BLUE-GREEN ALGAE (CYANOBACTERIA) IN MEKONG RIVER, VIETNAM

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ABSTRACT

Mekong river is the main water supply for agriculture and domestic use in Mekong delta. *Cyanobacteria, known as toxic microalgae, often occur with high concentration in lakes and rivers. They can cause toxicity to wildlife and humans intoxication because of their potential to produce toxins. We implemented a monitoring on cyanobacteria from January to June, 2015 at 7 sampling sites in Mekong delta. The result showed cyanobacteria were more diversity and abundance in upper-land area. More than 40 species of Cyanobacteria were recorded in Mekong river and species of Microcystis and Oscillatoria genera were frequently found. Concentrations of cyanobacteria were from 3.7 to 14,0 µg chlorophyll-a.L^{-1} in upper-land area and from 3,0 to 7,1 µg chlorophyll-a.L^{-1} in* downstream provinces. *Bloom of cyanobacteria was found with chlorophyll-a content of cyanobacteria was 28.9 µL^{-1} in Travinh province in April.*

Keywords*: cyanobacteria, chlorophyll-a, Mekong River, public health*

TÓM TẮT

Sông Mê Kông là nguồn cung cấp nước chính cho nông nghiệp và sinh hoạt ở đồng bằng sông Mê Kông. Tảo Lam, được biết đến như là 1 loài tảo độc, thường xuất hiện với nồng độ cao ở các hồ và sông. Tảo Lam có thể gây độc với động vật hoang dã và con người bởi vì chúng có thể sản xuất ra độc tố. Chúng tôi đã thực hiện một điều tra về tảo Lam từ tháng 1 đến tháng 6 năm 2015 tại 7 điểm thu mẫu tại đồng bằng sông Mê Kông. Kết quả cho thấy tảo Lam đa dạng và nhiều ở khu vực thượng lưu. Hơn 40 loài tảo Lam đã được phân loại ở sông Mê Kông và các loài thuộc giống Microcystis và Oscillatoria thường gặp nhất. Nồng độ của tảo Lam vào khoảng 3.7 tới 14,0 µg chlorophyll-a.L^{-1} ở thượng lưu và từ 3,0 to 7,1 µg chlorophyll-a.L^{-1} ở vùng hạ lưu. Sự nở hoa của tảo Lam cũng được phát hiện với hàm lượng chlorophyll-a.L^{-1} lên đến 28.9 µgL^{-1} ở tỉnh Trà Vinh vào tháng 4.

INTRODUCTION

The cyanobacteria or blue-green algae are photosynthetic prokaryotes living in various environments all over the world (Whitton and Potts, 2000). Cyanobacteria may proliferate in lakes, rivers, estuaries and coastal systems, where they may cause a multitude of water quality concerns. Many species of cyanobacteria can produce toxic metabolites known as Cyanotoxins. Cyanotoxins can cause acute or chronic toxicity to animals and humans via different exposure routes, such as drinking, inhalation and water contact activities (Chorus and Bartram, 1999). Hence, presence of cyanobacteria in the river might infer a health risk to humans. Mekong river is the main water supply for agriculture and domestic use in the Southwestern Vietnam. Our recent monitoring indicated that mass occurrences of cyanobacteria are typically found in Mekong river in dry season. Cyanobacteria are not consider as a health risk because information about cyanobacteria in the Mekong Delta is very limited. Study of Van et. al, 2012 found 3 species of cyanobacteria in Bac lieu – Soc Trang coastal zone and concentration of chlorophyll-a from 0,18 đến 3,99µg/L. However, this study did not focus on cyanobacteria and did not show

concentration of cyanobacteria (based on chlorophyll). In our study, concentration of cyanobacteria and total chlorophyll were measured by algae torch so the occurrence and distribution of cyanobacteria from upper-part to downstream of the Vietnamese Mekong river were clearly indicated.

METHODS

A monthly monitoring programme was established to investigate the occurrence, dominance and distribution of cyanobacteria from January to April, 2015 in the delta. Chlorophyll-a content of cyanobacteria and the total chlorophyll content of microalgae. Seven sampling sites in the Mekong river was selected for the monitoring including:

(1) two sites in upper-lands of the river (An Giang, Dong Thap province) (2) two sites in middle of the river (Can Tho, Vinh Long province) and (3) three sites in estuary of the river (Soc Trang, Tra Vinh, Ben Tre province) (Figure 1). One sample was collected at each site. Algae torch (http://www.bbe-moldaenke.de/chlorophyll/algaetorch/) was applied to quantify cyanobacterial- and total phytoplankton chlorophyll. Cyanobacterial samples for morphological identification were collected by towing a standard net (mesh-size 25µm) horizontally near the water surface and preserved in Lugol's iodine.

Cyanobacterial species were identified under microscopic observation (Olympus BX51). The following taxonomic documents: Cronberg, G. and Annadotter, H., (2006), Komárek and Anagnostidis (1989, 1999, 2005), were used to identify cyanobacteria in the samples.

RESULTS AND DISCUSSION

Composition of cyanobacteria in the river

There was only 42 species of cyanobacteria found in the river during our monitoring (table 1). They belong to three orders Chroococales, Noctocales and Oscilatoriales. Some genera have high potential to produce cynanotoxins, such as *Microcystis*, *Anabaena*, *Oscillatoria* and *Pseudanabaena*. Cyanobacteria in fresh-water areas (An Giang, Dong Thap, Can Tho and Vinh Long province) are more diverse than that in saline intrusion areas (Soc Trang, Tra Vinh and Ben Tre province). There were from 23 to 28 species in a sampling site recorded in fresh-water areas, meanwhile, there were from 16 to 19 species in a sampling site recorded in saline intrusion areas. Some species were only found in fresh-water areas, for examples *Merismopedia tenuissima, Merismopedia punctata*, *Snowella* sp., *Anabaena* spp., *Romeria* sp. and *Anabaenopsis* sp. (table 1). Increase of salinity may be effect to survival and growth of these species in saline intrusion areas. Although cyanobacteria can be found in brackish and marine water most of cyanobacteria grow in freshwater so number of cyanobacteria species is poor in downstream of the river. Benthic cyanobacteria, in addition, are commonly found in brackish areas but my monitoring only focus on planktoniccyanobacteria, which may be the reason for decreasing of cyanobacterial species.

Table 1. Composition of cyanobacteria in the river.

Stt	Scientific terminology	Sampling sites						
		An Giang	Dong Thap	Can Tho	Vinh Long	Soc Trang	Tra Vinh	Ben Tre
	CYANOBACTERIA							
	Chroococcales							
1	*Aphanocapsa delicatissima*	+	+	+	+		+	+
2	*Aphanocapsa sp.*		+	+	+	+	+	
3	*Chroococcus limneticus*	+	+	+	+	+	+	+
4	*Chroococcus sp.*	+	+	+				
5	*Merismopedia*		+		+			

	tenuissima							
6	*Merismopedia glauca*							+
7	*Merismopedia punctata*				+			
8	*Merismopeia sp.*	+		+				+
9	*Microcystis aeruginosa*	+	+	+	+		+	+
10	*Microcystis botrys*	+	+	+	+	+	+	+
11	*Microcystis wesenbergii*	+		+	+		+	
12	*Snowella sp.*			+				
	Noctocales							
14	*Anabaena cf. circinalis*	+	+	+	+	+	+	+
15	*Anabaena cf. flosaquae*		+					
16	*Anabaena cf. smithii*	+	+	+	+	+	+	+
17	*Anabaena sp.*	+		+	+	+	+	
18	Anabaena sp.1		+					
19	*Anabaena sp.2*		+					
20	*Anabaena sp.3*		+					
21	*Anabaenopsis sp.*			+	+			
	Oscilatoriales							
22	*Arthrospira masactii*	+	+	+	+	+	+	+
23	*Arthrospira sp.*	+						
24	*Lyngbya limnetica*			+		+		
25	*Lyngbya sp.*			+	+	+	+	+
26	*Lyngbya sp.1*	+	+				+	
27	*Lyngbya sp.2*	+	+					
28	*Lyngbya sp.3*	+	+					
29	*Oscillatoria limosa*	+	+	+	+		+	+
30	*Oscillatoria nigroviridis*			+		+	+	+
31	*Oscillatoria princeps*		+	+	+			+
32	*Oscillatoria sp.*		+	+	+	+	+	+
33	*Oscillatoria tenuis*	+		+	+	+	+	+
34	*Planktolyngbya limnetica*	+						+
35	*Phormidium sp.*	+		+				+
36	*Pseudanabaena limnetica*		+	+	+	+	+	
37	*Pseudanabaena moniliformis*	+	+	+	+	+	+	
38	*Pseudanabaena mucicola*	+	+	+	+			

39	*Pseudanabaena* sp.	+	+	+		+	+	+
40	*Romeria* sp.		+	+	+			
41	*Spirulina* sp.	+		+	+	+		
In total		**23**	**25**	**28**	**23**	**16**	**19**	**18**

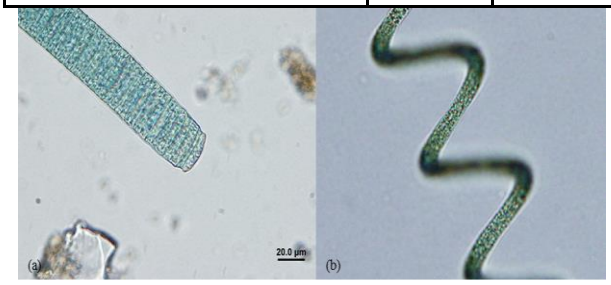

Figure 1. Cyanobacteria in Mekong river: (a) Oscillatoria sp and (b) Arthrospira sp.

Concentration and bloom of cyanobacteria in the Vietnamese Mekong river

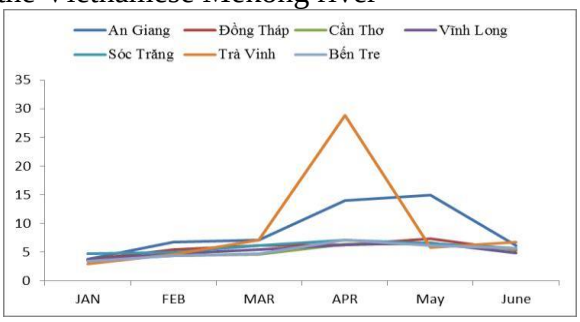

Figure 2. Variation in Chlorophyll-a content of cyanobacteria in dry season in the river.

Chlorophyll-a content of cyanobacteria increased from January to April, 2015 in the river (figure 2). The increase, however, was difference in various areas. Significant increase was found in upper-part and downstream of the river. Chlorophyll-a content of cyanobacteria increased from 3.8 µg/L to 14 µg/L in Angiang province. *Microcystis* spp. (Figure 3b) was dominancy in An Giang sampling site. Scums of these cyanobacteria flow on the water surface so they can be seen by naked eye. According to our observation, these scums followed current of water from Cambodia and grown in main river branches of the Vietnamese Mekong river. Especially, bloom of *Microcystis* (figure 3a,b) was found in April, 2015 in Travinh sampling site where Mekong water was mixed with sea water. Chlorophyll-a content of cyanobacteria was 28.9 µ/L in this site. Salinity of the water in this site was 6.7 ‰. In general, increasing salinity may restrict growth and proligeration of cyanobacteria but *Microcystis* is exceptional. Growth, microcystin cell quota and mycrocystin production of isolated *Microcystis* are not affected by elevated salinity up to 10 g/L (Tonk *et. al*, 2007). Therefore, the bloom of *Microcystis* in Travinh can be seen as a clear evidence for the adaptation of *Microcystis* in brackish water. Our annual monitoring shows there is no bloom of *Microcystis* in this site since 2012 so the bloom and dominancy of *Microcystis* in Travinh in April, 2015 is occasional event. *Microcystis* bloom may be boosted by unexpected increase of total nitrogen (2.07 mg/L), high temperature (33.2^0C) and moderate salinity (6.7 ‰) in this site.

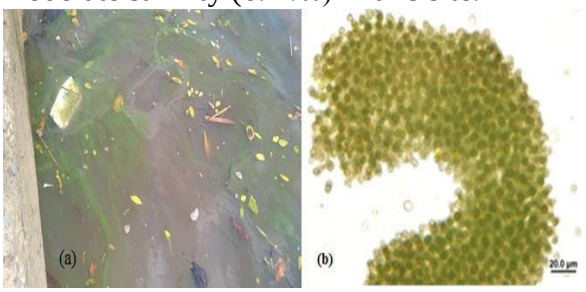

Figure 3. (a) Bloom of *Microcystis* and (b) *Microcystis* under microscope

After getting the highest peak in April, concentration of cyanobacteria was slightly decreased in June when heavy rains was coming. Reichwaldt and Ghadouani, (2012) indicated that heavy rain events can disturb cyanobacterial blooms so the decrease of cyanobacteria in Mekong delta in rainy season can be explained.

Total phytoplankton increased from January to April as well (figure 4). The increase was higher in the downstream areas (Tra Vinh, Ben Tre and Soc Trang province) in comparison with the middle.

(Can Tho and Vinh Long province) of the Vietnamese Mekong river. Diatoms contribute on the increase up to 35.6 and µg/L the total chlorophyll content of microalgae in Soc Trang and Ben Tre province. Cyanobacteria occupy only 20% of total phytoplankton in these provinces. On the contrary, cyanobacteria occupy ca 88% of total phytoplankton in Tra Vinh province.

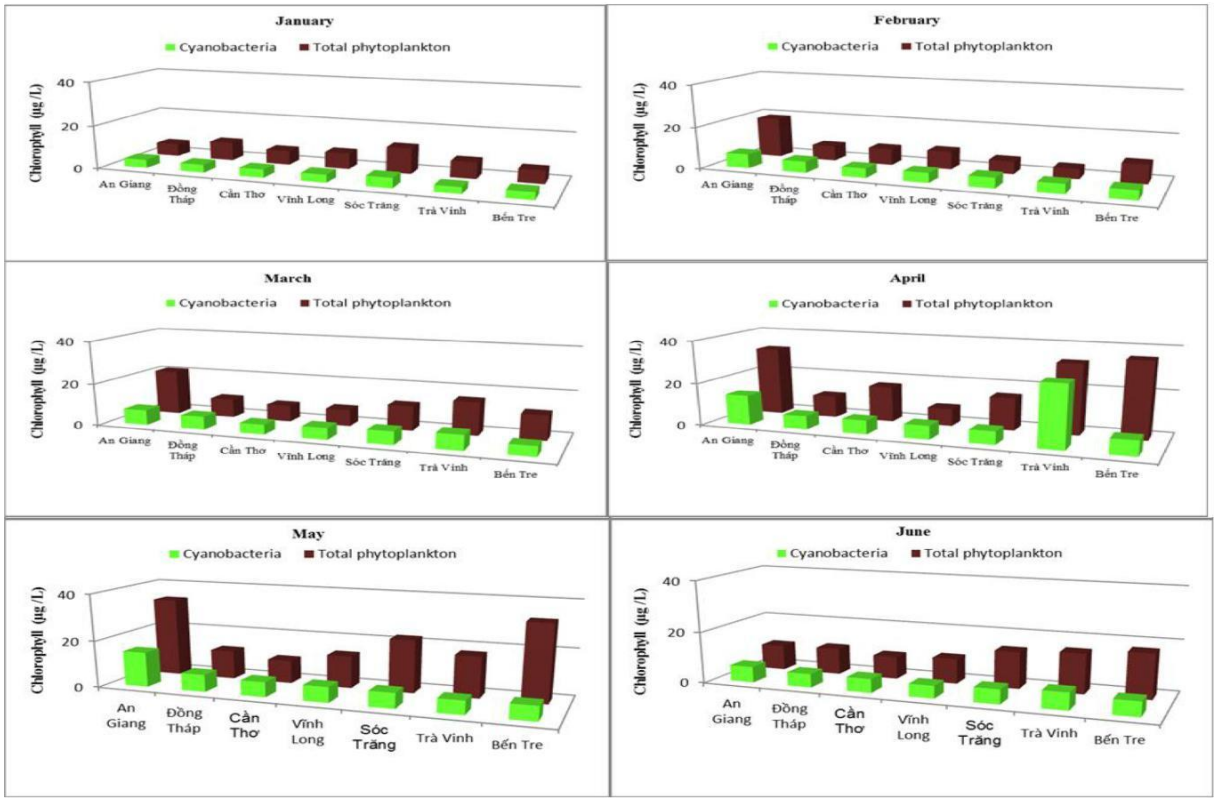

Figure 4. Chlorophyll-a content of cyanobacteria and the total chlorophyll content of microalgae in Vietnamese Mekong river from January to June, 2015.

CONCLUSIONS

Cyanobacteria in the Vietnamese Mekong river are less diversity with only 42 species found in dry season, 2015. Cyanobacteria were more diversity in upper-land area than in saline intrusion area. Concentration of cyanobacteria in the river increases from January to April and the bloom was recorded in saline intrusion area in April, 2015. The bloom, however, is sporadic or occasional events in the river. To our knowledge, this is the first report on cyanobacteria in Mekong delta.

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