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Diversity of some organisms in Chiang Mai Rajabhat University, Mae Rim Campus, Chiang Mai Province

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Abstract

The objective of this research is to study the diversity of phytoplankton, benthos, plants, birds, as well as water and soil quality in the area of Mae Rim Campus of Chiang Mai Rajabhat University, Mae Rim district in Chiang Mai province in Thailand. This research was conducted from October 2013 to September 2014. The study found that there were 5 divisions of phytoplankton consisting of 31 species from 22 genera with *Ankistrodesmus falcatus*, *Staurastrum smithii*, *Cosmarium contractum* and *Staurastrum* sp. as being most prominent. Two phyla consisting of 12 families from 8 Orders of benthos were found and the most abundance species were *Macrobrachium* sp. (freshwater prawns) and *Rhagadotarsus* sp. (water striders). Furthermore12 families consisting of 15 species of plants were found, and the most abundance species were *Dipterocarpus tuberculatus* and *Shorea siamensis*. Moreover, 15 orders consisting of 106 species from 77 genera within 43 families of birds were also found. That includes 83 resident species, 22 were winter visitors species and one passage migrant species. The concentration of nutrient in the soil was classified as low. The analysis showed that the amount of phosphorus and potassium in soil were 4.50-5.07 mg/kg and 35.67-95.67 mg/kg, respectively. However, from a biodiversity perspective, it can be concluded that the terrestrial and

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aquatic ecosystem in Mae Rim Campus, Chiang Mai Rajabhat University is suitable for using as local learning areas for students and communities. In addition, the university can use the database of this study to make decisions and to develop a policy on campus development in the future.

Keywords: phytoplankton, benthos, plants, birds

1. Introduction

Chiang Mai Rajabhat University, Mae Rim Campus, is located in Saluang and Khee Lek District, Mae Rim, Chiang Mai. It has a total area of approximately 10 km^2. The terrain is generally hilly and wild with abundant natural resources and high level of biodiversity. The forested area is of deciduous-dipterocarp, inherited by many birds and small mammals. In addition, the campus has several man-made reservoirs which were built as a back-up water resource for use in campus. Many plants, algae and animals can be found close to these reservoirs where animals use as shelter and for finding food.

Through the years, the campus has been expanded in many ways. The infrastructure such as roads, man-made reservoirs, office buildings, academic buildings and auditoriums have been constructed for various purposes. Trees were cut down to serve these expansions which has caused the decrease in habitats and population of animals and other wildlife. Considering these issues, it is obvious that the University itself has a policy to develop the area for academic purpose. However, the University appears to have no policy on the conservation of its natural resources. In the past, several scientific research conducted on the campus focused on specific groups and perspectives [1-2] . However, there has been no research to show proof or concrete evidence on biodiversity within this area that are recognized nationally or internationally.

This research will be the first study of its kind in the northern region to show the composition of organisms, consisting of both producers such as phytoplankton, benthic, plants and consumers such as birds, and also, to assess the properties of water and soil on the campus in order to fulfill educational aspects of the Plant Genetic Conservation Project initiated by H.R.H. Princess Maha Chakri Sirindhorn. In this study, the concept of sustainability of soil-water-forest relations was also used in the research process [3]. The results of this research will be served as a database on biodiversity, chemical and physical properties of water and soil, and for future planning and preventing the environmental problems relating to natural resources in the area for every sections such as the stake holder, local communities and university policy maker.

2. Materials and Experiment

2.1 Study sites and period

Study areas are located in Chiang Mai Rajabhat University, Mae Rim Campus, Chiang Mai Province, as shown in Figure 1. The type of forest is mostly deciduous-dipterocarp. Tung Piang (19°01'49.74" N 98°54'27.02" E, Saluang Nai (19°01'23.97" N 98°55'03.59" E) and Wiang Bua (19°01'33.90" N 98°55'59.74" E) reservoirs were selected to study phytoplankton and benthos diversity. The areas of 2.14 km^2 were separated to four plots consisting of plot A (0.18 km^2, 19°01'42.82" N 98°54'40.19" E), B (0.59 km^2, 19°02'09.98" N 98°54'27.47" E), C (0.51 km^2, 19°02'03.57" N 98°54'55.28" E) and D (0.86 km^2, 19°01'44.35" N 98°55'05.85" E) to study plants and birds diversity. The data collection period was from October 2013 to September 2014.

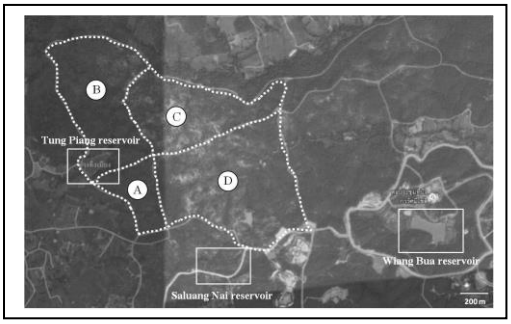

Figure 1 Aerial photograph of the Chiang Mai Rajabhat University, Mae Rim Campus and sampling sites.

2.2 Collection of phytoplankton and benthos

Samples of phytoplankton were collected by filtering 10 liters of water with a 10 μm pore size plankton net. The samples were preserved in Lugol's solution, and were identified and counted using relevant books and documents [4-7]. Benthos samples were collected by sweep sampling method with a pond net (1.4 X 1.4 mm meshes) and were preserved in 70% ethanol [8-9]. The aquatic insect samples were sorted, identified and counted according to the relevant books and documents such as McCafferty [10], Stehr [11], Wiggins [12], Sangpradub and Boonsoong [13], Merritt et al. [14].

2.3 Collection of plant

Four plots of 40 x 40 m^2 were randomly selected across the area for collecting plant samples. Numbers of species found were counted. Orders, families, specific names and common names were also recorded. The leaves, flowers and fruits were collected as a herbarium with labels of order, family and species. Some samples were conserved in suitable liquid preservatives. Photos of all samples were taken and their common and scientific names were identified using related books and references such as Spilsbury and Spilsbury [15], Gardner et al. [16], Samitinun [17]. Then, list of plant names and the numbers of plant species were put in order.

2.4 Bird survey

Bird surveys were conducted on foot in each study plot four times every month, from 0600 h to 0900 h and/or 1500 h to 1800 h. The study routes were determined by using the line transects. The distance of routes was not over 2 km. It was set to explore both left and right sides perpendicular to the path not over 25 m. Binoculars were used to search for the location of birds from the ground level, in grass, bushes and up to the tall trees. Subsequently, bird species were identified and confirmed using the bird guide [18]. Numbers, behavior, time and date of findings were also recorded. Correlation of birds and area conditions were studied by using the data extracted from the recorded information.

2.5 Measuring water and soil quality

The physical and chemical factors of water including water temperature, pH, turbidity, conductivity, DO, BOD_5, nitrate nitrogen, as well as ammonium nitrogen and orthophosphate values were measured according to the methods described by the American Public Health Association et al. [19]. Trophic status of the water was classified using the Applied Algal Research Laboratory-Physical and Chemical Score (AARL-PC Score) [20]. The physical and chemical properties of soil including total nitrogen, available phosphorus, available potassium, organic matters, pH and soil moisture values were measured according to the methods described by the Office of Science for Land Development [21].

3. Results and Discussion

3.1 Phytoplankton and benthos

According to the study of the biological diversity of phytoplankton in three reservoirs, total numbers of six phyla of phytoplankton were found, consisting of 11 orders, 17 families, 22 genera, 31 species (Table 1). All phytoplankton species found in the reservoirs were acknowledged as a common species that could be found in lentic ecosystems throughout Thailand [22]. Six phyla, 8 orders, 11 families, 14 genera, 19 species of phytoplankton were found. *Ankistrodesmus falcatus, Trachelomonas oblonga,* and *Pediastrum simplex* were found to be the dominant species in Wiang Bua reservoir. Five phyla, 6 orders, 9 families, 10 genera, 13 species of phytoplankton were found and *Staurastrum smithii*, *Staurastrum* sp. and *A. falcatus* were found to be the dominant species in Tung Piang reservoir. Five phyla, 7 orders, 8 families, 9 genera, 11 species of phytoplankton were found and *Staurastrum* sp., *Cosmarium contractum* and *Planktolyngbya limnetica* were found to be the dominant species in Saluang Nai reservoir. Moreover, the phytoplanktons which were found in Wiang Bua reservoir have been reported as potential indicators of mesotrophic to eutrophic status. The phytoplankton found in Tung Piang and Saluang Nai reservoirs have been reported as potential indicators of oligotrophic status [20].

Table 1 Taxonomic categories and species abundance of phytoplankton in the Wiang Bua (WB), Tung Piang (TP) and Saluang Nai (SN) reservoirs. (*** = dominant species, * = common species, - = absented)

Taxonomic categories	WB	TP	SN	Taxonomic categories	WB	TP	SN
Phylum Chlorophyta				Phylum Euglenophyta			
Order Sphaeropleales				Order Euglenales			
Family Hydrodictyaceae				Family Euglenaceae			
Pediastrum simplex	***	-	-	*Euglena limnophila*	*	-	-
Pediastrum sp.	-	*	-	*Euglena* sp.		*	-
Tetraedron incus	-	-	*	*Trachelomonas oblonga*	***	-	-
Family Scenedesmaceae				*Trachelomonas volvocina*	*	-	*
Scenedesmus sp.1	-	*	-	*Trachelomonas hispida*	-	-	*
Scenedesmus sp.2	-	*	-	*Trachelomanas* sp.	*	-	-
Family Selenastraceae				Phylum Dinophyta			
Ankistrodesmus falcatus	***	***	-	Order Peridiniales			
Monoraphidium contortum	*	*	-	Family Glenodiniaceae			
Monoraphidium sp.	*	*	-	*Peridiniopsis* sp.1	*	-	-
Family Neochloridaceae				*Peridiniopsis* sp.2	*	-	-
Golenkinia sp.	*	*	-	Phylum Cyanophyta			
Order Chlorellales				Order Synechococcales			
Family Chlorellaceae				Family Merismopediaceae			
Actinastrum hantzschii	-	-	*	*Aphanocapsa holsatica*	*	-	-
Order Trebouxiales				Family Leptolyngbyaceae			
Family Botryococcaceae				*Planktolyngbya limnetica*		*	***
Botryococcus braunii	-	*	-	Family Pseudanabaenaceae			
Order Chlamydomonadales				*Pseudanabaena* sp.	*	-	-
Family Chlorococcaceae				Order Oscillatoriales			
Chlorococcum sp.	-	-	*	Family Oscillatoriaceae			
Family Volvocaceae				*Oscillatoria* sp.	*	-	-
Eudorina sp.	-	-	*	Phylum Ochrophyta			
Phylum Charophyta				Order Mischococcales			
Order Desmidiales				Family Centritractaceae			
Family Desmidiaceae				*Centritractus* sp.	*	*	-
Closterium ehrenbergii	*	-	-	Order Synurales			
Cosmarium contractum	-	-	***	Family Mallomonadaceae			
Staurastrum smithii	-	***	*	*Mallomonas* sp.	*	-	*
Staurastrum sp.	*	***	***				

Total of two phyla of benthos were found, consisting of 8 orders and 12 families (Table 2). Two phyla, 6 orders and 6 families of benthos were identified in Wiang Bua reservoir, Palaemonidae were found to be the dominant family.Two phyla, 4 orders and 6 families of benthos were identified, and Palaemonidae were found to be the dominant family in Tung Piang reservoir. Two phyla, 4 orders and 4 families of benthos were identified and Gerridae were found to be the dominant family in Saluang Nai reservoir. Benthos found in the reservoirs were acknowledged as a common species that could be found in lentic ecosystems throughout Thailand. They have been reported to exist in water with low and medium levels of organic elements [23]. The results of this study are in consistent with the physical and chemical quality and utilization of water resources of Wiang Bua reservoir, with its most frequently used. As a result, Wiang Bua reservoir has more nutrients than other water sources.

Table 2 Taxonomic categories and families abundance of benthos in the Wiang Bua (WB), Tung Piang (TP) and Saluang Nai (SN) reservoirs. (*** = dominant species, * = common species, - = absented)

Taxonomic categories	**WB**	**TP**	**SN**	**Taxonomic categories**	**WB**	**TP**	**SN**
Phylum Arthropoda				Family Palaemonidae	***	***	-
Order Odonata				Order Hemiptera			
Family Gomphidae	*	-	-	Family Nuacoridae	-	*	-
Family Protoneuridae	-	-	*	Family Mesoveliidae	-	*	-
Order Coleoptera				Family Gerridae	-	-	***
Family Hydrophilidae	*	-	-	Phylum Mollusca			
Order Lepidoptera				Order Basommatophora			
Family Crambidae	*	-	-	Family Planorbidae	*	-	-
Order Diptera				Order Mesogastropoda			
Family Chironomidae	*	*	*	Family Viviparidae	-	*	-
Order Decapoda				Family Thiaridae	-	*	*

3.2 Plants

Twelve families, consisting of 15 plant species were found from all surveys. The Dipterocarpaceae was the dominant family. Most plants established in this area are common species in the deciduous-dipterocarp forest [24] as shown in Table 3. *Dipterocarpus* spp. was the notable species found in the area where slopes were not steep. *Shorea* spp. was also found in the area on very steep slopes. It demonstrated that the density of plants in the deciduous-dipterocarp forest was less than the mixed-deciduous forest. This is due to the fact that, in this kind of forest, there are quite a few characteristics of soil to retain low moisture. Moreover, there is very little supply of water which makes the primary production and the diversity of plant species less prominent compared to other plant communities [25].

Table 3 Taxonomic categories and species abundance of plant in Chiang Mai Rajabhat University, Mae Rim Campus. (*** = dominant species, * = common species, - = absented)

Taxonomic categories	**A**	**B**	**C**	**D**	**Taxonomic categories**	**A**	**B**	**C**	**D**
Kingdom Plantae					*Flacourtia indica*	*	*	-	-
Order Sapindales					Family Clusiaceae				
Family Anacardiaceae					*Garcinia xanthochymus*	*	*	-	-
Buchanania latifolia	-	*	*	*	Order Myrtales				
Family Burseraceae					Family Lythraceae				
Canarium subulatum	*	-	*	*	*Lagerstroemia macrocarpa*	-	-	-	*
Order Malvales					var. *macrocarpa*				
Family Dipterocarpaceae					Family Melastomataceae				
Dipterocarpus obtusifolius	***	-	*	*	*Memecylon edule*	*	*	*	*
Dipterocarpus tuberculatus	***	***	*	***	Family Chrysobalanaceae				
Shorea obtusa	*	-	***	***	*Parinari anamensis*	-	***	-	*
Shorea siamensis	***	*	***	***	Order Gentianales				
Order Malpighiales					Family Rubiaceae				
Family Euphorbiaceae					*Catunaregam spathulifolia*	*	*	*	*
Aporosa villosa	*	***	*	***	Order Sapindales				
Family Phyllanthaceae					Family Sapindaceae				
Phyllanthus emblica	*	*	*	*	*Dimocarpus longan*	*	*	-	-
Family Salicaceae									

3.3 Birds

The observation revealed that the study area was generally the plain forest [26] which abounds with natural resources. There were several dried-up creeks and swamps, and agricultural activities were performed in some parts of the area, which makes it easy to find various types of birds. Fifteen orders consisting of 106 species from 77 genera within 43 families of birds were found in the area. Eighty-three of them were resident species, 22 species were winter visitors and one species was passage migrant [18] (Table 4). Differences in forest conditions made the birds spread in particular ways [27-29]. Generally, in the study area, birds were found in open habitats and spread out to find food. On the forest ground, lump lateritic soil, where little humidity and organic elements, non-decomposed leaves, grass and not densely undergrowths were found, This is suitable for birds foraging on the forest floor and for medium-sized birds, such as *Gallus gallus* (red jungle fowls), *Francolinus pintadeanus* (Chinese francolins), *Streptopelia chinensis* (spotted doves). Those birds often found foraging among the grass, undergrowths and open spaces, most of which are primarily insectivorous birds, such as *Orthotomus sutorius* (common tailorbird), *Prinia inornata* (white-browed wren-warbler), and granivorous birds, such as *Lonchura striata* (white-rumped munia). As for the tree canopy, there is a little continuation of the tree tops which depicts a lot of open spaces, most birds found were insectivorous and small vertebrate eaters such as *Cyornis banyumas* (hill blue flycatcher), *Culicicapa ceylonensis* (grey-headed flycatcher), *Dicrurus paradiseus* (greater racket-tailed drongo), *Urocissa erythrorhyncha* (red-billed blue magpie), *Sturnus nigricollis* (black-collared starling). Frugivorous and nectarivorous birds were rarely found. This may be due to the lack of plant variety suitable for these birds. These birds were *Megalaima haemacephala* (coppersmith barbet), *Pycnonotus aurigaster* (sooty-headed bulbul), *P. Blanfordi* (streak-eared bulbul), *Dicaeum cruentatum* (scarlet-backed flowerpecker), *D. concolor* (Nilgiri flowerpecker). As for bird's behaviour in general, flying appeared to be the most dominant behaviour followed by perching, vocal communication, walking and courtship behaviour. This meant that it was perhaps not the mating season yet [30].

3.4 Water and soil properties

The physical and chemical properties of water and trophic level in each reservoir are shown in Table 5. The Wiang Bua reservoir is classified as mesotrophic status and Saluang Nai and Tung Piang reservoirs are classified as oligo-mesotrophic status, which is consistent with previous reports regarding lentic ecosystem in Northern Thailand, such as the Mae Kuang Udom Thara Dam, Mae Ngad Dam, Mae Jok Luang and Huai Tueng Thao Reservoirs, King Rama IX Royal Park Reservoir (Pollution Control) [22, 31, 32].

The physical and chemical properties of soil in each crop are shown in Table 6. The soil property in all plots was classified as very low in available phosphorus, available potassium, organic matters and pH. The humidity in soil, along with levels of phosphorus were between 4. 50-5. 07 mg/kg and potassium levels between 35.67-95.67 mg/kg indicated the characteristics of lateritic soil in the deciduous-dipterocarp forest, characterised by low humidity with little organic matters. It is suggested that a large amount of lime is needed to neutralize acidic conditions in soil, so plants are able to thrive [24].

Table 4 Bird species found in Chiang Mai Rajabhat University, Mae Rim Campus

Order	No. of Family	No. of Species	Status		
			No. of Residents	No. of Winter Visitors	No. of Passage Migrants
Accipitriformes	1	5	4	1	-
Anseriformes	1	1	1	-	-
Caprimulgiformes	2	3	2	1	-
Charadriiformes	2	2	2	-	-
Ciconiiformes	1	1	-	1	-
Columbiformes	1	4	4	-	-
Coraciiformes	3	5	4	1	-
Cuculiformes	1	6	6	-	-
Falconiformes	1	1	1	-	-
Galliformes	1	3	3	-	-
Gruiformes	1	1	1	-	-
Passeriformes	23	63	49	13	1
Pelecaniformes	1	4	-	4	-
Piciformes	2	4	3	1	-
Strigiformes	2	3	3	-	-
Total	43	106	83	22	1

Table 5 Average and Standard Deviation (n=3) of the physical-chemical factors and trophic level in the Tung Piang, Saluang Nai, Wiang Bua reservoirs.

Physico-chemical factors	Wiang Bua	Tung Piang	Saluang Nai
Water Temperature (°C)	32±0.00	31±0.00	32±0.00
pH	7.24±0.02	6.77±0.04	7.31±0.04
Turbidity (FAU)	21.33±0.58	22.0+0.0	6.67+0.58
Conductivity ($\mu s/cm^{-1}$) *	91.50±0.20	61.67±2.08	95.67±1.53
DO (mg/L) *	6.53±0.12	6.60±0.20	7.47±0.12
BOD_5 (mg/L) *	0.33±0.06	1.33±0.31	1.47±0.12
Nitrate nitrogen (mg/L) *	0.57±0.06	0.50±0.10	0.0+0.0
Ammonium nitrogen (mg/L) *	0.15±0.02	0.06±0.02	0.0+0.0
Orthophosphates (mg/L) *	0.17±0.02	0.09±0.04	0.28±0.02
Trophic level	Mesotrophic	Oligo-mesotrophic	Oligo-mesotrophic

Note: * Factors were calculated Trophic level

Table 6 Average and Standard Deviation (n=3) of the physical-chemical factors and soil quality in in Chiang Mai Rajabhat University, Mae Rim Campus

Physico-chemical factors	Crop A	Crop B	Crop C	Crop D
pH	5.33±0.49	4.97±0.15	4.47±0.21	4.63±0.15
Soil Moisture (%)	6.80±1.45	6.47±0.55	9.90±2.91	12.81±2.50
Total nitrogen (%)	0.009±0.003	0.008±0.001	0.021±0.004	0.012±0.001
Available Phosphorus (mg/kg)	5.07±1.36	4.50±1.14	4.57±1.53	4.57±0.80
Available Potassium (mg/kg)	35.67±9.24	31.33±9.07	95.67±24.21	39.67±13.61
Organic Matter (%)	0.26±0.17	0.28±0.12	0.79±0.35	0.27±0.06
Soil Quality	low	low	low	low

4. Conclusions

Phytoplankton species in medium to good quality water were discovered, namely: *Ankistrodesmus falcatus*, *Trachelomonas oblonga* and *Pediastrum simplex*, indicated that the quality of all 3 water sources were good, especially in Tung Piang and Saluang Nai reservoirs. Other dominant phytoplankton species were *Staurastrum smithii*, *Staurastrum* sp., *Cosmarium contractum* and *Planktolyngbya limnetica*, which were only found in good water quality and low nutrient level. In the process, 2 orders of benthos were also found; Palaemonidae and Gerridae. The predominant plant species found were *Dipterocarpus* spp. and *Shorea* spp., which are common in deciduous forests. The nutrient integration of the soil was low, however it was not a major problem for the ecosystem. Productivity mainly occurs during the rainy season when soil moisture is adequate. The study area was characterized by dipterocarp forest, where most trees have an average height of 5-15 m with a lot of canopy gap between them. The forest floor is covered with grass especially during the rainy season. The quality of soil in the study area was very poor. The moisture and organic matters in the soil were also low, particularly phosphorus and potassium, which is the nature of the lateritic soil. There were some grass and undergrowths, but not as dense. A hundred and six species of birds were observed scattered on different levels of the forest. The majority of birds, which were foraging in the grass, ground floor or open spaces, were insectivorous birds. Frugivorous and nectarivorous birds were rarely discovered due to few kinds of edible plants. Predominant characteristic of birds from the survey was flying behaviour. The data of species obtained from this study clearly shown that the study sites have a diversity of producers and consumers, which shows the richness and food chain in the area. The overall data shown a moderate to high diversity of selective organisms which presents that Chiang Mai Rajabhat University, Mae Rim Campus, can be used as a study area for soil-water-forest relationship. The acquisition of this database, not only does it lead to sustainable development, transferring knowledge to stakeholders and communities is also important in the study area [3]. From the diverseness of areas and organisms, Chiang Mai Rajabhat University, Mae Rim Campus is appropriate for using as the learning sites for conservation and diversity study. Moreover, the data from this investigation can be used for the area management and planning by the university decision committee and administrations.

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