CHAPTER 4
RESULTS

4.1 Distribution of *Microcystis aeruginosa*, microcystin producing blue green algae and microcystins in prawn and fish ponds.

Ten earthen ponds were studied since April 2006 – February 2007. Four prawn ponds were located in Thoeng District, Chiang Rai Province. Four fish ponds were located in Pan District, Chiang Rai Province and two other fish ponds were located at Sansai District, Chiang Mai Province.

4.1.1 Identification and enumeration of microcystin producting blue green algae and other phytoplankton.

The list of phytoplankton species which were found in each pond are shown in Appendix B. The dominant species of phytoplankton which were found in prawn and fish ponds were blue green algae (*Arthospira*, *Cylindrospermopsis*, *Microcystis*, *Oscillatoria*, *Pseudanabaena*), green algae (*Chlorella*, *Monoraphidium*, *Pediastrum*, *Scencedesmus*) diatoms (*Aulocoseira*, *Fragilaria*), dinoflagellates (*Ceratium*, *Peridinium*) and euglenoids (*Euglena*, *Phacus*) (Table 4.1, Figures 4.1-4.2).

Table 4.1 Dominant species of phytoplankton which were found in fish and prawn ponds.

	Dominant species of phytoplankton			
sample	Apr 2006	Jul 2006	Oct 2006	Feb 2007
P1	*Microcystis* spp. *Pseudanabaena* sp.	*Microcystis* spp.	*Microcystis aeruginosa*	*Fragilaria* sp.
P2	-	*Microcystis* spp.	*Microcystis* spp.	*Microcystis* spp. *Fragilaria* sp. *Aulacoseira granulata*
P3	-	*Microcystis* spp. *Peridinium bipes*	*Microcystis* spp.	*Microcystis* spp. *Peridinium bipes*
P4	-	*Ceratium furcoides* *Microcystis aeruginosa* *Oscillatoria limosa*	*Microcystis aeruginosa*	*Microcystis aeruginosa* *Oscillatoria limosa*

Table 4.1 (continued)

sample	Dominant species of phytoplankton Apr 2006	Jul 2006	Oct 2006	Feb 2007
T1	*Euglena* spp., *Phacus* spp.	*Chlorella* sp. *Monoraphidium* spp.	*Pediastrum duplex*	-
T2	*Euglena* spp.	*Chlorella* sp. *Scenedesmus armatus* var. *bicaudatus*	*Pediastrum duplex* *Scenedesmus falcatus*	-
T3	*Arthospira* sp. *Phacus* sp. *Microcystis* spp. *Scenedesmus* spp.	*Chlorella* sp. *Pediastrum biradiatum*	*Scenedesmus* spp.	-
T4	*Euglena* sp. *Cylindrospermopsis* spp. *Arthospira* sp.	*Microcystis aeruginosa* *Cylindrospermopsis curvispora*	*Scenedesmus* spp.	-
T5	-	-	-	*Aulacoseira granulata* *Ceratium furcoides*
T6	-	-	-	*Scenedesmus* spp.

Blue green algae which were found in this investigation could be classified into 3 orders 6 families 7 genera and 10 species as follows;

Order Chroococcales

Family Merismopediaceae

Merismopedia tenuissima Lemmermann

Family Microcystaceae

Microcystis aeruginosa Kützing

M. flos-aquae (Wittrock) Kirchner ex Forti

M. ichthyoblabe Kützing

M. wesenbergii Komárek

Order Oscillatoriales

Family Pseudanabaenaceae

Pseudanabaena sp.

Family Phormidiaceae

Arthospira sp.

Family Oscillatoriaceae

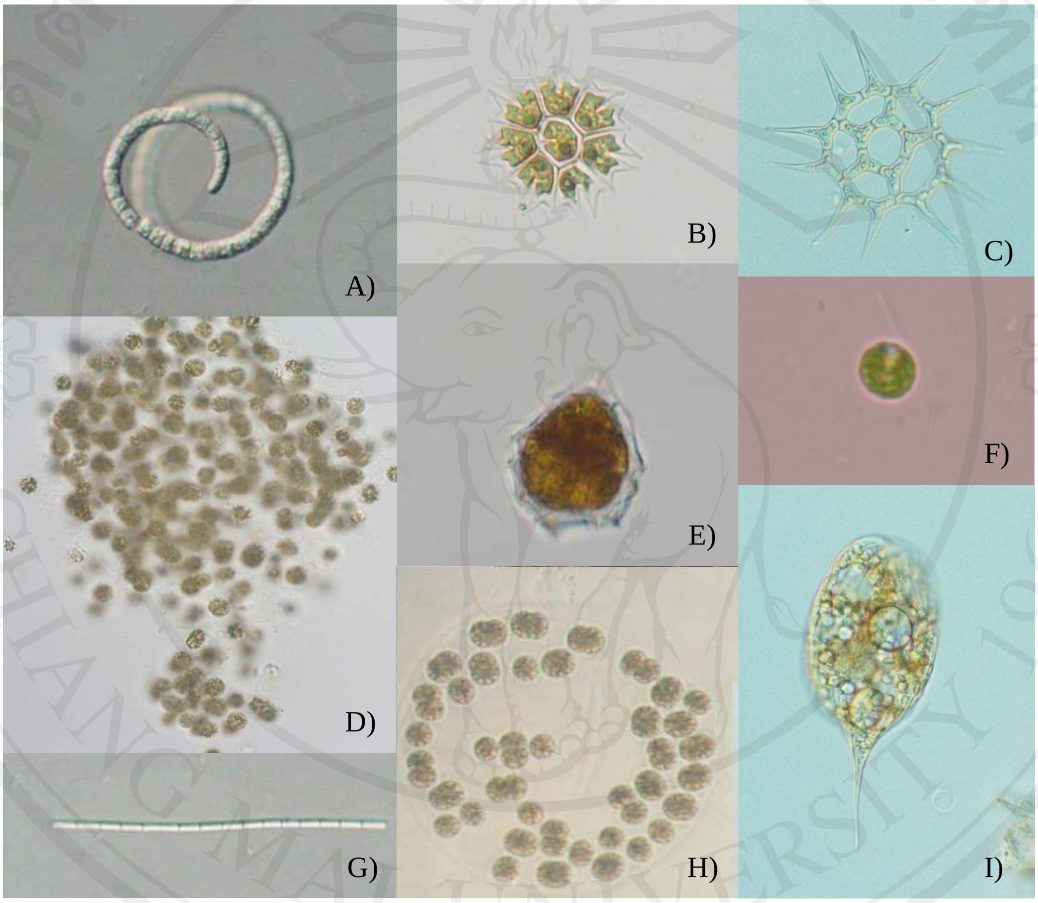
Oscillatoria limosa (C. Agardh) Gomont

Order Nostocales

Family Nostocaceae

Anabaena sp.

Cylindrospermopsis curvispora M. Watanabe



Scale bar = 10 μm

except F) = 20 μm

Figure 4.1 Dominant phytoplankton which were found in fish and prawn ponds
A) *Cylindrospermopsis curvispora* M. Watanabe B) *Pediastrum tetras* (Ehrenberg) Ralfs C) *Pediastrum simplex* Meyen D) *Microcystis aeruginosa* KÜtzing E) *Peridinium* sp. F) *Chlorella* sp. G) *Pseudanabaena* sp. H) *M. wesenbergii* Komárek I) *Phacus caudatus* K. Hübner

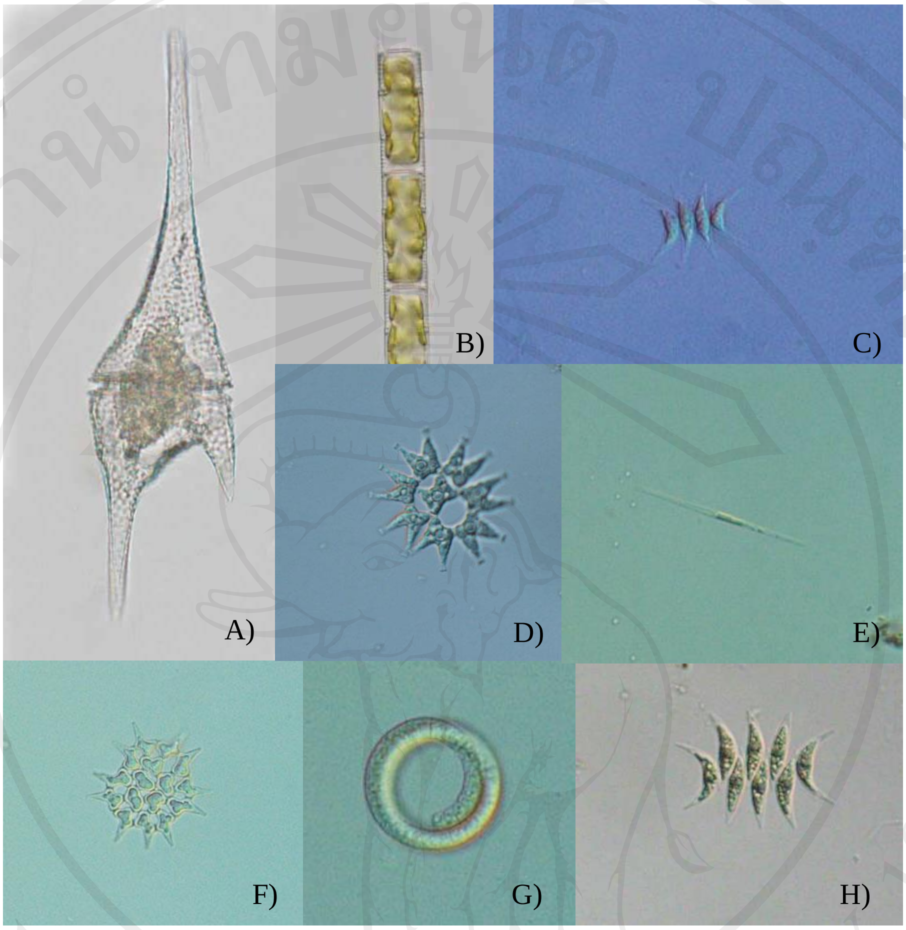


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Figure 4.2 Dominant phytoplankton which were found in fish and prawn ponds

A) *Ceratium hirundinella* Dujardin B) *Aulacoseira granulata* (Ehrenberg) Simonsen C), H) *Scenedesmus acuminatus var. tetradesmoides* Smith D) *Pediastrum duplex* Meyen E) *Fragilaria* sp. F) *Pediastrum* sp. G) *Arthospira* sp.

Not only *M. aeruginosa* but also six morphotypes of blue green algael taxa which were known to be microcystin producing genera were found in this investigation. They were *Anabaena* sp., *Cylindrospermopsis curvispora* Watanabe, *M.*

wesenbergii Komárek, *M. ichthyoblabe* Kützing, *M. flos-aquae* (Wittrock) Kirchner ex Forti and *Oscillatoria* sp. (Figure 4.3). Six species of them were found in fish ponds whereas five species of them were found in prawn ponds. Biovolume ($\mu m^3.L^{-1}$) of these blue green algae was shown in table 4.2

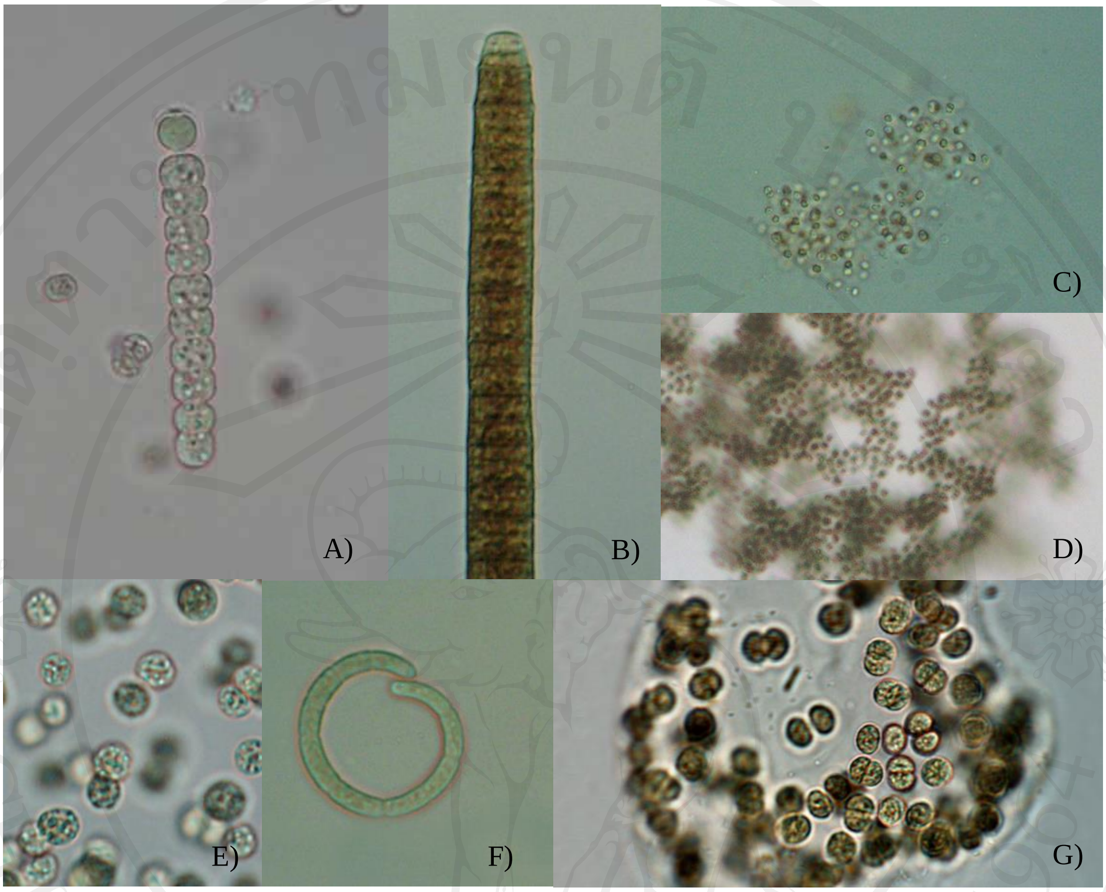
Table 4.2 Biovolume ($\mu m^3.L^{-1}$) of microcystin producing blue green algae which were found in prawn and fish ponds during 2006-2007.

		Blue green algal species							
	Sample	Anab	C.cur	M.aeru	M.wese	M.ich	M.flos	Osci	Total
Jul-06	T1	0	0	0	0	0	0	1,987	1,987
	T2	0	0	513	26,708	0	0	26,708	53,929
	T3	0	0	0	0	0	0	0	0
	T4	0	0	33	0	0	0	0	33
	P1	0	0	35,093	0	2,025	0	0	37,118
	P2	164	0	25,948	0	0	4,733	2,827	33,672
	P3	0	0	49,717	0	0	9461	2,120	61,298
	P4	0	0	203,817	0	0	0	1,395	205,212
Oct-06	T1	0	0	0	0	0	0	0	0
	T2	0	0	0	0	0	0	0	0
	T3	0	0	302	0	0	0	0	302
	T4	50,448	194,141	63,921	0	0	0	0	308,510
	P1	0	0	2,925,000	262,500	116	0	76,201	3,263,817
	P2	0	0	6,316	8,124	0	0	112,593	127,033
	P3	0	0	78,000	172,500	0	0	0	250,500
	P4	0	0	38,824	0	0	0	1,224,531	1,263,355
Feb-07	T5	0	0	0	0	0	0	0	0
	T6	0	0	0	0	0	0	0	0
	P1	0	0	302	0	0	0	0	302
	P2	0	0	63,921	0	0	0	0	63,921
	P3	0	0	1,950	6,750	2,587	0	0	11,287
	P4	0	0	6,316	1,875,000	0	0	0	1,881,316

Anab = *Anabaena* sp. C.cur = *Cylindrospermopsis curvispora*

M.aeru =*Microcystis aeruginosa* M.wese = *Microcystis wesenbergii*

M.ich = *Microcystis ichthytoblabe* M.flos = *Microcystis flos-aquae* Osci = *Oscillatoria* sp.



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—— for A), C), D) and G)

—— for E) and F)

—— for B)

Figure 4.3 Microcystin producing blue green algae which were found in fish and prawn ponds (April 2006 – February 2007).

A) *Anabaena* sp. B) *Oscillatoria limosa* (C. Agardh) Gomont

C) *Microcystis flos-aquae* (Wittrock) Kirchner ex Forti

D) *Microcystis ichthyoblabe* Kützing E) *Microcystis aeruginosa* Kützing

F) *Cylindrospermopsis curvispora* M. Watanabe

G) *Microcystis wesenbergii* Komárek

High amount of *Microcystis* spp. especially, *Microcystis aeruginosa* Kützing was found in prawn ponds (Figure 4.4). Only 36% of fish ponds which were found *M. aeruginosa* whereas 84% of prawn ponds were contaminated with this cyanobacterium (Figure 4.5).

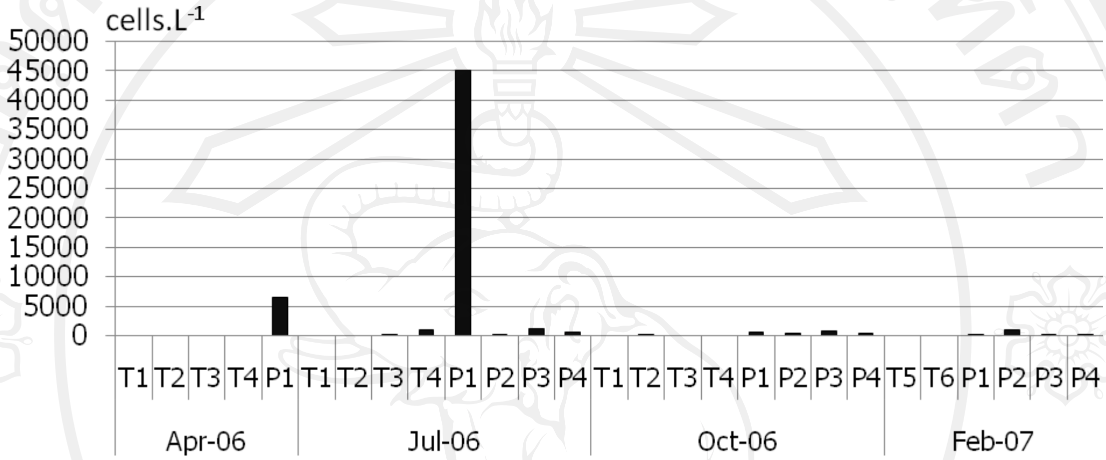


Figure 4.4 *Microcystis aeruginosa* count (cells.L^{-1}) in the fish (T) and prawn ponds (P) during 2006-2007.

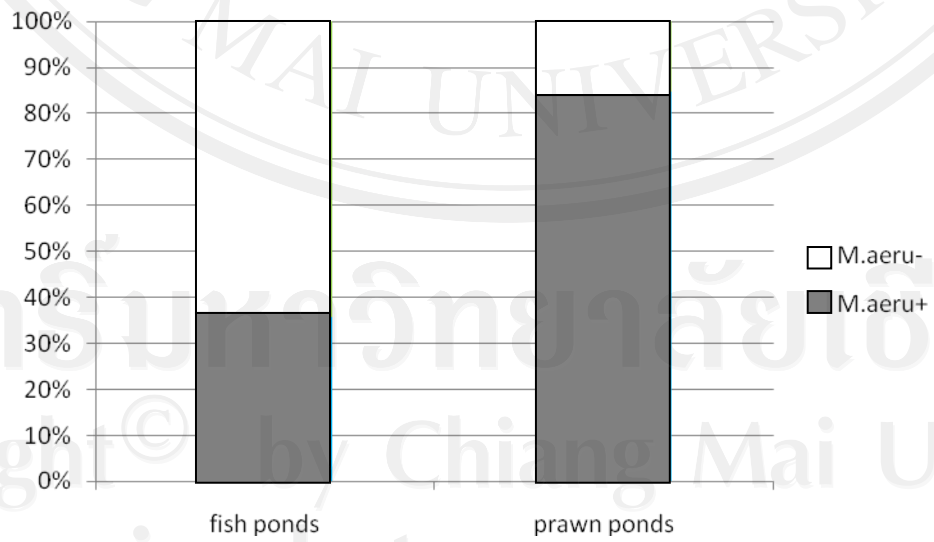


Figure 4.5 Proportion of sampling sites with contained *Microcystis aeruginosa*

High amount of *Cylindrospermopsis curvispora* was found in fish ponds in October 2006 whereas *Oscillatoria* sp. was found in prawn ponds in same month.

Total biovolume of these blue green algae in prawn ponds water was higher than those in fish ponds water (Table 4.3 and Figure 4.6). The highest amount of biovolume was found in prawn pond; P1, October 2006 and the lowest amount of them were found in fish ponds; T3 (July 2006), T1 and T2 (October 2006), T5 and T6 (February 2007).

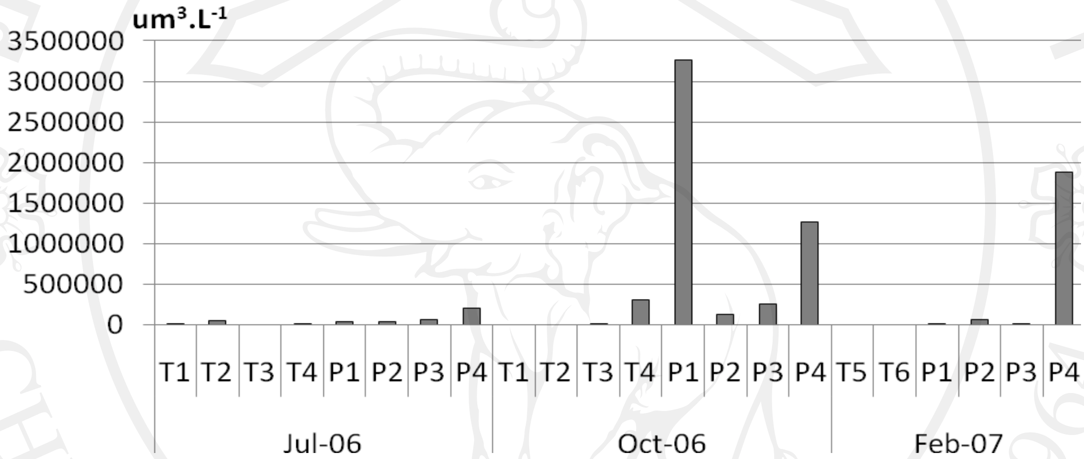
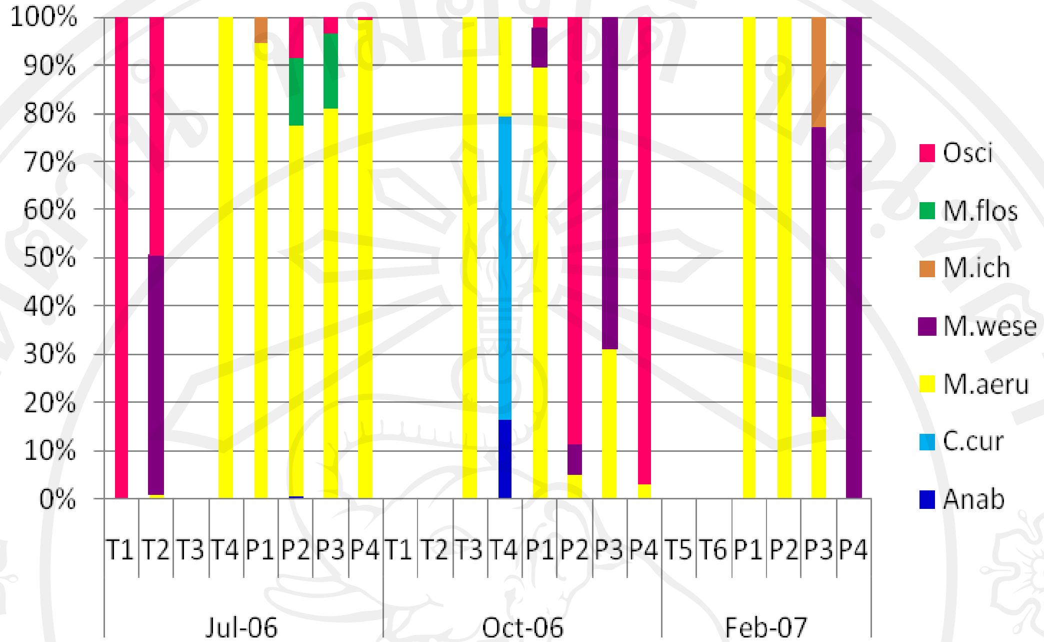


Figure 4.6 Total biovolume of blue green algae ($\mu m^3.L^{-1}$) in the fish (T) and prawn ponds (P) during 2006-2007.

The proportion of toxin producing blue green algal genera in each sampling site was presented in figure 4.7. *Microcystis aeruginosa* was cosmopolitan genera which disperse in both fish and prawn ponds. Moreover, it was main species which was found in highest biovolume contained pond.

Many sites contained single species of blue green algae i.e. *Oscillatoria* sp., *Microcystis aeruginosa* and *Microcystis wesenbergii*. *Oscillatoria* sp. was found in P1 (July 2006). *M. aeruginosa* was found in five sampling sites; there were T4 and P4 in July 2006, T3 in October 2006, P1 and P2 in February 2007. *M. wesenbergii* was found in prawn pond, P4 (February 2007).



Anab = *Anabaena* sp. C.cur = *Cylindrospermopsis curvispora*

M.aeru =*Microcystis aeruginosa* M.wese = *Microcystis wesenbergii*

M.ich = *Microcystis ichthytoblabe* M.flos = *Microcystis flos-aquae* Osci = *Oscillatoria* sp.

Figure 4.7 The proportion of toxin producing genera in fish and prawn pond during 2006-2007.

Analysis of correlation and regression of the relationships between blue green algael species and environmental parameters were done but the results remained inconclusive. The occurrence of blue green algal population in various water resources did not related to physico-chemical parameters or water quality significantly (Appendix B).

4.1.2 Microcystins in fish and prawn samples

Total microcystins were analyzed by ELISA Microcystin Plate Kit. The result was exposed in Table 4.3 and Appendix B. Both prawn and fish samples were found to be contaminated with microcystins at the concentration of 0.03-3.02 μg.kg^{-1} d.w. and n.d.-0.85 μg.kg^{-1} d.w., respectively.

Table 4.3 Amount of microcystins (μg.kg^{-1} d.w.) which found in sampling sites during 2006-2007.

	Number of samples	microcystins (μg.kg^{-1})	
		Min-Max	Mean ± SE
Nile tilapia	14	0-0.85	0.730±0.258
Giant freshwater prawn	13	0-3.02	0.148±0.070

The highest quantity of microcystins, 3.02 μg.kg^{-1} d.w. was found in prawn sample from July 2006 (P2). But high content of microcystins did not co-occur neither with high density of *Microcystis aeruginosa* nor other microcystin producing genera (Figures 4.8 and 4.9). For example, the highest amount of both *M. aeruginosa* and microcystin producing blue green algael biovolume were found in P1 (October 2006) whereas microcystin content in prawn meat was only 0.34 μg.kg^{-1} d.w.

The amount of microcystins in the prawn samples was higher than fish samples. Although it seemed to be correlated with cell counts of *M. aeruginosa* but there was no correlation between *Microcystis* cell numbers and microcystins in prawn and fish samples (r^2 = -0.0409).

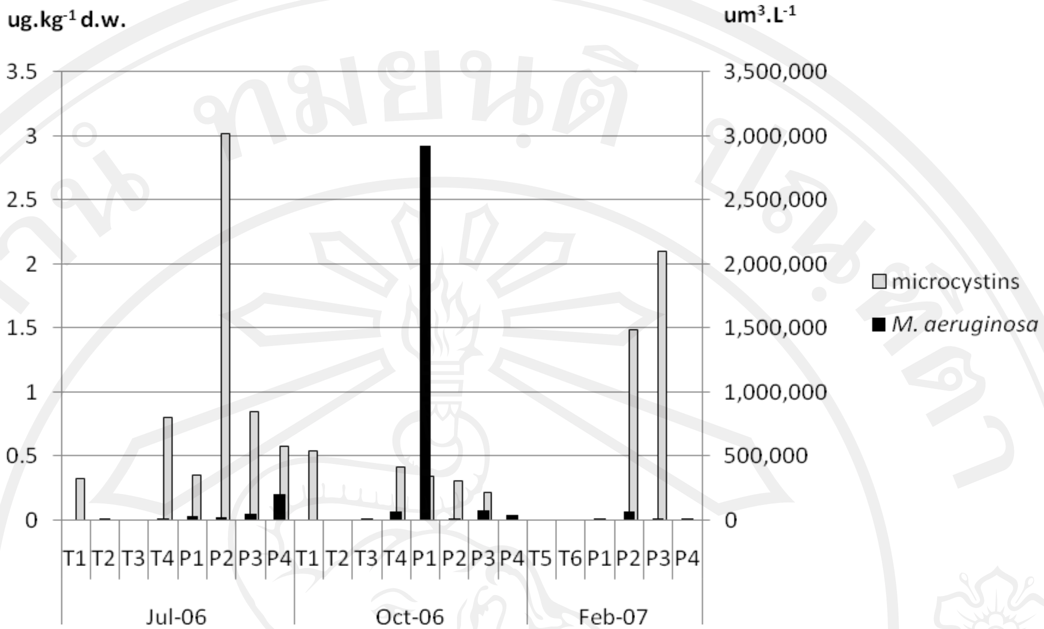


Figure 4.8 Microcystins (μg.kg^{-1} d.w.) in fish (T) and prawn (P) sample and biovolume of *Microcystis aeruginosa* (μm^{3}.L^{-1}) from various ponds during

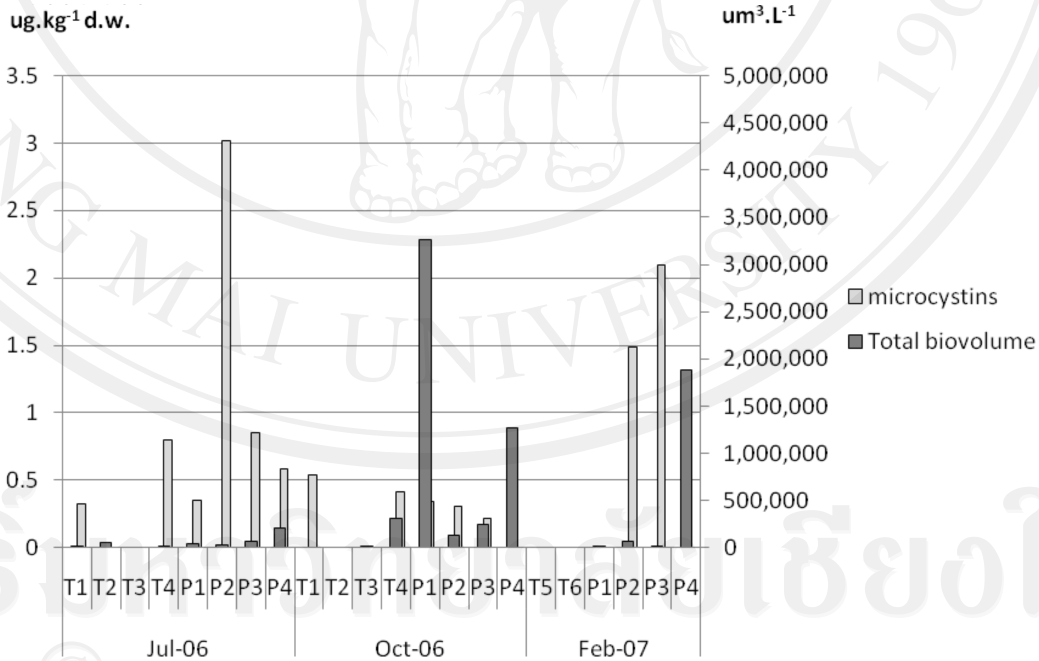


Figure 4.9 Microcystins (μg.kg^{-1} d.w.) in fish (T) and prawn (P) sample and biovolume of other microcystin producing blue green algae (μm^{3}.L^{-1}) from various ponds during 2006-2007.

4.1.3 Analysis of some physico-chemical properties of water.

The assessment of water quality was done by considering some physico-chemical parameters and dominant genera of phytoplankton (Appendix A). The data of each parameter are shown in Appendix B.

The water qualities ranged from clean- moderate (oligo-mesotrophic status) to moderate-polluted (meso-eutrophic status) (Table 4.4). It seemed that the water quality in prawn pond was slightly clean better than that in fish pond because the amount of nutrients in prawn pond was lower than in fish pond (Table 4.5). However, the nutrients in both ponds decreased slightly in July 2006 (Figure 4.10).

Table 4.4 Water quality of water in fish and prawn ponds.

Sample Date	P1	P2	P3	P4	T1	T2	T3	T4	T5	T6
Apr 2006	M-E	-	-	-	M-E	M-E	M-E	M-E	-	-
Jul 2006	M	M	M	M	O-M	O-M	M	O-M	-	-
Oct 2006	M-E	M	M-E	M	M	M	M	M	-	-
Feb 2007	M	M	M	M	-	-	-	-	M-E	M

O = Oligotrophic status = clean water quality
O-M = Oligotrophic-mesotrophic status = clean-moderate water quality
M = Mesotrophic status = moderate water quality
M-E = Mesotrophic-eutrophic status = moderate-polluted water quality
E = Eutrophic status = polluted water quality
H-E = Hypereutrophic status = very polluted water quality
- = Not studied

P = prawn pond T = tilapia pond

Table 4.5 Some physico-chemical properties of water in fish and prawn ponds during April 2007 – February 2008.

Parameters	Mean±S.E.	
	Giant freshwater prawn pond (n=13)	Tilapia pond (n=14)
pH	7.68±0.19	7.36±0.12
DO (mg/L)	5.61±0.53	5.89±0.21
Temperature (°C)	29.88±0.54	27.63±1.05
Conductivity (µS.cm^{-1})	369.75±34.07	197.31±14.23
NH_4-N (mg.L^{-1})	0.29±0.04	0.17±0.03
NO_3-N (mg.L^{-1})	0.61±0.12	0.91±0.15
PO_4-P (mg.L^{-1})	0.07±0.02	0.20±0.07

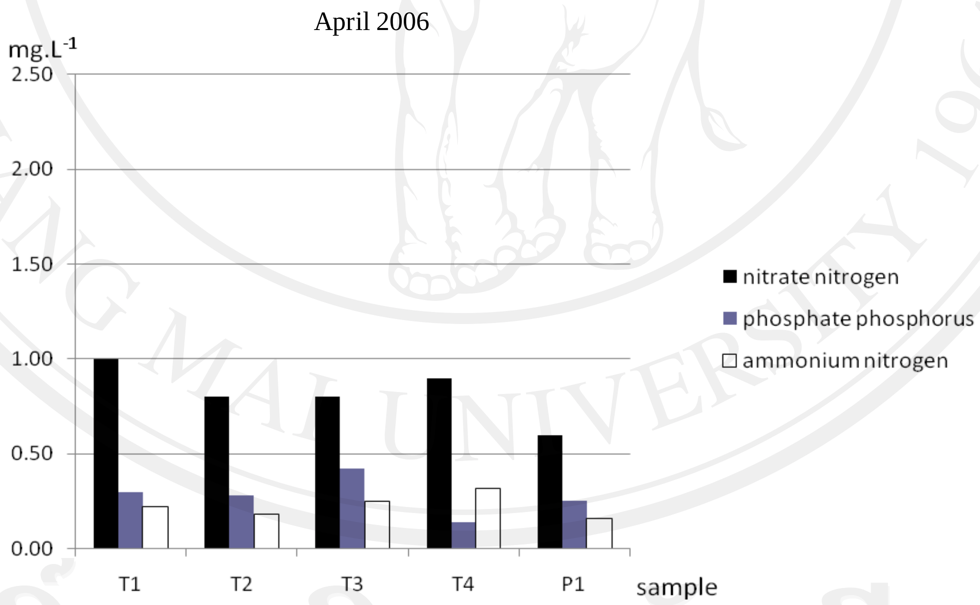
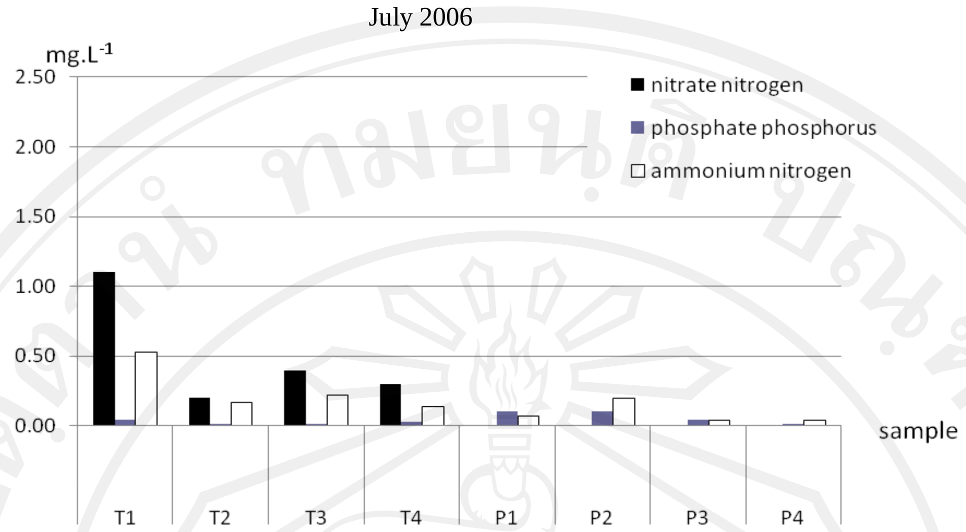
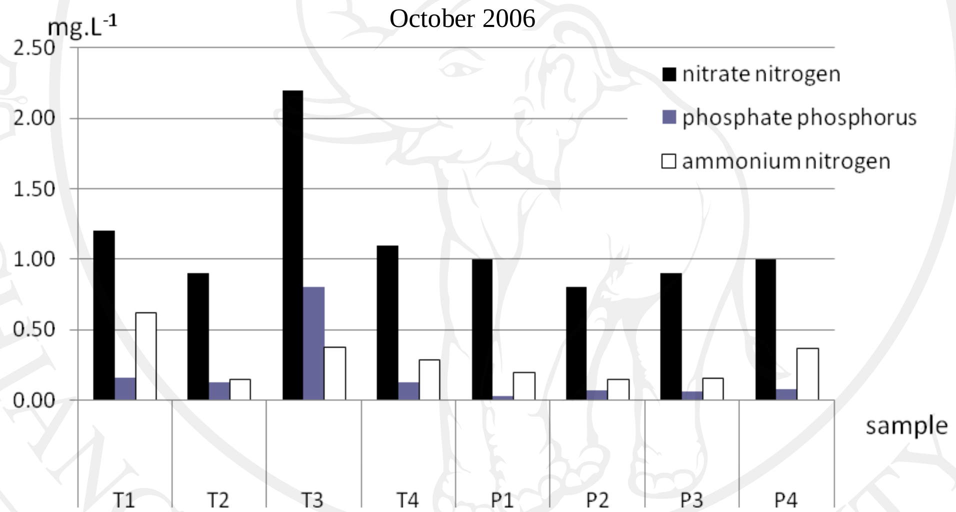


Figure 4.10 Nutrients of water in fish and prawn ponds (April 2006 – February 2007)





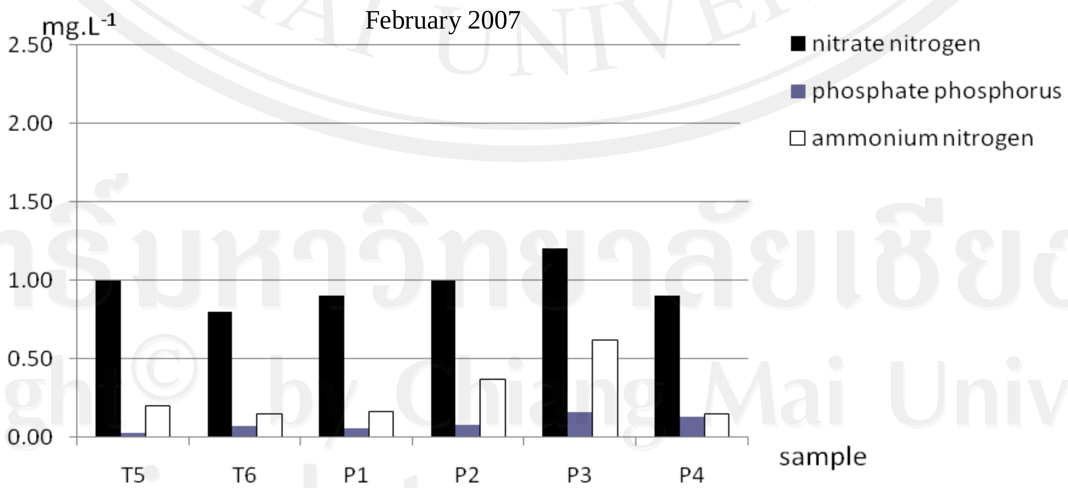


Figure 4.10 (continued)

4.2 The accumulation of microcystins in fish and prawn samples in demonstrated ponds

Two types of demonstrated ponds were used for prawn and Nile tilapia cultivation i.e. earthen pond and cement pond

4.2.1 Earthen pond 7.0 x 14.2 square meter with water depth of 0.80 meter

Promoting of *Microcystis aeruginosa* bloom by adding dry chicken manure at the rate of 200 kg/rai/week was not successful. One year of cultivation shown that the dominant species of phytoplankton in earthen ponds were *Euglena* spp. and *Oscillatoria* spp.

After 3 months of cultivation, *M. aeruginosa* cell was not detected in water sample. Therefore the experiment for promoting the mass of *M. aeruginosa* was designed. Six treatments were created.

Treatment 1 no fertilization

Treatments 2 – 6, dry chicken manure was applied at the rate of 0, 30, 60, 90, 120 and 150 kg/rai/week respectively. Ponds were dried for one week prior to adding water and chicken manure was applied weekly. The mass of *M. aeruginosa* at surface water were detected by naked eyes every 2 days. But the scum of *M. aeruginosa* never appear all the period of cultivation. Although adding *M. aeruginosa* culture were done.

It was found that the dominant species of phytoplankton found in treatment 1 was *Coelastrum* sp.

Treatment 2, *Cylindrospermopsis raciborskii* and *Pediastrum simplex* Meyen.

Treatment 3, *Crucigeniella crucifera* and *Microcystis aeruginosa*

Treatment 4, *Cylindrospermopsis raciborskii*, *Scenedesmus falcatus* and *Microcystis aeruginosa*.

Treatment 5, *Oscillatoria subbrevis* and *Euglena oxyuris*

Treatment 6, *Euglena elastica* and *Phacus longicauda*

Although *M. aeruginosa* were detected as dominant species in treatment 3 and 4 but it was not a mass of them. Only 3,000 and 6,750 cells.L^{-1} were found in treatments 3 and 4 respectively. The amounts of phytoplankton and some physico-chemical parameters in each treatment were shown in appendix C. Therefore, the accumulation of microcystins in fish and prawn samples in earthen ponds was not accomplished in this study.

4.2.2 Cement pond

4.2.2.1 Fish pond

1. Identification and Enumeration of *M. aeruginosa* and Phytoplankton in Fish Ponds

Nile tilapia (*Tilapia nilotica*) was selected organism for this study. Three treatments were conducted for the accumulation of microcystins in fish

Dominant species of phytoplankton excluding *M. aeruginosa* were found to belong to 5 divisions i.e. Divisions Chlorophyta, Cyanophyta, Euglenophyta, Bacillariophyta and Pyrrhophyta. Dominant species were Chlorophyta (green algae) such as *Scenedesmus* spp. and *Pediastrum* spp. (Table 4.6, Figure 4.11 and 4.12).

Table 4.6 Dominant species of phytoplankton which were found in each treatment (excluding *M. aeruginosa*)

Treatment / Sampling time	Tr.1 Control	Tr.2 *M.aeruginosa* + feeding	Tr.3 *M.aeruginosa*
Replicate I Week I	*Pediastrum duplex*	*Pediastrum duplex* *Scenedesmus* sp. 1 *Scenedesmus* sp. 3	*Scenedesmus* sp. 2 *Scenedesmus* sp. 3
Week II	*Scenedesmus* spp.	*Scenedesmus* sp. 1 *Scenedesmus* sp. 2	*Scenedesmus* sp. 2 *Navicula* sp. 1
Week III	*Pediastrum simplex* *Oscillatoria* sp. *Dictyosphaerium pulchellum*	*Scenedesmus* sp. 1 *Scenedesmus* sp. 2	*Dictyosphaerium pulchellum*
Week IV	*Ankistrodesmus fusiformis*	*Scenedesmus* sp. 1	*Scenedesmus* sp. 1

Figure 4.6 (continued)

Treatment Sampling time	Tr.1 Control	Tr.2 *M.aeruginosa* + feeding	Tr.3 *M.aeruginosa*
Replicate II	*Nitszchia* sp.	*Nitszchia* sp.	*Scenedesmus* sp. 1 *Scenedesmus* sp. 2
Week I	*Scenedesmus* sp. 1 *Navicula* sp. 1	*Scenedesmus* sp. 1 *Fragilaria* sp. 1	*Scenedesmus* sp. 1 *Nitszchia* sp.
Week II	*Scenedesmus* sp. 1 *Navicula* sp. 1	*Scenedesmus* sp. 1, *Gomphonema* sp. 1	*Scenedesmus* sp. 1 *Navicula* sp. 1
Week III	*Pediastrum duplex*	*Scenedesmus* sp. 2	*Coelastrum astroideum*
Week IV	*Chlorella* sp. *Scenedesmus* sp. 1 *Navicula* sp. 1	*Microcystis wesenbergii* *Scenedesmus* sp. 1 *Navicula* sp. 1	*Scenedesmus* sp. 1

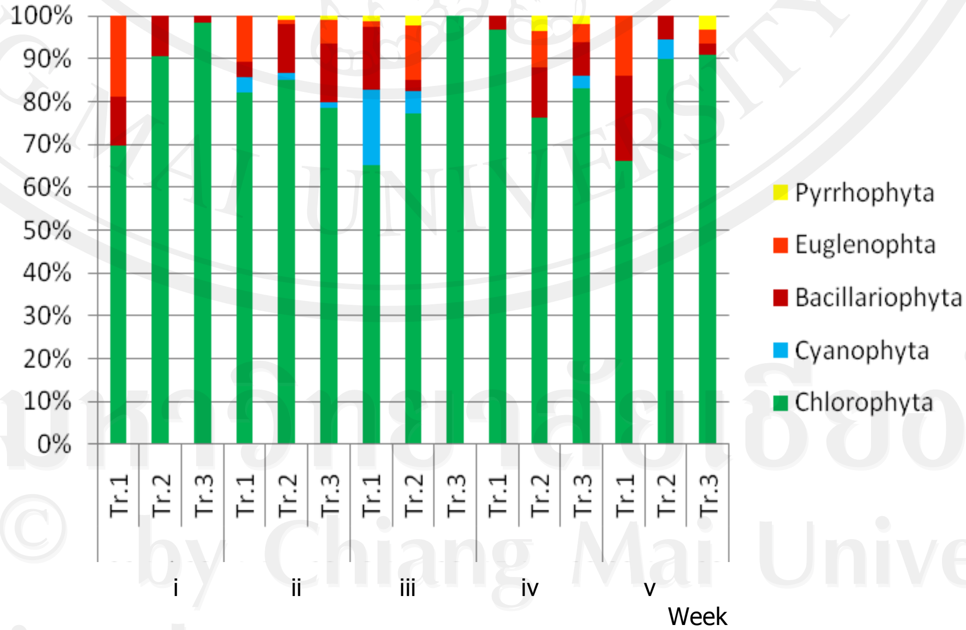


Figure 4.11 Species composition of phytoplankton in each treatment (Replicate I fish pond).

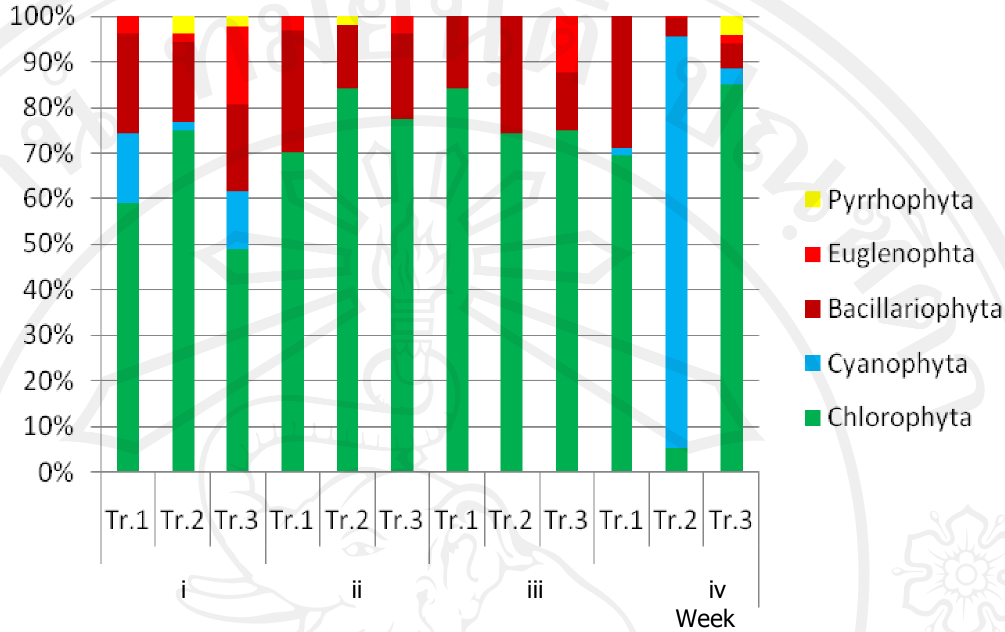


Figure 4.12 Species composition of phytoplankton in each treatment (Replicate II fish pond).

The species composition was similar in each treatment except Tr. 2, *Microcystis wesenbergii* was found as dominant species. Tr. 1 had lowest amounts of phytoplankton. Whereas the highest amounts of phytoplankton were found in Tr. 3 and Tr. 2, respectively (Figures 4.13 and 4.14).

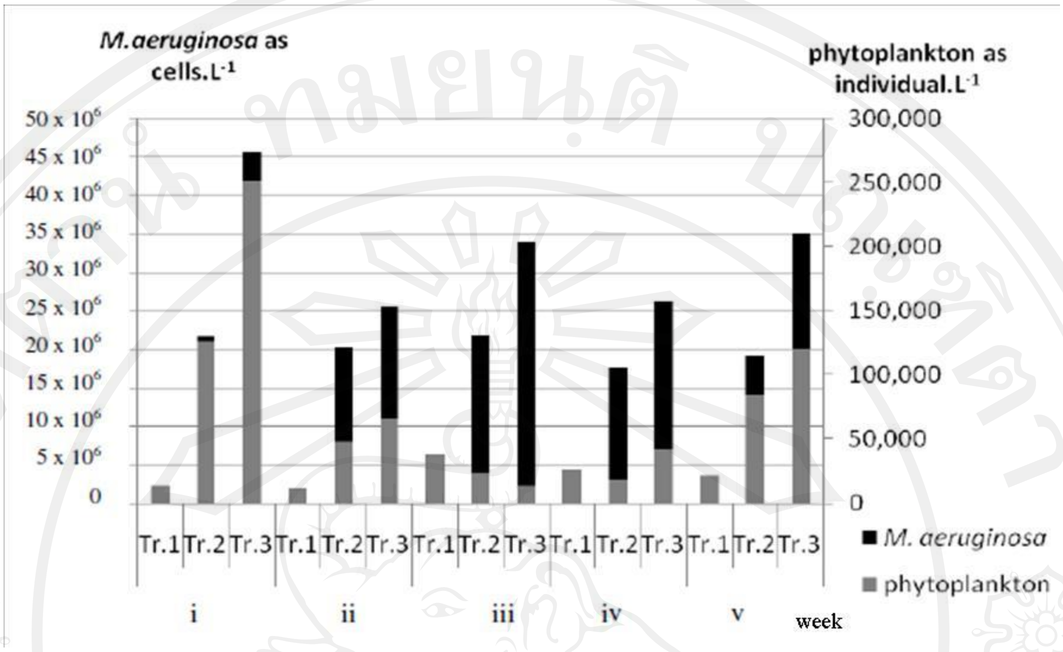


Figure 4.13 Amounts of phytoplankton and *M. aeruginosa* in each treatment (Replicate I fish pond).

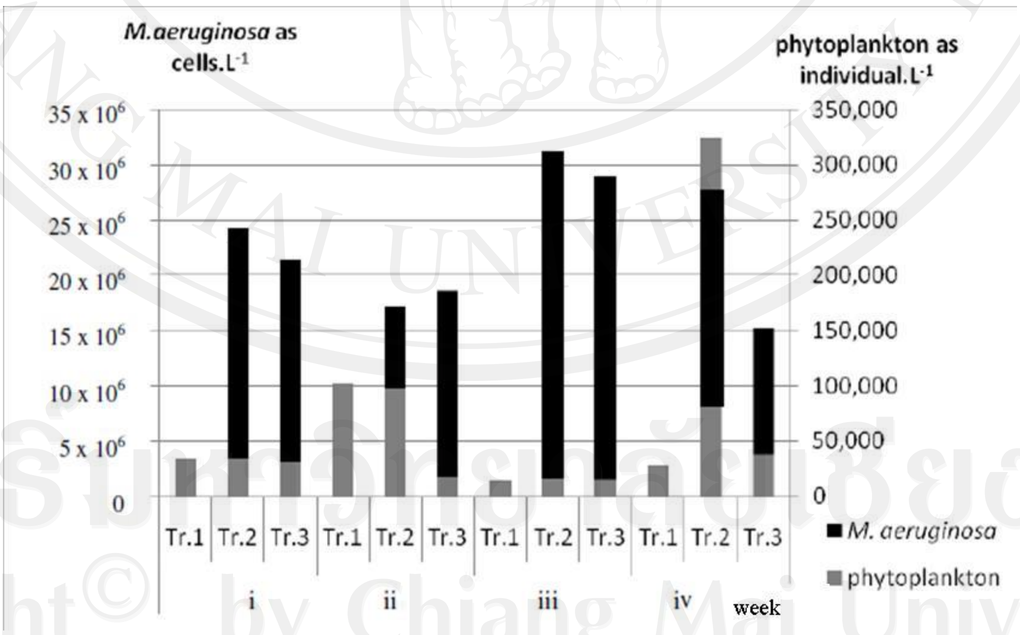


Figure 4.14 Amounts of phytoplankton and *M. aeruginosa* in each treatment (Replicate II fish pond).

2. Microcystin Contents in Fish Samples

Table 4.7 shown the averaged weight of Nile tilapia and the amounts of microcystins which found in fish meat. High microcystin contents were detected. in the fish of Tr.2 and Tr. 3.

Total weight of Nile tilapia was slightly increased whereas high microcystin contents in fish samples which were cultured about 1 month were detected. Samples cultured in Tr. 2 and Tr. 3 which contained high amounts of *M. aeruginosa* also contained high amounts of microcystins.

Table 4.7 Total weight of Nile tilapia and microcystins contents.

Sampling time	Treatment	Weight (g)	Microcystin content ($\mu g.kg^{-1}$ d.w)
Replicate I Week I	Tr.1	16.50±0.12	0.028±0.001
	Tr.2	26.60±0.08	0.034±0.001
	Tr.3	26.48±0.03	0.024±0.001
Replicate I Week V	Tr.1	18.70±0.10	0.029±0.001
	Tr.2	27.90±0.15	7.835±0.720
	Tr.3	27.62±0.09	8.844±0.942
Replicate II Week I	Tr.1	6.76±0.11	0.051±0.018
	Tr.2	6.13±0.06	0.057±0.012
	Tr.3	6.15±0.08	0.073±0.015
Replicate II Week IV	Tr.1	7.93±0.05	0.061±0.014
	Tr.2	11.12±0.12	8.325±0.755
	Tr.3	10.51±0.07	9.349±1.451

1) Green water system.

2) Green water system with *M. aeruginosa* and combined with feeding.

3) Green water system with *M. aeruginosa*.

4.2.2.2 Prawn Ponds

1. Identification and Enumeration of *M. aeruginosa* and Phytoplankton in Prawn Ponds

Species compositions of phytoplankton including the numbers of *M. aeruginosa* were investigated (Appendix C). Phytoplankton in 5 divisions i.e. Division Chlorophyta, Cyanophyta, Euglenophyta, Bacillariophyta and Pyrrhophyta were found in each treatment. The dominant group of phytoplankton was slightly changed from diatoms to green algae or green algae to diatoms but blue green algae excluding *M. aeruginosa* never appear as dominant species during cultivation.

Dominant phytoplankton species excluding *M. aeruginosa* in the prawn pond were diatoms such as *Cyclotella* spp. and *Acthanthidium* spp. The amounts of *M. aeruginosa* and other phytoplankton are shown in Figure 4.15.

Dominant species of phytoplankton excluding *M. aeruginosa* were presented as Table 4.8. The species composition was similar in each treatment (Figures 4.15 and 4.16).

Table 4.8 Dominant species of phytoplankton which were found in each treatment (excluding *M. aeruginosa*).

Treatment Sampling time	Tr.1 Control	Tr.2 *M. aeruginosa*
Replicate I Week I	*Cyclotella* sp.	*Cyclotella* sp.
Week IV	*Cyclotella* sp. *Achnanthidium* sp.	*Cyclotella* sp.
Replicate II Week I	*Achnanthidium* sp.	*Monoraphidium arcuatum* *Monoraphidium minutum*
Week IV	*Scenedesmus* sp.	*Nitzschia* sp.

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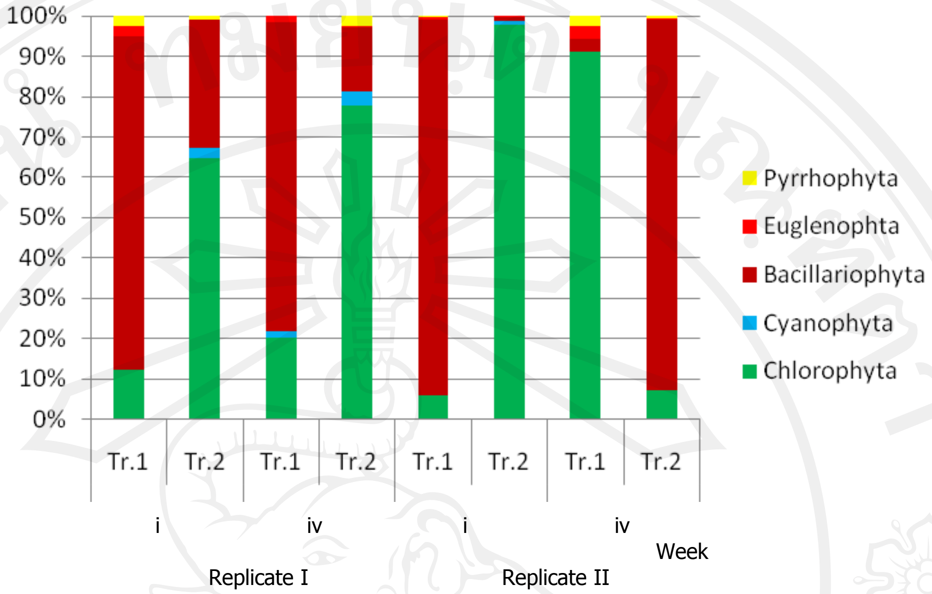

Figure 4.15 Species composition of phytoplankton in each treatment (prawn pond).

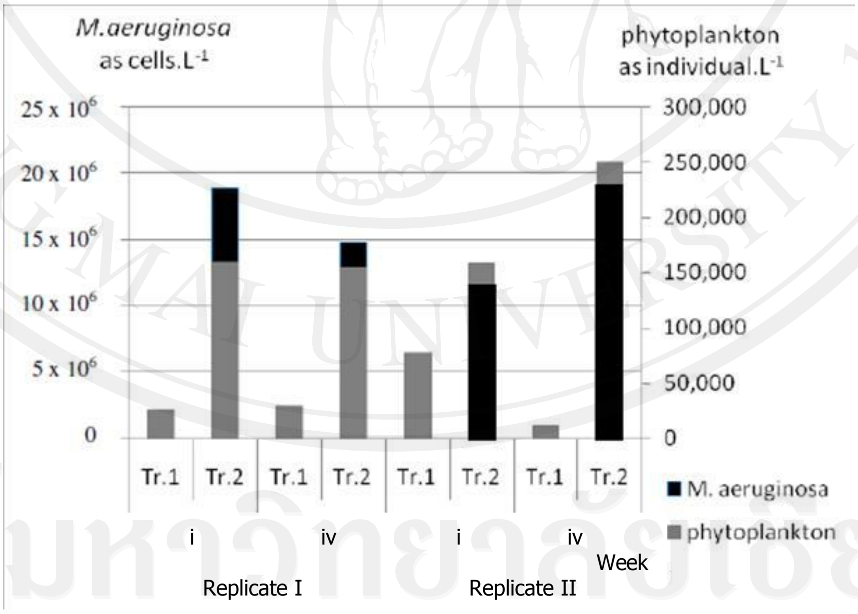

Figure 4.16 Amounts of phytoplankton and *M. aeruginosa* in each treatment (prawn pond).

2. Microcystin contents

Total weight and the amounts of microcystins in prawn meat were shown in Table 4.9. Microcystin contents were detected in prawn meat at the end of cultivation.

Table 4.9 Total weight of giant freshwater prawn and microcystins contents.

Sampling Time	Treatment	Weight (g)	Type	Microcystin contents ($\mu g.kg^{-1}$ d.w.)
Replicate II	Tr.1	2.68+1.31	A	0.025+0.003
Week I			B	0.024+0.004
	Tr.2	2.84+0.84	A	0.028+0.002
			B	0.059+0.011
Replicate II	Tr.1	2.75+1.02	A	0.027+0.008
Week IV			B	0.032+0.005
	Tr.2	4.35+1.01	A	14.424+1.627
			B	12.153+2.328

4.3 Controlling of *Microcystis aeruginosa* and microcystins by using Effective Microorganisms (EM)

Three concentrations of EM (0.3, 0.5 and 1.0 $mL.L^{-1}$) of two commercial EM were compared with control treatment for the ability to eliminate *M. aeruginosa* and microcystins. The results were shown in Table 4.10.

Table 4.10 Amounts of *Microcystis aeruginosa* and microcystins in each treatment.

Type	Treatment	Date	Cell No. ± S.E. (cells.L^{-1})	microcystins± S.E. (µg.L^{-1} d.w.)
EM1	control 1	3-Mar-09	20.8 x10^6± 3.0x10^6	6.373±0.131
		7-Apr-09	1.7 x10^6±3.8 x10^4	6.783±0.310
	T0.3	3-Mar-09	21.5 x10^6±2.3 x10^6	6.058±0.839
		7-Apr-09	1.7 x10^6±4.1 x10^4	6.192±0.206
	T0.5	3-Mar-09	22.6 x10^6±0.7 x10^6	5.777±0.276
		7-Apr-09	1.7 x10^6±4.7 x10^4	6.587±0.400
	T1.0	3-Mar-09	22.3 x10^6±0.5 x10^6	6.717±0.173
		7-Apr-09	1.8 x10^6±5.8 x10^4	6.114±0.306
EM2	control 2	3-Mar-09	17.1 x10^6±0.8 x10^6	6.7673±0.131
		7-Apr-09	1.6 x10^6±5.7 x10^4	6.6552±0.083
	T0.3	3-Mar-09	17.8 x10^6±0.5 x10^6	6.5708±007
		7-Apr-09	1.8 x10^6±0.05 x10^4	6.8996±096
	T0.5	3-Mar-09	20.5 x10^6±0.6 x10^6	7.5726±079
		7-Apr-09	1.8 x10^6±3.0 x10^4	6.6760±031
	T1.0	3-Mar-09	20.8 x10^6±0.9 x10^6	6.4263±199
		7-Apr-09	1.7 x10^6±11.4 x10^4	6.5360±0.166

Declining of *M. aeruginosa* cells showed in similar amounts. Whereas the amounts of microcystins were slightly changed. No correlation was found between concentration of EM and amounts of *M. aeruginosa* or microcystins.

4.3.1 Amounts of *Microcystis aeruginosa*

The numbers of *M. aeruginosa* in each treatment was shown in Appendix C. The percent removal of *M.s aeruginosa* was presented in Figure 4.17.

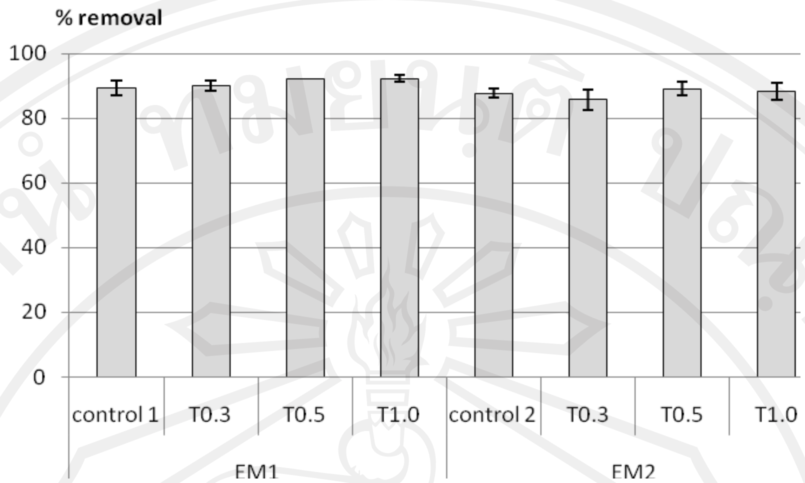

Figure 4.17 Percentage removal of *Microcystis aeruginosa* cultured in various concentration of EM.

Percent of *M. aeruginosa* removal ranged from 85 – 92%. Concentration of EM had no significant difference in *M. aeruginosa* cells compared with control.

4.3.2 Amounts of microcystins

Microcystin contents in water sample in all treatment were observed. The result was shown in Figure 4.18. Similar to the amount of *M. aeruginosa*, microcystins was not correlated to EM in all concentrations including control.

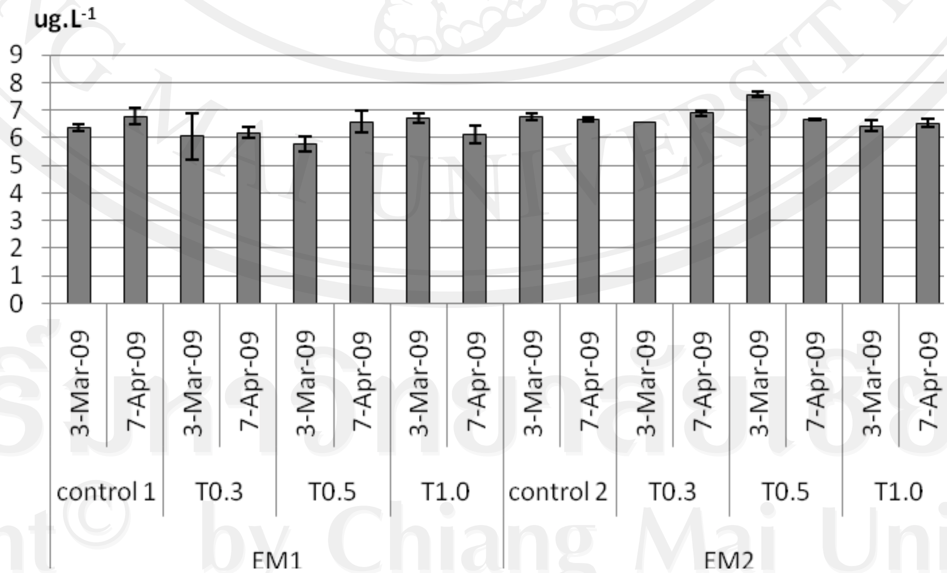

Figure 4.18 The amounts of microcystins ($\mu g.L^{-1}$) in various concentration of EM.