

Anthropogenic impact assessment on aquatic insect diversity at hill evergreen forest higher than 2,000 meters above mean sea level, Doi Inthanon national park, Chiang Mai

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Abstract : This research was aimed to study the impact of human activities on water quality by using aquatic insects as an biological indicators. The study was taken place at hill evergreen forest areas with the altitudes over 2,000 meters above mean sea level in Doi Inthanon National Park, Chom Thong District, Chiang Mai Province. Physical, chemical and biological properties were compared between non-human activities area and area with human activities. The samples were collected for 6 times from the 6 study points to pursue an altitude ranging from 2,000 to 2,500 meters above mean sea level in October to December 2014, and February, April, June, and August 2015. The aquatic insects were collected using a pond net. Eight orders, 49 families were identified. Water quality of all the study areas were moderately clean to clean level. The BMWP index and ASPT score showed that December had the lowest water quality with 5.25 ASPT score, which corresponded to the Ephmeroptera, Trichoptera and Plecptera Ratio (EPT taxa) of 0.33, was less diverse than the other study sites. Moreover, Ammonia-nitrogen and BOD₅ at this study sites were 3.4 mg/L and 5.5 mg/L respectively, which exceeded the surface water quality standard of Thailand. The result indicated that human activities during the high tourist season affected water quality and diversity of aquatic insects in the study area of Doi Inthanon National Park in Chom Thong District, Chiang Mai Province.

Keywords : ASPT, BMWP, Doi Inthanon National Park, EPT, human activities

Introduction

Evergreen forest is an ecosystem related to cloud humidity and found in tropical and subtropical zones. In Thailand, evergreen forest is found at 1,200-2,500 meters above mean sea level with cold weather and high humidity all year round. These evergreen forests are found in some areas of Thailand such as Khao Luang National Park Nakhon Si Thannarat Province and Doi Inthanon National Park Chiang Mai Province. Doi Inthanon National Park is a watershed area contributing to Ping River and also has high biodiversity (Santisuk, 2004). Because Doi Inthanon National Park is different from other areas in terms of humidity, temperature and altitude, therefore endemic animals can also be found such as, crocodile salamander (*Tylototriton verrucosus*) and big-headed turtle (*Platysystemum megacephalum*) (Mitchell, 1997). Nowadays, Doi Inthanon National Park has been encroached for farming. A large number of tourists are increasing every year and exceed capacity of public service provided by the national park (Doi Inthanon National Park, 2015). Therefore, human activities might have impacts on Doi Inthanon ecosystem, particularly some species that are sensitive to environmental stresses (Vuori, 1996).

This research ware aimed to assess the impacts of human activities on aquatic insect communities and water quality of Doi Inthanon National Park.

Methodology

1. Sampling sites

This study was conducted between October 2014 and August 2015. Water samples and aquatic insect samples were collected from 6 sampling sites in Mae la Mor stream, Sai Lugnd stream and Mae Klang stream at altitudes over 2,000 meters above mean sea level at Doi Inthanon National Park (Figure 1).

1. (DI 1) Ang Ka Nature Trail N18 ° 35'18.80 "E098 ° 29'30.40" elevation 2,519 meters.
2. (DI 2) Opposite Ang Ka Nature Trail N18 ° 35'14.20 "E098 ° 29'10.20" altitude 2,550 meters.
3. (DI 3) Thai National Observatory N18 ° 34'22.60 "E098 ° 28'48.90" altitude 2,376 meters.
4. (DI 4) Kew Mae Pan trail N18 ° 33'28.90 "E098 ° 28'52.50" altitude 2,215 meters.
5. (DI 5) Opposite Kew Mae Pan trail N18 ° 33'29.40 "E098 ° 29'70.80" altitude 2,115 meters.
6. (DI 6) Phra Maha Dhatu Nabhapol Bhumisiri N18 ° 33'60.80 "E098 ° 28'52.60" altitude 2,078 meters.

2. Water quality

Physicochemical properties were measured according to air and water temperature using a mercury thermometer, velocity using velocity meter, conductivity and total dissolved solid (TDS) using Multi-parameter analyzer Consort C933, suspended solid (SS) measured by spectrophotometer, pH using the pH meter, dissolved oxygen (DO) and biochemical oxygen demand (BOD₅) using Azide Modification Method (Greenberg *et al.*, 2005) and ammonia nitrogen (NH₄⁺) using the Nesslerization technique, nitrate nitrogen (NO₃⁻) using the Cadmium Reduction Method and orthophosphate (PO₄²⁻) using the Ascorbic Acid Method and measured by spectrophotometer.

3. Aquatic insect sampling

A D-frame net (0.5 mm²/mesh) was used to collect aquatic insects from mud, sand, gravel, cobble, rock, bedrock and plant roots covering 60 m² area for 15 minute. All samples were preserved in 4% formalin and brought to the laboratory for sorting and identification (Mustow, 2002; Compin and Céréghion, 2003).

4. Biological index

Biomonitoring Working Party score (BMWP^{Thai} score) is a score from family of aquatic insect family assigned to its tolerance to pollution and varies from 1 to 10 score. BMWP^{Thai} score was used to calculate the Average Score Per Taxa (ASPT) for assigned water quality and value of ASPT show in table 1. ASPT can be calculated as follows:

$$\text{ASPT} = \frac{\text{BMWP}}{\text{Number of family with score}}$$

EPT Index is the total number of family of aquatic insect in groups order, Trichoptera, Ephemeroptera, and Plecoptera and value of EPT index show in table 2. EPT Index can be calculated as follows:

$$\text{EPT} = \frac{\text{Family in groups EPT}}{\text{Number of family}}$$

Results and Discussion

1. Water quality

Higher value of conductivity, NO₃N, especially BOD (Figure 2) and NH₃N (Figure 3) were measured at the sampling site DI2 than at the other sites in December 2014. These were related to an increasing number of tourists in Doi Inthanon National Park in December about 20,000 people per day (Doi Inthanon National Park, 2015). Moreover, this sampling site was located downstream to the Tourist Service Center, and might receive the impact from tourist activities such as lavatory. All the physicochemical properties between October 2014 and April 2015 are shown in Table 3.

2. Aquatic insect diversity

Eight orders and 49 families of the aquatic insects were classified in this study. The most abundant orders Trichoptera of the aquatic insects represented by Hydropsychidae, Odontoceridae and Leptoceridae respectively. Order Trichoptera showed the highest richness, followed by Coleoptera and Diptera (Figure 4). However, the sampling site DI2 in December 2014 had the lowest richness with only 10 families of the aquatic insects.

3. Biological indicator

From the ASPT score it was found that the score of all the sampling periods ranged between 5.25 to 7.4. The water qualities were from moderate to clean the lowest score was found at the site DI2 with 5.25 in December 2014 (Figure 5). The EPT ratios from all the sampling periods were between 0.3 to 0.65, which represented moderate to clean level of water quality. The lowest score was observed at the sampling site DI2 in December 2014. (Figure 6)

Relationship between physicochemical and biological properties

The relationships between physicochemical and biological properties were assessed by Spearman correlation. The result showed that EPT was positively correlated with only the DO. Whereas, both the EPT and the ASPT represented significantly negatively correlated with the BOD, conductivity, TDS, SS and all the nutrients (Table 2). The increasing of some physicochemical properties such as the BOD and the nutrients and the decreasing of the EPT and the ASPT at the sampling site DI2 probably indicated an impact of human activities on water quality and the aquatic insect communities on Doi Inthanon National Park

Conclusion

The water qualities of 6 the sampling sites ranged from moderate to clean water quality assessed using biological indices. Higher values of BOD, conductivity and nutrients in December 2014 indicated an anthropogenic impact on water quality and diversity of the aquatic insects during the high tourist season of Doi Inthanon National Park, Chiang Mai Province.

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Table 1 Water quality as define by ASPT value

ASPT score	Water quality
>6	Clean water
5-6	Doubtful quality
4-5	Probable moderate pollution
<4	Probable severe pollution

Table 2 Water quality as define by EPT ratio value.

EPT ratio	Water quality
>0.75	Clean water
0.75-0.5	Doubtful quality
0.5-0.25	Probable moderate pollution
<0.25	Probable severe pollution

Table 3 The physicochemical properties of 6 sampling site at each sampling period.

	pH	DO (mg/L)	BOD (mg/L)	Nitrate (mg/L)	Ammonia (mg/L)	Phosphate (mg/L)	Conductivity ($\mu S/cm$)	Water		Velocity (m/s)	SS (mg/L)	TDS (mg/L)
								Tem. (°C)	Air			
DI1Oct	5.1	8	1	1.3	0.16	0.14	12.37	12	12	0.41	5	3.56
DI2Oct	6.4	7.7	2.9	1	0.59	0.12	47.5	14	13	0.63	14	23.7
DI3Oct	5.18	8.3	1.7	1.1	0.07	0.12	5.32	14	13	0.93	4	2.67
DI4Oct	4.6	8.5	3.7	1	0.09	0.07	6	15	14	0.47	7	3
DI5Oct	6.45	8.5	1.3	1	0.08	0.08	17.85	17	15	0.35	4	8.98
DI6Oct	5.63	8	0.6	1	0.1	0.06	9.3	17	14	0.45	5	4.65
DI1Dec	5.68	8.5	2.1	1.1	0.14	0.11	12.1	7.5	7	0.84	1.5	6.08
DI2Dec	6.16	6.6	5.5	2.7	3.4	0.45	117.6	6.5	10	0.47	36	58.5
DI3Dec	5.64	8	1.1	1.1	0.09	0.11	6.62	10	10	1.15	14	3.31
DI4Dec	6.34	8.3	1.6	1	0.08	0.05	6.62	12	9.5	0.46	2	3.38
DI5Dec	6.75	8.8	0.9	1	0.16	0.18	19.47	15	11	0.46	3	9.65
DI6Dec	6.34	8.5	1.1	1.3	0.39	0.12	19.84	16	10.3	1.05	1	8.94
DI1Feb	5.86	8	0.2	1.1	0.2	0.12	13.18	7.5	8	0.57	1	6.6
DI2Feb	5.33	8.8	1.6	1.9	0.39	0.14	40.3	8	9.4	0.77	30	20.2
DI3Feb	5.45	7.6	0.8	0.9	0.17	0.11	7.43	9	10.3	0.86	18	3.71
DI4Feb	5.93	8	0.4	1	0.2	0.07	25.1	12.5	11	0.7	13	12.6
DI5Feb	6.58	8.2	0.2	0.9	0.09	0.08	7.49	12	11	0.49	2	3.79
DI6Feb	5.79	7.8	0.8	1.4	0.34	0.15	19.91	13.5	11.1	0.46	2	10.1
DI1Api	6.02	6.6	0.6	1.2	0.23	0.17	17.25	13	12.3	0.67	2	8.51
DI2Api	6.52	7.5	0.9	2.2	0.22	0.94	42.4	19	13.4	0.68	15	21.1
DI3Api	7.7	6.7	1.3	1	0.12	0.18	10.12	16	14	0.69	7	4.53
DI4Api	7.44	7.3	0.5	1.1	0.12	1.04	8.6	18	15.2	0.4	1	4.3
DI5Api	6.7	7.7	0.7	0.9	0.11	0.19	28	18	15.2	0.39	2	13.7
DI6Api	6.6	6.8	0.6	1.1	0.15	0.54	22.3	19.5	15.3	0.68	2	11.2
DI1Jun	6.1	7.1	1.1	0.8	0.27	0.19	14.58	16	13	0.43	2	7.35
DI2Jun	7.24	7.1	0.2	1.9	0.19	0.21	47.7	15	14	0.55	24	23.7
DI3Jun	6.82	6.9	0.5	0.1	0.1	0.22	8.29	14	14.5	0.25	12	4.14
DI4Jun	7.12	7.2	0.3	0	0.15	0.17	9.88	16	15.2	0.23	1.5	4.96
DI5Jun	6.87	7.4	0.9	1	0.1	0.08	29.3	16.3	16	0.24	0	14.6

Table 3 The physicochemical properties of 6 sampling site at each sampling period. (cont.)

	pH	DO (mg/L)	BOD (mg/L)	Nitrate (mg/L)	Ammonia (mg/L)	Phosphate (mg/L)	Conductivity ($\mu S/cm$)	Water Tem. ($^{\circ}C$)	Air	Velocity (m/s)	SS (mg/L)	TDS (mg/L)
DI6Jun	7.6	7.1	0.6	1	0.07	0.01	17.3	16.5	16	0.24	1	8.61
DI1Aug	6.18	7.6	0.8	1	0	0.08	14.12	14.5	12	0.43	0	7.02
DI2Aug	6.23	7.6	0.6	1.5	0	0.17	29.7	16	13.5	1.03	9	14.9
DI3Aug	5.3	7.2	0.4	0.7	0	0.13	6.48	15.5	13.9	1.1	0	3.3
DI4Aug	6.84	7.6	0.4	0	0.4	0.1	7.02	15.3	15	0.55	2	3.86
DI5Aug	6.34	7.8	0.5	0	0.09	0.06	19.3	16	15	0.6	8	9.75
DI6Aug	5.79	7.4	0.3	0	0	0.12	10.4	16	15	0.68	7	5.5

Table 4 The spearman correlation by comparison with the relationship between water chemistry - physical and biological properties at the 6 sampling sites.

	EPT	ASPT	Abun	pH	DO	BOD	NO ₃ ⁻	NH ₄ ⁺	PO ₄ ²⁻	Con	Air T	Water T	Velo	SS	TDS
EPT	1														
ASPT	.561*	1													
Abun	-.453	-.260	1												
pH	.100	-.164	.296	1											
DO	.517*	.329	-.238	.005	1										
BOD	-.497*	-.670**	.292	-.202	-.437	1									
NO ₃ ⁻	-.690**	-.695**	.419	-.013	-.502*	.632**	1								
NH ₄ ⁺	-.681**	-.707**	.490*	.160	-.745**	.751**	.875**	1							
PO ₄ ²⁻	-.609**	-.643**	.405	.149	-.643**	.656**	.876**	.936**	1						
Con	-.634**	-.842**	.391	.195	-.649**	.723**	.868**	.954**	.888**	1					
Air T	.636**	.296	-.267	.133	.381	-.222	-.486*	-.414	-.451	-.375	1				
Water T	.308	.045	-.343	-.167	.048	.084	-.245	-.144	-.216	-.108	.798**	1			
Velo	-.022	.121	.433	-.182	.111	-.119	-.063	-.149	-.105	-.165	-.240	-.375	1		
SS	-.788**	-.782**	.346	-.165	-.513*	.566*	.740**	.700**	.640**	.764**	-.528*	-.122	.126	1	
TDS	-.649**	-.849**	.396	.204	-.645**	.724**	.860**	.951**	.880**	.999**	-.377	-.111	-.161	.767**	1

*EPT (EPT ratio), ASPT (ASPT score), Abun (Abundant), DO (Dissolved Oxygen), BOD (Biochemical Oxygen demand), NO₃⁻ (Nitrate-Nitrogen), NH₄⁺ (Ammonia-Nitrogen), PO₄²⁻ (Ortho-phosphate), Con (Conductivity), Air T (Air Temperature), Water T (Water Temperature), Velo (Velocity), SS (Suspended solid) and TDS (Total dissolved solid)

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

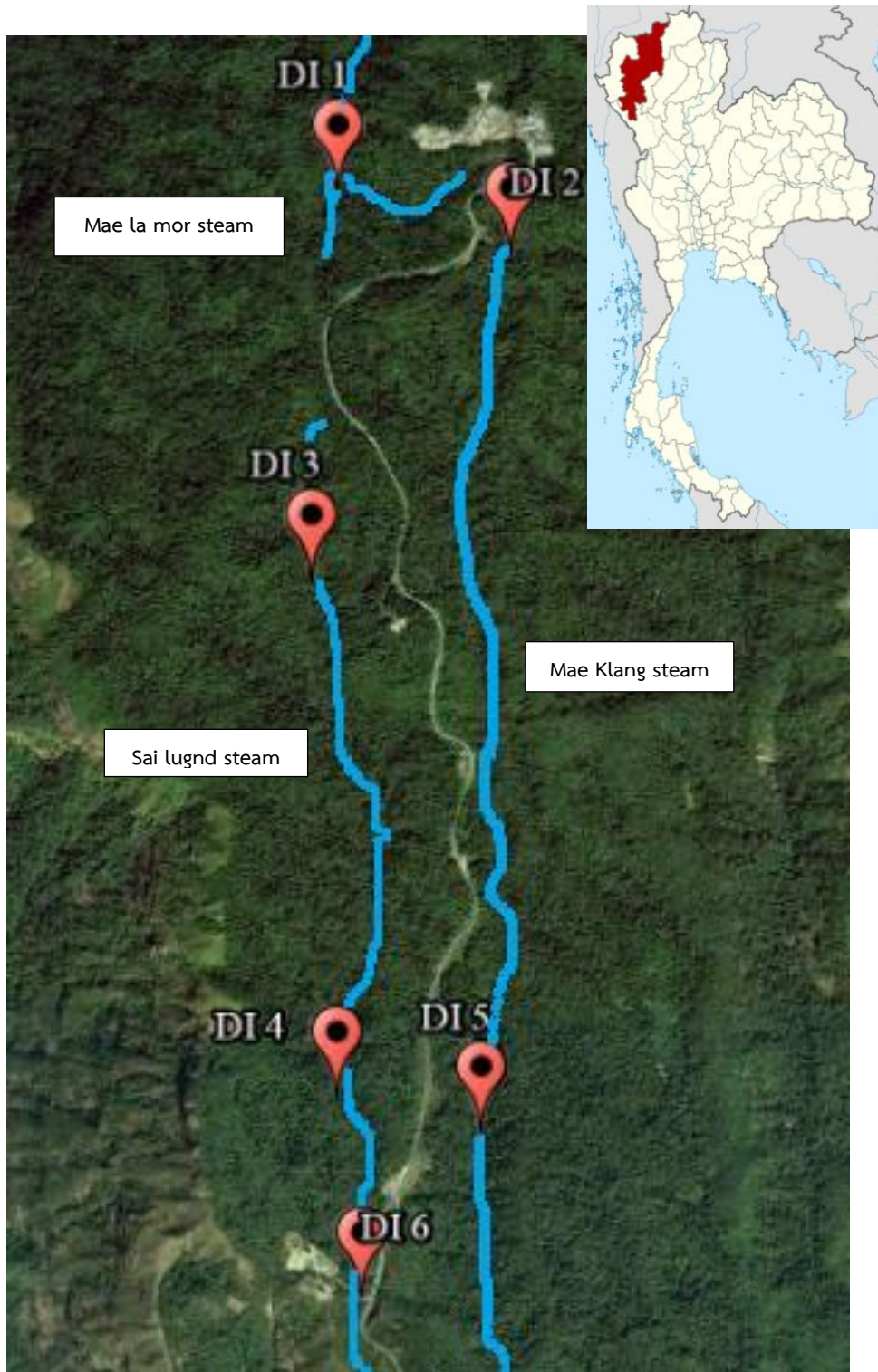


Figure 1 Locations of the Mae la mor stream, Sai lugnd stream Mae Klang stream, and 6 study sites at Doi Inthanon National Park.

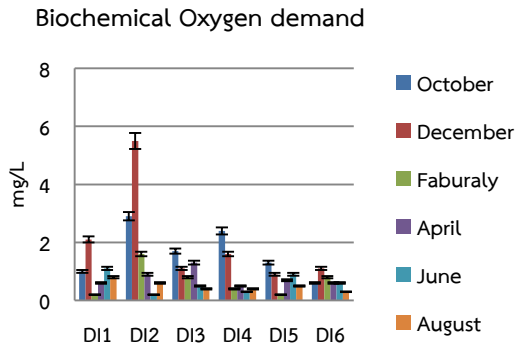


Figure 2 Biochemical Oxygen demand (BOD₅) in the 6 sampling sites.

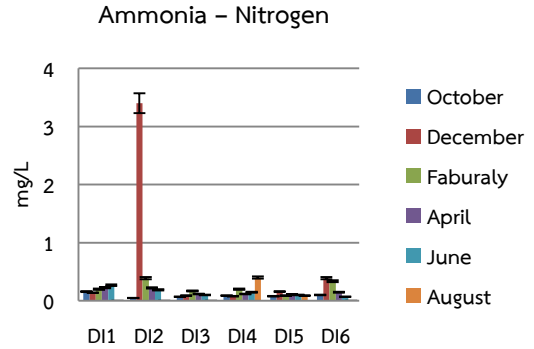


Figure 3 Ammonia - Nitrogen in the 6 sampling sites.

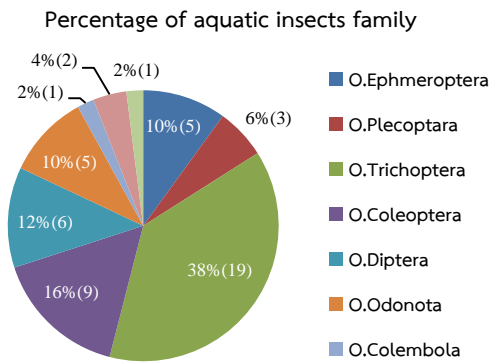


Figure 4 Percentage of the aquatic insects found at the 6 sampling sites.

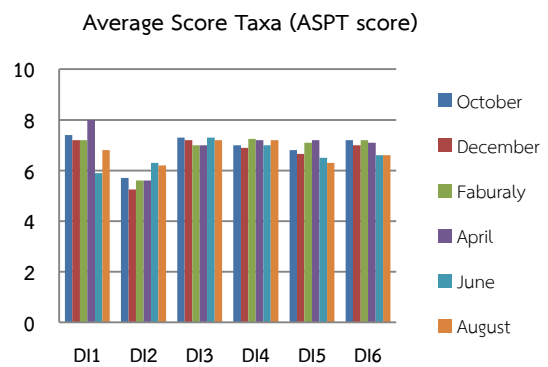


Figure 5 Average score per taxa (ASPT Score) of the 6 sampling sites.

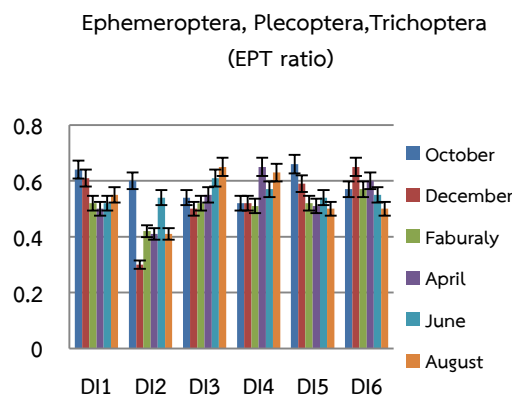


Figure 6 Ephemeroptera, Plecoptera, Trichoptera (EPT ratios) at the 6 sampling sites.