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The Composition of Algae, Cyanobacteria and the Application in Water Quality Assessment in Truc Bach Lake, Hanoi

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Abstract: Phytoplankton and water samples were repeatedly collected in November 2015; February and May 2016 from 12 sampling sites in Truc Bach lake. 115 species and subspecies of phytoplankton had been recorded. They belong to 5 divisions (Cyanobacteriophyta, Bacillariophyta, Pyrrophyta, Euglenophyta, Chlorophyta). Cyanobacteriophyta hadthe largest density (23 species, 8021 cells/l). Based on Palmer index (Pollution index), Shannon - Weiner index (Diversity index)and physiochemical and biological parameters, we found that Truc Bach lake was polluted with organic substances, especially substances that are hard to decompose and nitrogenous sewage.

Keywords: Phytoplankton, biodiversity, water quality, Truc Bach lake.

1. Introduction

Algae play an important role in the aquatic ecosystem.They function as the primary producers in the food chain, producing organic material from sunlight, carbon dioxide and water. Besides that, they also form the oxygen necessary for the metabolism of the consumer organisms [1].

Algae are suited to water quality assessment because of their nutrient needs, rapid reproduction rate, and very short life cycle. Algae are valuable indicators of ecosystem conditions because they respond quickly both in species composition and densities to a wide range of water conditions due to changes in water chemistry.

Truc Bach isa large lake located in the northwest of Hanoi. It is not only a water regulation lake of Hanoi, but also an well known tourist destination.

In recent years, the economy in Hanoi has developed at relatively fast pace. Apart from its positive effects, the economic development also has many negative consequences, one of which is its the alarming pollution level in waterbodies of the city, particularly the Truc Bach lake. Most of the pollution comes from “enrichment nutrients”, which cause the decline of the water quality, as well as aquatic ecosystem and

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biodiversity. Study on the physiochemical and biological attributes of Truc Bach lake is the essential basic for improving and maintaining the pureness of it.

In order to assess this problem, in this study, we investigated the phytoplankton communities and the water quality from Truc Bach lake.

2. Materials and methods

Sampling was periodically carried out in November 2015, February and May 2016 from 12 sampling sites in Truc Bach lake (Figure 1).

Figure 1. The sampling sites at Truc Bach lake.

The phytoplankton samples were collected by phytoplankton net No. 64, fixed by formaldehyde 4% solution and analyzed under a microscope in the laboratory of Department of Botany and Microscope Laboratory, Faculty of Biology, VNU University of Science based on the main references number 2 to4.

The water samples were collected at studying sites based on the basic methods in Vietnam Standards on water quality, TCVN 1996:1995. Physical, chemical characteristics representing water quality, including 8 variables (temperature, pH, DO, NO_3^-, NH_4^+, PO_4^{3-}, BOD_5 and COD) were analyzed at the laboratory of Ecology and Environmental Biology, Faculty of Biology, VNU University of Science [5].

3. Result

3.1. Composition of Phytoplankton

Species composition of Algae and Cyanobacteria is presented in Table 1.115 species and subspecies of phytoplankton were recorded. They belong to 19 families, 8 orders of 5 divisions (Cyanobacteriophyta, Bacillariophyta, Pyrrophyta, Euglenophyta and Chlorophyta) (Table 1).

With 44 species and subspecies of 14 genera, 19 families, 9 orders in the studied area. Chlorophyta was the most abundant division, made up 38.26%. Euglenophyta had 33 species of 6 genera, about 28.7%; Cyanobacteriophyta made up 20% with 23 species of 5 genera; Bacillariophyta with 13 species of 6 genera, approximated 11.3%; Pyrrophyta had the smallest proportion with 2 species of 2 genera, made up about 1.74%.

In general, the number of species at each sampling site wasn't high. Chlorophyta and Euglenophyta were more abundant in species composition than the other divisions, especially Pyrrophyta. That was the characteristic of the aquatic ecosystem which was in contamination.

Some particular specieswhich were used as bioindicators for contamination are *Euglena viridis* Ehr, *Phacus pleuronectes* (Ehr.) Duj, *Euglena acus* Ehr, *E. oxyuris* Schmard, *E. deses* Ehr, *E. proxima* Dang, *Monomorphina pyrum* (Ehr.) Mereschik, *Cyclotella menneghiniana* Kutz, *Microcystis pulverea* (H.C.Wood) Forti and *Microcystis aeruginosa* Kutzing [4].

According to Palmer's genus index of organic pollution tables (1969), the algal pollution indices over three study periodsalternately were 19, 13 and 21 [6]. The level of organic pollution decline from the first period (probable) to the second period (no evidence) but increase immediately in the third study period (clearsupporting evidence) [6].

Table 1. Species composition of Algae and Cyanobacteria of Truc Bach lake

	Scientific name		Scientific name
	Cyanobacteriophyta	57	*Euglena* sp2.
1	*Merismopedia minima*	58	*Lepocinclis fusiformis*
2	*Merismopedia marssonii*	59	*Lepocinclis ovum*
3	*Microcystis aeruginosa*	60	*Lepocinclis globulus*
4	*Microcystis pulverea* f. *holsatica*	61	*Lepocinclis sphagnophila*
5	*Microcystis pulverea* f. *minor*	62	*Lepocinclis* sp.
6	*Microcystis* sp.	63	*Monomorphina pyrum*
7	*Oscillatoria agardhii*	64	*Phacus acuminatus*
8	*Oscillatoria boryana*	65	*Phacus anomalus*
9	*Oscillatoria brevis*	66	*Phacus tortus*
10	*Oscillatoria claricentrosa* var. *bigranulata*	67	*Phacus pleuronectes*
11	*Oscillatoria cortiana*	68	*Phacus orbicularis*
12	*Oscillatoria homogenea*	69	*Strombomonas fluviatilis*
13	*Oscillatoria irrigua*	70	*Strombomonas* sp.
14	*Oscillatoria rupicola*	71	*Trachelomonas dubia*
15	*Oscillatoria pseudogeminata*		**Chlorophyta**
16	*Oscillatoria quadripunctulata*	72	*Schroederia setigera*
17	*Oscillatoria quasiperforata*	73	*Pandorina* sp.
18	*Oscillatoria tenuis*	74	*Pediastrum boryanum*var. *boryanum*
19	*Oscillatoria* sp1.	75	*Pediastrum duplex* var. *duplex*
20	*Oscillatoria* sp2.	76	*Pediastrumduplex* var. *reticulatum*
21	*Spirulina abbreviata*	77	*Pediastrum integrum*var. *integrum*
22	*Spirulina hanoiensis*	78	*Pediastrum tetras* var. *tetras*
23	*Anabaenopsis elenkinii*	79	*Pediastrum tetras* var. *tetraodon*
	Bacillariophyta	80	*Pediastrum simplex var. duodenaarium*
24	*Cyclotella comta*	81	*Pediastrum simplex var. simplex*
25	*Cyclotella menneghiniana*	82	*Tetraëdron trilobulatum*
26	*Cyclotella stelligera*	83	*Tetraëdron minimum*
27	*Gomphonema affine*	84	*Tetrastrum heterocanthum*
28	*Gomphonema intricatum*	85	*Tetrastrum glabrum*
29	*Gomphonema parvulum*	86	*Coelastrum microporum*
30	*Gomphonema pseudoaugur*	87	*Coelastrum* sp.
31	*Navicula lanceolata*	88	*Ankistrodesmus acicularis*
32	*Navicula pupula*	89	*Ankistrodesmus angustus*
33	*Navicula* sp.	90	*Ankistrodesmus arcuatus*
34	*Nitzschia palea*	91	*Ankistrodesmus gracilis*
35	*Surirella* sp.	92	*Hyaloraphidium rectum*
36	S*ynedra ulna*	93	*Kirchneriella contorta*

	Pyrrophyta	94	*Kirchneriella lunaris*
37	*Ceratiumrhomvoides*	95	*Actinastrum hantzchii*
38	*Glenodinium* sp.	96	*Crucigenia crucifera*
	Euglenophyta	97	*Crucigenia tetrapedia*
39	*Euglenaacus* Ehr	98	*Crucigenia quadrata*
40	*Euglena anabaena* Mainx.	99	*Crucigenia rectangularis*
41	*Euglena bivittata* Kudo.	100	*Tetralanthos lagerheimii*
42	*Euglena deses*	101	*Scenedesmus acuminatus* var. *biseratus*
43	*Euglena ehrenbergii*	102	*Scenedesmus acuminatus* var. *acuminatus*
44	*Euglena hemichromata*	103	*Scenedesmus apiculatus*
45	*Euglena oxyuris*	104	*Scenedesmus arcuatus* var. *arcuatus*
46	*Euglena pisciformis*	105	*Scenedesmus arcuatus* var. *platydisca*
47	*Euglena proxima*	106	*Scenedesmus bicaudatus* var. *bicaudatus*
48	*Euglena rostrifera*	107	*Scenedesmus bijugatus* var. *bijugatus*
49	*Euglena sanguina*	108	*Scenedesmus bijugatus*var. *alternans*
50	*Euglena spirogyra*	109	*Scenedesmus curvatus*
51	*Euglena terricola*	110	*Scenesdesmus dispar*
52	*Euglena wangi*	111	*Scenedesmus incrassatulus*
53	*Euglena variabilis*	112	*Scenedesmus obliquus*var. *obliquus*
54	*Euglena velata*	113	*Scenedesmusobliquus* var. *alternans*
55	*Euglena viridis*	114	*Scenedesmus quadricauda*
56	*Euglena* sp1.	115	*Closterium* sp.

3.2. Density of phytoplankton

The species density was shown in Table 2 and Figure 2. Bacillariophyta and Pyrrophyta had the smallest algae density while Cyanobacteriophyta had the largest algae density. The species number of Euglenophyta decreased over three periods; The density of Chlorophyta increased from the first to second period but decreased slightly in the third period. The number of Cyanobacteriophyta increased considerably, especially the genus *Microcystis*, which probably was the causethat restrainedthe growth of the other algae.

The Shannon Wiener indices (diversity indices) in Truc Bach lake over three study periods alternately are 1.46, 1.33 and 1.01 corresponding with the average pollution level of aquatic ecosystem [6].

3.3. Assessment of water quality

The water quality parameter values obtained at the sampling sites during the physical-chemical surveillance programme are presented in Table 2.

Table 2. Density of phytoplankton at Truc Bach lake over three study periods

	1		2		3	
	Density (cell/l)	Proportion	Density (cell/l)	Proportion	Density (cell/l)	Proportion
Cyanobacteriophyta	8021	80.15%	12799	65.62%	23430	87.82%
Bacillariophyta	48	0.48%	29	0.15%	173	0.65%
Pyrrophyta	4	0.04%	1	0.01%	3	0.01%
Euglenophyta	44	0.44%	91	0.47%	37	0.14%
Chlorophyta	1891	18.89%	6586	33.76%	3038	11.39%
Sumary	**10008**	**100%**	**19506**	**100%**	**26681**	**100%**

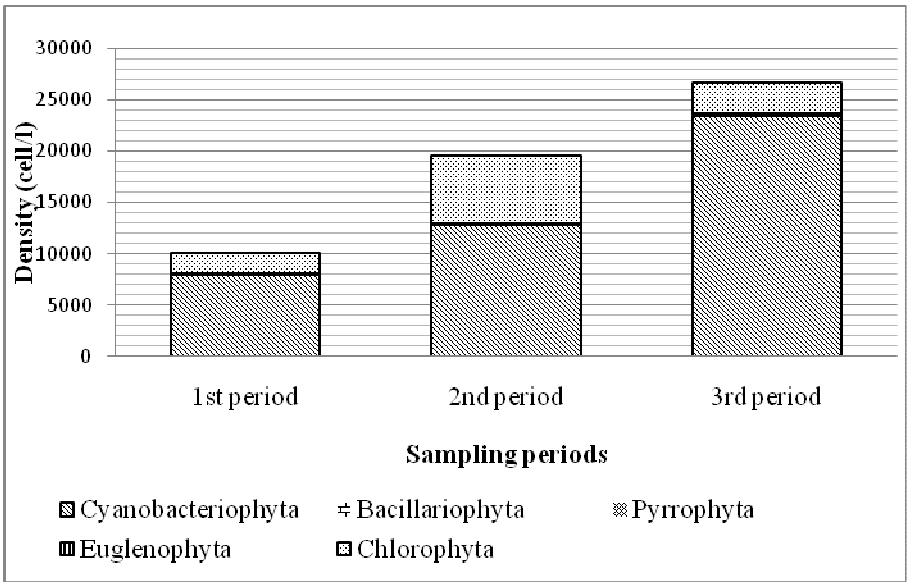

Figure 2. Density of phytoplankton at Truc Bach lake.

Table 2. Means of water quality parameter values of the Truc Bach lake

Parameters	Truc Bach Lake	QCVN 08/2008	
		A2	B1
pH	7.26	6-8,5	5,5-9
Temperature(^oC)	18.6	-	-
DO (mg/l)	2.77	≥ 5	≥ 4
BOD_5 (mg/l)	12.06	6	15
COD (mg/l)	28.77	15	30
NH_4^+(mg/l)	7.39	0,2	0,5
NO_3^-(mg/l)	48.55	5	10
PO_4^{3-}(mg/l)	0.69	0,2	0,3

Based on the results of water analyses, we found that:

Temperature, pH, BOD and COD were within the acceptable levels and suitable for aquatic life [7].

DO concentrations were measured at the lake, with value of 2.77 mg l^{-1}. Low dissolved oxygen concentrations, probably due to high concentration of organic matters. This could be the main cause of pollution in the lake. All NH_4^+, NO_3^- and PO_4^{3-}concentrations were higherthan safety levels in QCVN 08-2008 which indicated the serious organic pollution status (eutrophy) at Truc Bach lake [7].

Based on chemical parameters,we suggested that Truc Bach lake was polluted by organic matter biodegradation and nitrogenous sewage.

4. Conclusion

1. In the study on phytoplankton composition, 115 species and subspecies were recorded. They belong to 19 families, 8 orders of 5 divisions Cyanobacteriophyta, Bacillariophyta, Pyrrophyta, Euglenophyta and Chlorophyta. In phytoplankton composition, some particular genera, by their presence, were indicative of pre-existing high nutrient status as *Oscillatoria*, *Microcystis* belong to Cyanobacteriophyta; *Crucigenia*, *Scenedesmus* were of Chlorophyta; *Euglena*, *Phacus* belong to Euglenophyta. Cyanobacteriophyta had the largest density which played an important role in determining the density of phytoplankton at Truc Bach lake. Morever, based on Palmer and diversity indices (Shannon Weiner index), we assess the organic pollution level of the aquatic ecosystem of Truc Bach lake.

2. Water quality parameters at Truc Bach lake were within the acceptable levels and suitable for aquatic life. NH_4^+, NO_3^- and PO_4^{3-} concentrations were higher than safety levels in QCVN 08-2008 which warned of the serious organic pollution status (eutrophy) at Truc Bach lake.

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Hệ Tảo, Vi khuẩn lam và ứng dụng của chúng trong đánh giá chất lượng môi trường nước hồ Trúc Bạch, Hà Nội

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Tóm tắt: Kết quả phân tích mẫu thực vật nổi và mẫu nước trong 3 đợt nghiên cứu: 11/2015, 2/2016, 5/2016 tại 12 điểm lấy mẫu trênhồ Trúc Bạch, thành phố Hà Nội. Về thành phần thực vật nổi, bước đầu phân loại được 115 taxon loài và dưới loài, thuộc 19 họ, 8 bộ của 5 ngành Tảo: Vi khuẩn lam (Cyanobacteriophyta), Tảo silic (Bacillariophyta), Tảo Giáp (Pyrrophyta), Tảo Mắt (Euglenophyta) và Tảo Lục (Chlorophyta). Ngành Vi khuẩn lam có mật độ cao nhất, là nhóm quyết định đến mật độ thực vật nổi tại khu vực nghiên cứu. Dựa trên các chỉ số sinh học như chỉ số Palmer và chỉ số Shannon - Weiner và các thông số thủy lý hóa cho thấy hồ Trúc Bạch đang bị ô nhiễm khá nghiêm trọng.

Từ khóa: Hồ Trúc Bạch, thực vật nổi, chất lượng môi trường nước.