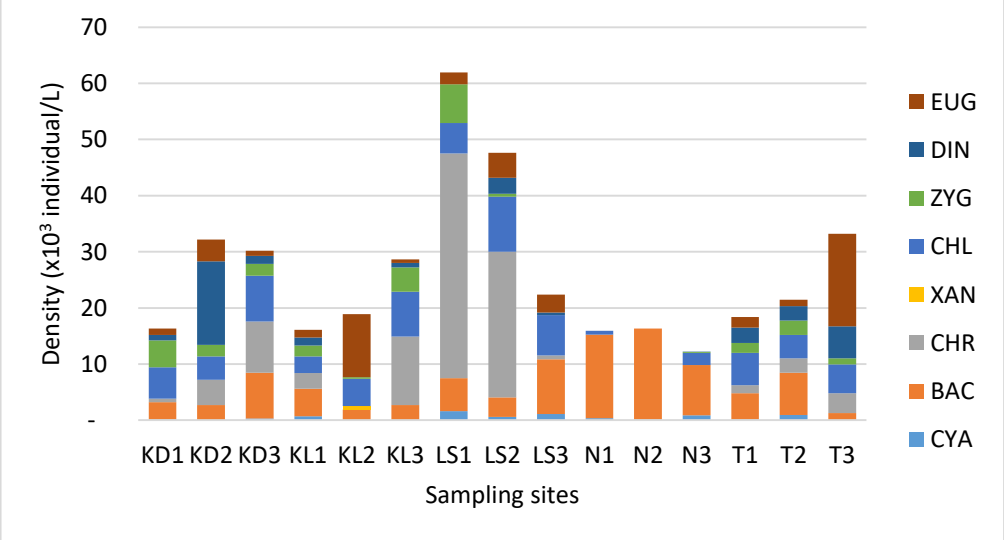

Figure 10: Density of phytoplankton in the rainy season

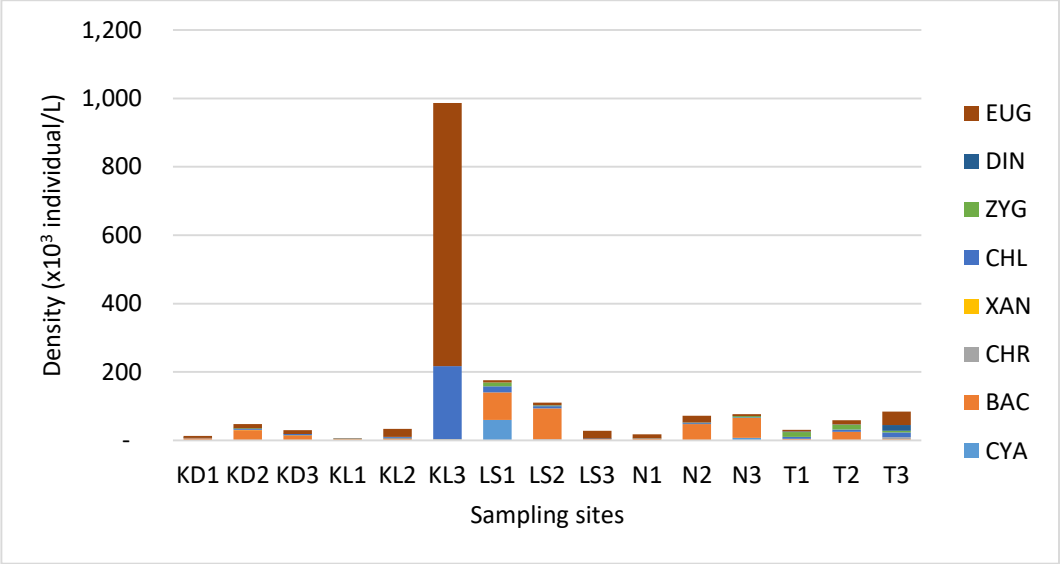

Figure 11: Density of phytoplankton in the dry season

Table 1
Number of taxa, density (individual/L), Diversity and Evenness

	Rainy season					Dry season			
Sampling site	**Number of taxa**	**Density**	**Evenness index**	**Diversity index**		**Number of taxa**	**Density**	**Evenness index**	**Diversity index H'**
KD1	25	16320	0,872	2,808		28	13400	0,875	2,918
KD2	27	32160	0,660	2,177		43	47480	0,890	3,351
KD3	26	30160	0,777	2,534		27	29920	0,644	2,124
KL1	30	16080	0,887	3,019		19	5640	0,919	2,706
KL2	15	18880	0,767	2,078		24	33600	0,568	1,808
KL3	27	28640	0,680	2,241		15	986680	0,288	0,780
LS1	35	61920	0,495	1,762		35	175440	0,721	2,564
LS2	28	47640	0,590	1,968		23	110400	0,889	2,788
LS3	29	22400	0,847	2,852		24	27520	0,728	2,315
N1	17	15960	0,871	2,469		26	17760	0,807	2,629
N2	12	16320	0,872	2,169		36	72320	0,700	2,511
N3	14	12240	0,715	1,887		34	77080	0,756	2,668
T1	25	18400	0,874	2,816		44	31120	0,849	3,214
T2	29	21440	0,890	2,997		47	58560	0,834	3,211
T3	24	33200	0,778	2,474		33	84160	0,718	2,513
Total	302	26117				205	118072		

Table 2
The number of taxa at studies

	Class	**1994**	**2002**	**This study**
CYA	Cyanophyceae	nd	43	25
BAC	Bacillariophyceae	nd	75	53
CHR	Chrysophyceae	2	3	5
XAN	Xanthophyceae	0	6	3
RAP	Raphidophyceae	0	1	0
CHL	Chlorophyceae	32	54	55
ZYG	Zygnematophyceae	148	80	162
DIN	Dinophyceae	1	7	3
EUG	Euglenophyceae	18	80	44
	Total	201	349	349

nd: no data

Conclusion

The study identified 349 taxa phytoplankton in Tram Chim national park belonging to 8 classes, in which class Zygnematophyceae was having number of taxa highest. The number of taxa phytoplankton in rainy season was higher than dry season. The similarity in phytoplankton composition between samling sites was low. Phytoplankton was recorded much in buffer canal, core canal and Melaleuca forest. The density of phytoplankton in dry season was higher than in rainy season. The diversity of phytoplankton was high.

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