Diversity of Aquatic Insects in Some Stream of Thong Pha Phum National Park, Kanchanaburi Province, Thailand

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Abstract: A study was conducted on the diversity of aquatic insects in the area of Thong Pha Phum National Park at Thong Pha Phum District, Kanchanaburi Province, Thailand. Sampling was done 4 times from November 2001 to January 2003. Biological and physico-chemical properties of water were collected and measured from 10 sites. The aquatic insects were collected by using a Surber sampler and pond net. 11 orders, 91 families and 197 species (morphospecies) were identified. The greatest number of aquatic insects (8 orders, 58 families and 100 species) were found from Huai Khayeng III in the summer. The dominant family that was found in almost every study site was Baetidae, order Ephemeroptera. Diversity indices were significantly different among seasons ($p \le 0.01$). A statistics program, the ordination method of multivariate analysis (MVSP), was used to assess the water quality of each study site by using physico-chemical and biological data. The dendrogram, from cluster analysis showed two groups of study sites. The first group indicated the study sites that were undisturbed from residential areas, which was related to altitude. The second group indicated study sites that were disturbed from residential areas, which was related to alkalinity, conductivity, temperature, and pH.

Key words: Thong Pha Phum, aquatic insects, diversity, water quality

Introduction

Although world development is the origin of many things such as the development of technology, which has resulted in inventions of high technology equipment. These include both the aspect of economics that involves communication with foreigners in commerce and the aspect of communication that involves the development of modern equipment. In another way, technology and development of resources can be damaging to the environment. These may cause the degradation of nature, especially by effects on the environment. Although Nature has mechanisms to restore itself, this takes a long time. This doesn't mean that Nature will return to its original state.

Man has been found to be the main cause of many problems in the environment including in land and water ecosystems. At present, man is using resources from forest areas, which may be watershed areas, especially the sources of class 1A streams which are sensitive areas. Human activities are influential to organisms that are in these areas. There is also an increase in the effects on species diversity, genetic diversity and ecological diversity. Forest areas provide us with so many resources, so we should realize the values of natural diversity before it will be lost as a result of human activities.

Natural protection can be started by surveying where the organisms exist. So, diversity studies of aquatic insects in streams are part of this prevention. The important role of aquatic insects in the ecosystem is energy transmission through the food chain. A potential of elimination in natural waste is "self purification". If this potential is increased by an increase in the number of families, the potential is higher. The importance of aquatic insects is that their properties can be used as indicators of environmental quality, especially in stream ecological systems. So this research has the objective to study some physico-chemical and biological water quality parameters which focus on the diversity of aquatic insects and investigate the relationships between water quality and the diversity of aquatic insects. Finally, the results will be used for management of streams and for protection from human activities that can be harmful to organisms in the stream and disturb water quality.

Methodology

This study was concerned with the diversity of aquatic insects and their relationships to physico-chemical factors and nutrients in the study streams. Sampling was done at 7 sites, from November 2001 to January 2003. The study was divided into 3 parts which involved the study of biological and physico-chemical factors in some streams of Thong Pha Phum National Park, Kanchanaburi Province, in the western part of Thailand. This area covers 1,200 square kilometers. Seven sites were selected which cover this area (Fig. 1).

In this research, the sites were studied over one. The details of each site are given in Table 1.

1. Biological Parameters

Aquatic insects were sampled with a Surber sampler (Surber, 1937) and pond net and preserved on-site using 4% formalin. The aquatic insects were collected and sorted under a stereomicroscope (x10 to x40 magnification) for their identification up to family-level using McCafferty (1981) and Morse (1997) as keys for the majority of specimens. A species diversity index was calculated using data on collected aquatic insects. Total coliform bacteria were analyzed in the laboratory by the method of Harrigan and Cance (1976).

Table 1. The details of each site in the area of the Golden Jubilee Thong Pha Phum Project, Thong Pha Phum District, Kanchanaburi Province.

Site name	Code	Altitude (m)
1. Huai Jok Kra Din	St1	685
2. Huai Ae Tong	St2	689
3. Huai Jok Tong	St3	887
4. Huai KhaYeng 1	St4	302
5. Huai KhaYeng 2	St5	273
6. Huai KhaYeng 3	St6	193
7. Huai KhaYeng 4	St7	160

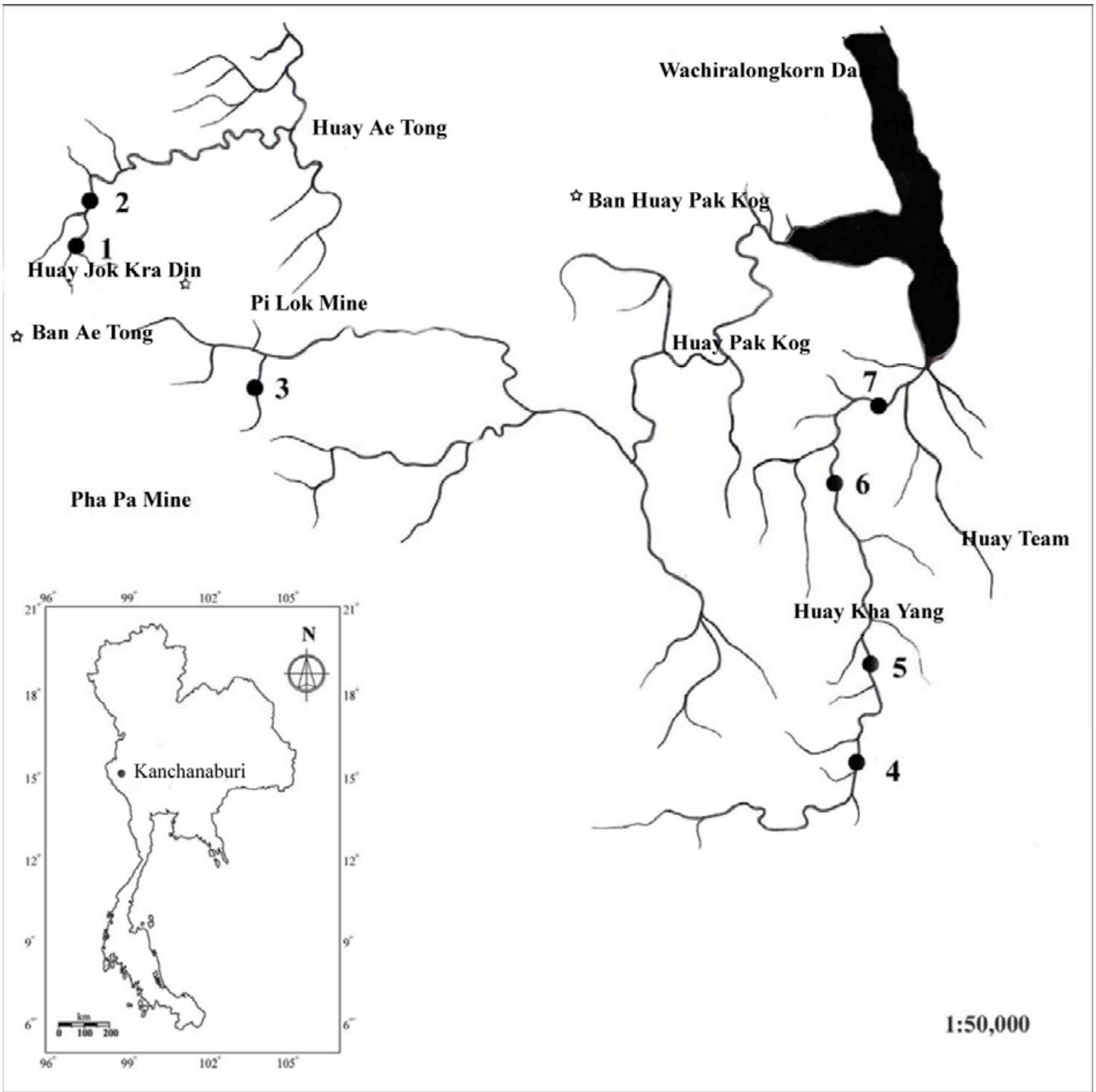

Figure 1. Map of sampling sites in Thong Pha Phum District, Western Thailand

2. *Physico-Chemical Parameters*

Water samples were in-field analyzed for velocity, Dissolved Oxygen (DO), conductivity, pH, and water temperature using portable instruments during each sampling time. In the laboratory analysis, turbidity, alkalinity, BOD_5, ammonium nitrogen, nitrate nitrogen, and soluble reactive phosphorus (SRP) were also analyzed.

Velocity was measured by using a velocity meter. The Azide Modification Method was used for the determination of DO and BOD_5. Alkalinity was determined by using the Phenolpthalein-methyl orange indicator method. The pH and water temperature were measured using a pH meter and conductivity was measured by using a conductivity meter. Turbidity was determined by an absorptometric method. Nitrate nitrogen and ammonium nitrogen were determined by using the Cadmium Reduction Method. SRP was analyzed by using ascorbic acid method. Amounts of nutrients, i.e. nitrate nitrogen, SRP, and ammonium nitrogen were measured according to the methods described by APHA, AWWA, WPCF (1992).

3. *Data Analysis*

Biological and Physico-chemical data were analyzed by using Multi-Variate Statistic Package (MVSP). Principal components analysis (PCA) was calculated by using ordination methods. Mathematically, PCA consists of Eigen-analysis of a covariance or correlation matrix calculated on the original measurement data. Graphically, it can be described as a rotation of a swarm of data points in multidimensional space.

Results

To study the biological and physico-chemical parameters, samples at each particular site should be taken for each season. However, there was difficulty in taking the samples for some sites

and season because of flooding in the rainy season. There was a risk to take samples from sites st3, st5, st6, and st7. Physico-chemical and some biological parameters of the study sites are given in Table 2.

1. *Biological Parameters*

Aquatic insects were found in 11 orders, 91 families and 197 taxa (morphotaxa). The highest amount of aquatic insects was found to be 10 orders, 65 families and 132 taxa from st5. The highest number of taxa were in the order Trichoptera, while the order of Ephemeroptera had the highest number. The dominant family that was found in most study sites was Baetidae, order Ephemeroptera. For water quality monitoring using aquatic insects, the diversity index was significantly different in each season relative to some physico-chemical parameters: water temperature, water velocity, turbidity, pH, DO, BOD_5, ammonium nitrogen, and SRP. In the summer, the highest diversity index was found due to the seasonal influence. It was agreed with Dudgeon (1992) who reported that a higher number of caddisfies appeared before the rainy season due to lower mortality before flooding. Total coliform bacteria values were significantly different in each season ranging from 110-24,000 MPN/100 ml, which was directly similar to the trend in each season. Total coliform bacteria were found in low amounts in study sites st1, st2, and st3

Table 2. Physico-chemical and Biological parameters of the study sites.

Site	st1	st2	st3	st4	st5	st6	st7
Altitude (m.)	685	689	887	302	273	193	160
Velocity ($m.s^{-1}$)	0.69	0.74	0.57	0.83	0.80	1.10	0.76
Temperature (C°)	21.7	23.0	21.2	23.5	25.9	23.9	25.3
Conductivity ($\mu S.cm^{-1}$)	13.6	17.2	15.4	43.7	156.0	207.8	241.8
Turbidity (FTU)	9	6	18	35	36	68	63
pH	6.86	6.51	5.47	6.64	7.17	7.69	7.56
DO ($mg.L^{-1}$)	8.19	8.13	6.99	8.19	7.61	7.44	7.98
BOD ($mg.L^{-1}$)	1.65	1.60	1.63	1.93	2.90	2.73	1.73
Alk ($mg.L^{-1}$)	7	7	7	24	72	107	125
NO_3-N ($mg.L^{-1}$)	0.80	1.20	1.00	0.83	0.75	1.00	0.83
NH_3-N ($mg.L^{-1}$)	0.31	0.24	0.33	0.27	0.28	0.38	0.34
PO_4-P ($mg.L^{-1}$)	0.04	0.29	0.10	0.13	0.17	0.12	0.21
Total Coli Bacteria (MPN/100 ml)	895	995	1,124	1,283	1,513	3,033	2,000

st1= Huai Jok Kra Din st2= Huai Ae Tong st3= Huai Jok Tong st4= Huai KhaYeng 1 st5= Huai KhaYeng 2 st6= Huai KhaYeng 3 st7= Huai KhaYeng 4 which were undisturbed from residential areas, while high amounts of Total colifrom bacteria in the study sites (st4, st5, st6, and st7) that were disturbed from residential areas. In addition, the dry season was found to have the highest total colifrom bacteria.

2. *Physical Parameters*

Sites st1, st2, and st3 were located in higher altitudes, while st4, st5, st6, and st7 were located in lower altitudes. The study sites (st1, st2, and st3) were located in forest areas, which were densely covered with trees which resulted in the reception of fairly low intensity solar radiation. The rest of the sites (st4, st5, st6, and st7) were located in residential areas. Due to the higher exposure to sunlight, these sites showed higher water temperatures than the ones that were located in the forest areas. The substrates of most sites were mainly sand-pebble but were bedrock in some parts of st4. The width of the stream and water velocity increased in the rainy season. These caused the turbidity to be different in each season. Therefore, peripheral soil erosion and surface runoff increased in the rainy season in every site.

3. *Chemical Parameters*

There were significantly different pH values in all study sites and seasons. They ranged from 5.47 to 7.82 in sites st1 to st8. In the rainy season, pH values were decreased at almost all the study sites, due to organic matter which washed into the stream with the rain. St3 had the lowest values in every season, because it was covered with an overhanging bamboo canopy and therefore leaves fell directly into the stream. Conductivity was found to be significantly different in each study site. Sites st1, st2, and st3 exhibited lower values while sites st4, st5, st6, and st7 showed relatively higher values. Higher values in sites st4 - st7 were caused from these sites being located in urbanized areas which received loads of domestic sewage and agricultural effects. There was a significant difference in value of DO between seasons. According to the standard surface water quality in 2-category, the values of most of the study sites were not below 6 $mg.L^{-1}$. Due to lower water volume and velocity there was a reduction in the DO level in water. BOD values were significantly different in each season. They were lowest in the rainy season, while winter II showed the highest values. Therefore in winter II, water volume was reduced while organic depositions from autumnal leaf-fall into stream increased. Also organic decomposition rates were increased as well in the rainy season. Due to organic matter concentration being diluted from increased water volume, BOD_5 values were low in this season. The alkalinity value refers to the amount of ions in solution which is related to conductivity values. The sites found to have high conductivity values were st5 - st7, which showed high levels of alkalinity as well. Sites 5 to 7 were found to be highly alkaline in every season resulting from the spillage of polluted waste-water form villages. For nutrient content, there was no significant difference of nitrate-nitrogen values between sites and seasons and nutrient content ranged from 0.4-1.7 $mg.L^{-1}$. Although nitrate nitrogen compounds are major elements in the soil and are easily diluted and drained into the water, they were very low when compared with the surface fresh water quality standaedsof Thailand set by the National Environmental Board of Thailand (1994); the values were not more than 5.0 $mg.L^{-1}$. On the other hand, the ammonium nitrogen value was significantly different in each season, ranging from 0.06- 0.7 $mg.L^{-1}$. SRP values were significantly different between seasons and were highest in the dry season, resulting from a high organic decomposition rate.

4. *Data Analysis*

A MVSP statistics Program was used for data analysis. PCA ordination was used for analyzing physico-chemical data. The study sites were divided into 4 groups (Fig. 2). The first group st1, st2, and st3 were mostly located in forest areas and were undisturbed from human activities. Therefore, different altitudes resulted in different water quality (Goldman and Horn, 1983). These sites were associated with higher altitudes than the rest of the sites. The second group was found to be associated with high conductivity, alkalinity pH and water temperature. These sites were located in urban

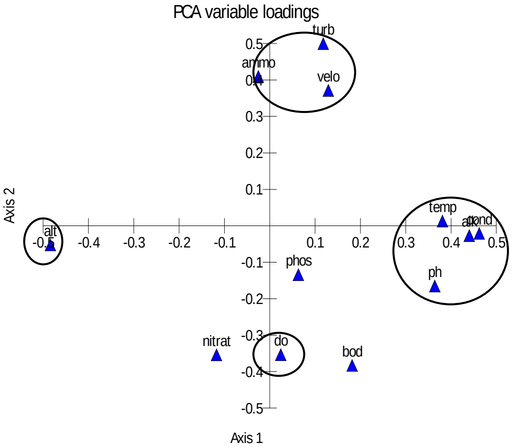

Figure 2. PCA Ordination of water quality based on study site

areas where the stream was polluted from human activities, such as wastewater discharge and agricultural runoff. The third group was found to be associated with high turbidity, velocity and ammonium nitrogen which occur mostly in the rainy season. These are the main parameters which were easily diluted and drained into the water in these seasons that were located in urbanized areas. The last group was found to be associated with DO value. On the other hand, the study sites were divided into 2 subgroups by UPGMA clustering method of physico-chemical data (Fig. 3). One group was located in the forest area while another was located in an urban area which was disturbed from a village.

PCA ordination method for aquatic insects' data can be separated into two groups (Fig. 4). The first group was located in the forest area and the second group was located in the urban area and disturbed from a village.

On the other hand, the study sites were divided into 3 groups by the UPGMA clustering method of aquatic insects' data (Fig. 5). According to the results, there are similarities but these statistics can be further

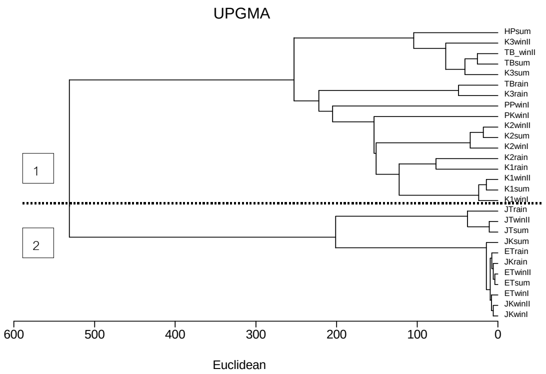

Figure 3. UPGMA Cluster analysis of study sites based on water quality

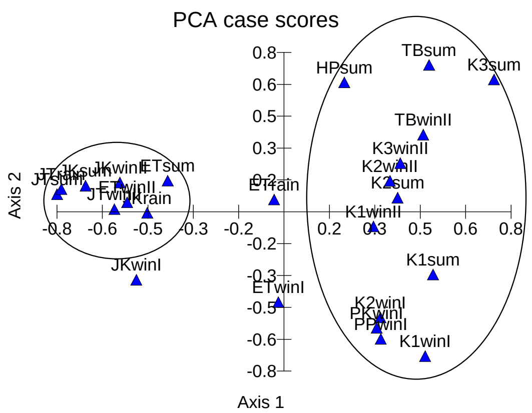

Figure 4. PCA Ordination of study site based on water quality

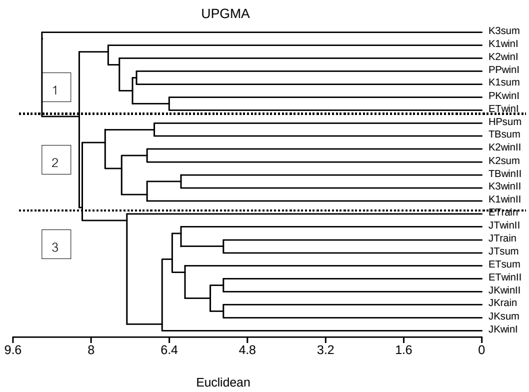

Figure 5. UPGMA Cluster analysis of study sites based on aquatic insect

divided. The first 2 groups were disturbed by an urban area and the third one was undisturbed by an urban area.

There were no statistical differences derived from the physico-chemical and biological data analysis. The study sites can be divided into 2 groups, the first group indicated the study sites that were undisturbed from residential areas and the second group indicated the study sites that were disturbed from residential areas.

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