CHAPTER 4

RESULTS AND DISSCUSSION

4.1 Community structure and distribution of Trichoptera at four different sites

4.1.1 Trichoptera larvae at four stream sites May 2002-July 2003

Abundance of Trichoptera larvae (Figure 8) showed two different patterns. During June 2002-October 2002, the larvae was low. The lowest larvae abundance was in August 2002, with 4 larvae at Waterwheel Waterfall. From November 2002 to May 2003, larvae abundance raised up to the highest number of 238 larvae in January at Man Dang Noi Stream. The occurrence of larvae in two different periods coincided with the dry and wet seasons (Dudgoen, 1999).

The comparison of larvae in each study site showed a different community structure. The number of larvae was very low during the wet or 'rainy season' (June to October), while it was high in the dry season (November 2002-May2003). The lowest larva abundance was in August 2002 with no larva at Romglao-Paradorn Waterfall, a single larva at Kha Mun Noi Stream, 4 larvae at Waterwheel Waterfall and 8 larvae at Man Dang Noi Stream. In Romglao-Paradorn Waterfall, the habitat is predominantly bedrock, which causes high turbulent flow and is inaccessible. Therefore, a few larva specimens were able to be collected during the wet season and the flood conditions. Total number of Trichoptera larvae at each site is showed monthly (Figure 8) and indicates the peak and the decline of the number of larvae in accordance with the season and water discharge.

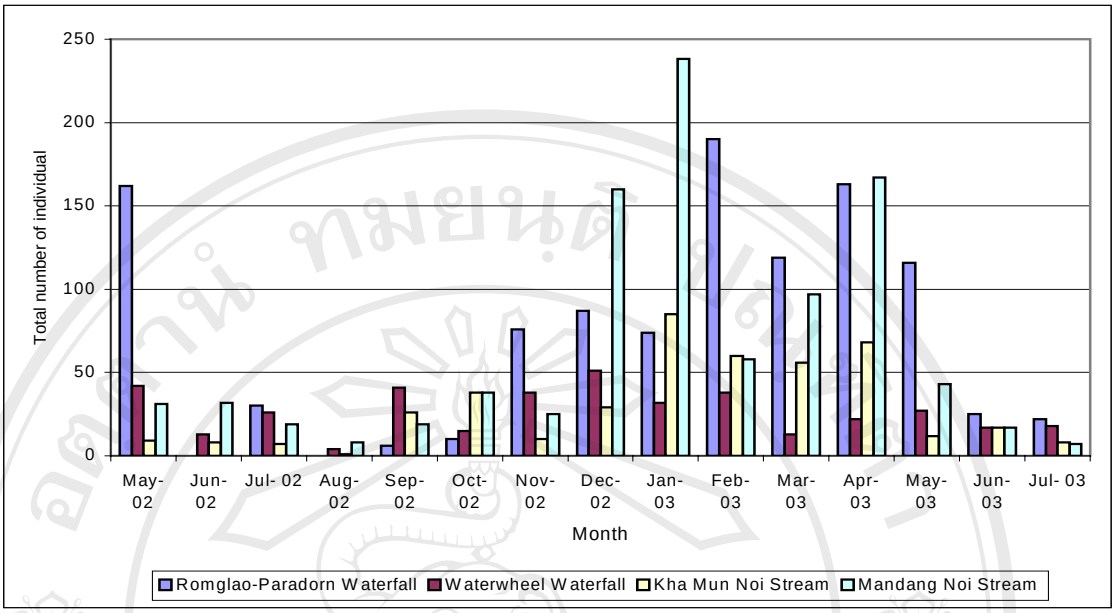

Figure 8 Total number of Trichoptera larvae at four different sites collected monthly from May 2002-July 2003

Romglao-Paradorn Waterfall

There is a different family of Trichoptera larvae which occur in each month. The highest diversity was in April 2003, while March and July 2003 had the second and third highest diversity, respectively. The number of each different larvae is shown in Figure 9. The highest and the second highest abundant families were the Lepidostomatidae (716 individual) and the Helicopsychidae (138 individuals), respectively. The Helicopsychidae and Glossosomatidae were found only in this site. The family richness and abundance of Trichoptera larvae were in accordance with water discharge. Number of larvae were low from June 2002-October 2002 and high during the high water discharge in the wet season (i.e. November -May 2003). The highest and the second highest family richness were in April 2003 (11 families) and

March 2003 (7 families), respectively. Family Lepidostomatidae was mainly collected from debris pool near bedrock (Figure 9), which was similar to other studies (Silalom, 2000; Nawvong, 2004). Dudgeon (1999) also indicated the larvae of lepidostomatid inhabited slow-flowing streams with abundant accumulations of riparian and plant litter. The situation of the classification and identification of the family is unstable and a resolution of the status of certain genera will require a more complete knowledge of the Oriental lepidostomatid, in Thailand.

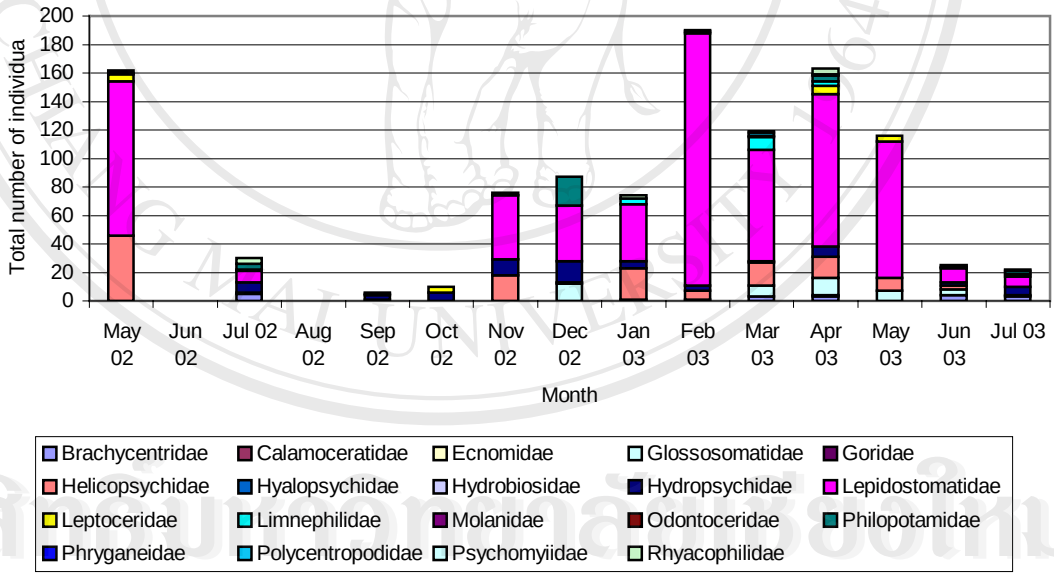

Figure 9 Trichoptera larvae found in Romglo-Paradorn Waterfall from May 2002 -July 2003

Waterwheel Waterfall

Number of larvae was generally lower than other sites and this remains constantly low most of the year. The highest diversity was in January 2003 (9 families) and lower diversity levels of larvae occurred in late February, April 2002 and May 2002, respectively, which were found in a total of 8 families. The difference in numbers are shown in Figure 10. The high abundant families were Hydropsychidae (85 individuals), Calamoceratidae (62 individuals) and Lepidostomatidae (45 individuals).

In this site, larval abundance tended to correspond with the season and water discharge, which showed decreasing larvae trends in June-October, and then gradually increasing after the wet season.

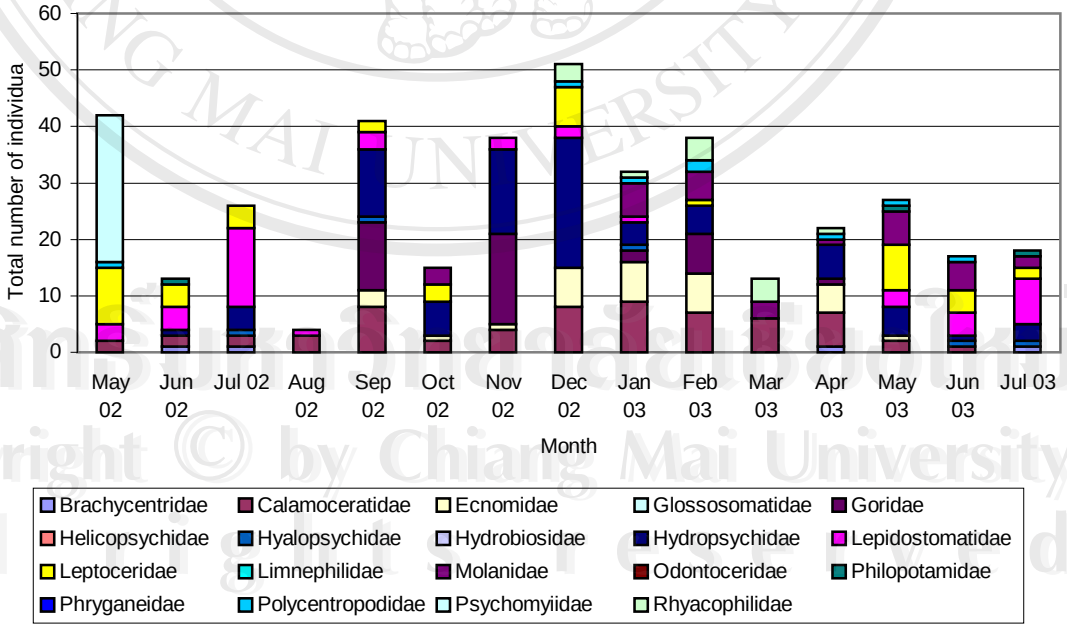

Figure 10 Trichoptera larvae found in Waterwheel Waterfall from May 2002-July 2003

Table 2 List of number of Trichoptera larvae found in Romglao-Paradorn Waterfall from May 2002-July 2003

Trichoptera Family	May 2002	Jun 2002	Jul 2002	Aug 2002	Sep 2002	Oct 2002	Nov 2002	Dec 2002	Jan 2003	Feb 2003	Mar 2003	Apr 2003	May 2003	Jun 2003	Jul 2003
Brachycentridae		N/A	5	N/A	1						3	3		4	3
Calamoceratidae		N/A		N/A					1	1		1			
Ecnomidae		N/A		N/A											
Glossosomatidae		N/A		N/A				12			8	12	7	4	
Goeridae		N/A		N/A											
Helicopsychidae	46	N/A	1	N/A			18	1	22	6	16	15	9	3	1
Hyalopsychidae		N/A		N/A											
Hydrobiosidae		N/A		N/A											
Hydropsychidae		N/A	7	N/A	3	6	11	15	5	4	1	7		2	6
Lepidostomatidae	108	N/A	8	N/A	1		45	39	40	177	78	107	96	10	7
Leptoceridae	5	N/A		N/A		4						6	4		
Limnephilidae	1	N/A	1	N/A					4		9	3			2
Molannidae		N/A		N/A											
Odontoceridae		N/A		N/A											
Philopotamidae	2	N/A	4	N/A				20			1	4		1	2
Phryganeidae		N/A		N/A											
Polycentropodidae		N/A		N/A						1	2	1			
Psychomyiidae		N/A		N/A											
Rhyacophilidae		N/A	4	N/A	1		2		2	1	1	4		1	1

Note: N/A, not available

Table 3 List of number of Trichoptera larvae found in Waterwheel Waterfall from May 2002-July 2003

Trichoptera Family	May 2002	Jun 2002	Jul 2002	Aug 2002	Sep 2002	Oct 2002	Nov 2002	Dec 2002	Jan 2003	Feb 2003	Mar 2003	Apr 2003	May 2003	Jun 2003	Jul 2003
Brachycentridae		1	1									1			1
Calamoceratidae	2	2	2	3	8	2	4	8	9	7	6	6	2	1	
Ecnomidae					3	1	1	7	7	7		5	1		
Glossosomatidae															
Goeridae					12		16		2	7		1			
Helicopsychidae															
Hyalopsychidae			1		1				1					1	1
Hydrobiosidae										5					
Hydropsychidae		1	4		12	6	15	23	4			6	5	1	3
Lepidostomatidae	3	4	14	1	3		2	2	1	1			3	4	8
Leptoceridae	10	4	4		2	3		7					8	4	2
Limnephilidae															
Molannidae						3			6	5	3	1	6	5	2
Odontoceridae															
Philopotamidae		1											1		1
Phryganeidae															
Polycentropodidae	1							1	1	2		1	1	1	
Psychomyiidae	26														
Rhyacophilidae								3	1	4	4	1			

Kha Mun Noi Stream

The high abundant families in Kha Mun Noi Stream were Lepidostomatidae (89), Hydropsychidae (71) and Rhyacophilidae (45). The highest diversity was in April 2003 (13 families), while October 2002 and January-May 2003 showed less diversity with 9 families.

The number of larvae followed a similar trend of water discharge in that taxa abundance declined in June-August 2002 and gradually peaked after the wet season, with the highest number in January 2003 (85 individuals) (Figure 11).

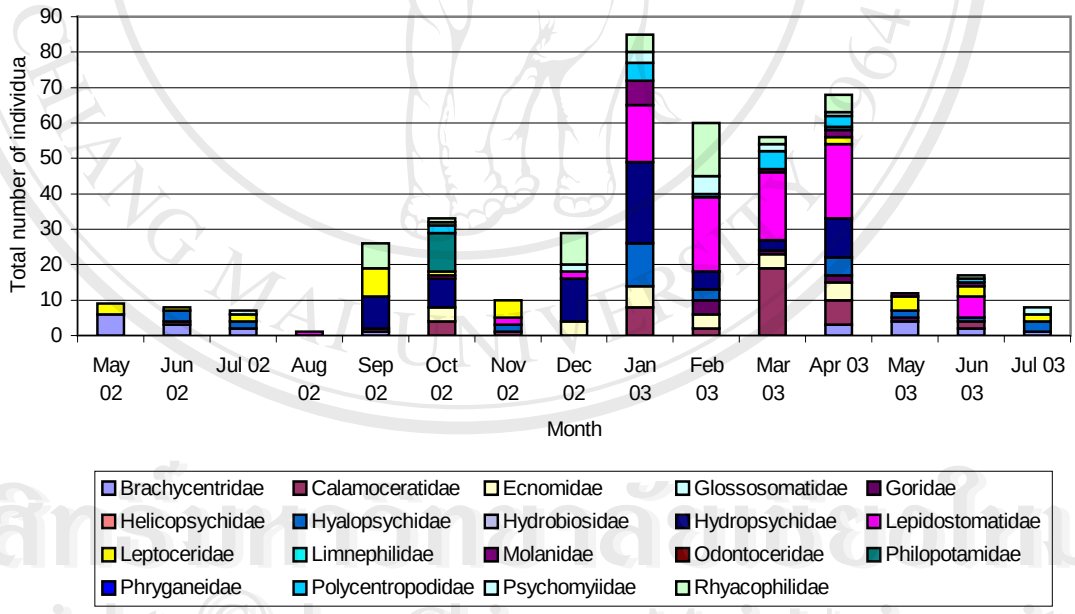

Figure 11 Trichoptera larvae found in Kha Mun Noi Stream from May 2002-July 2003

Table 4 List of number of Trichoptera larvae found in Kha Mun Noi Stream from May 2002-July 2003

Trichoptera Family	May 2002	Jun 2002	Jul 2002	Aug 2002	Sep 2002	Oct 2002	Nov 2002	Dec 2002	Jan 2003	Feb 2003	Mar 2003	Apr 2003	May 2003	Jun 2003	Jul 2003
Brachycentridae	6	3	2		1							3	4	2	1
Calamoceratidae		1			1	4	1		8	2	19	7		2	
Ecnomidae						4		4	6	4	4	5			
Glossosomatidae															
Goridae										4	1	2	1		
Helicopsychidae															
Hyalopsychidae		3	2				2		12	3		5	2	1	3
Hydrobiosidae															
Hydropsychidae					9	8		12	23	5	3	11			
Lepidostomatidae				1		1	2	2	16	21	19	21		6	
Leptoceridae	3	1	2		8	6	5					2	4	3	2
Limnephilidae															
Molanidae									7		1	2	1	1	
Odontoceridae															
Philopotamidae						11						1			
Phryganeidae															
Polycentropodidae						2			5	1	5	3		1	
Psychomyiidae			1			1		2	3	5	2	1			2
Rhyacophilidae					7	1		9	5	15	2	5		1	

Man Dang Noi Stream

Man Dang Noi Stream had higher numbers of larvae from December 2002-January 2003 and in April 2003 than other sites. Family richness and abundance of Trichoptera larvae at each site is shown monthly in Figure 12. April 2003 and December 2002 had the highest and second highest diversity with 14 and 10 families, respectively. Polycentropodidae and Ecnomidae were the highest and second highest abundant families with the number of larvae of 248 and 200, respectively.

Family Phryganeidae, which was found only in Man Dang Noi, was present all year at the site. A single member, *Eubasillissa mackachkani* White 1862, of this family was reported only in Doi Inthanon National Park with the altitude above 1200 m asl., based on adult specimens studied (Malicky and Chantatramongkol, 1993; 1999) Thamsenanupap (2005), reported the occurrence of early instar larva of Phryganeidae in January and adult from October to November at Siriphum Waterfall at Doi Inthanon National Park.

Table 5 List of number of Trichoptera larvae found in Man Dang Noi Stream from May 2002-July 2003

Trichoptera Family	May 2002	Jun 2002	Jul 2002	Aug 2002	Sep 2002	Oct 2002	Nov 2002	Dec 2002	Jan 2003	Feb 2003	Mar 2003	Apr 2003	May 2003	Jun 2003	Jul 2003
Brachycentridae															
Calamoceratidae	2					1			2	1	4	5	2		
Ecnomidae	6	2	2		3	17	6	30	57	20	21	25	7	3	1
Glossosomatidae															
Goeridae											1	3			
Helicopsychidae															
Hyalopsychidae	5	1			4		2	10	16	7	22	24	7		
Hydrobiosidae															
Hydropsychidae		1				1						1		1	1
Lepidostomatidae	1	1	1			2		4	12	5	2	18	8	2	1
Leptoceridae	1				1							1			
Limnephilidae								7				3			
Molannidae			5	4	5			5	2	8	22	28	10	2	
Odontoceridae															
Philopotamidae	3	15			1	2	5	10				27	2	4	2
Phryganeidae	2	7	11	3	1		2	9	9	7	8	12	2	1	
Polycentropodidae	6	2		1		10	4	54	130	9	15	10	5	2	
Psychomyiidae	5	1			3	4		8	6		2	8			
Rhyacophilidae		2			1	1	6	23	4	1		2		2	2

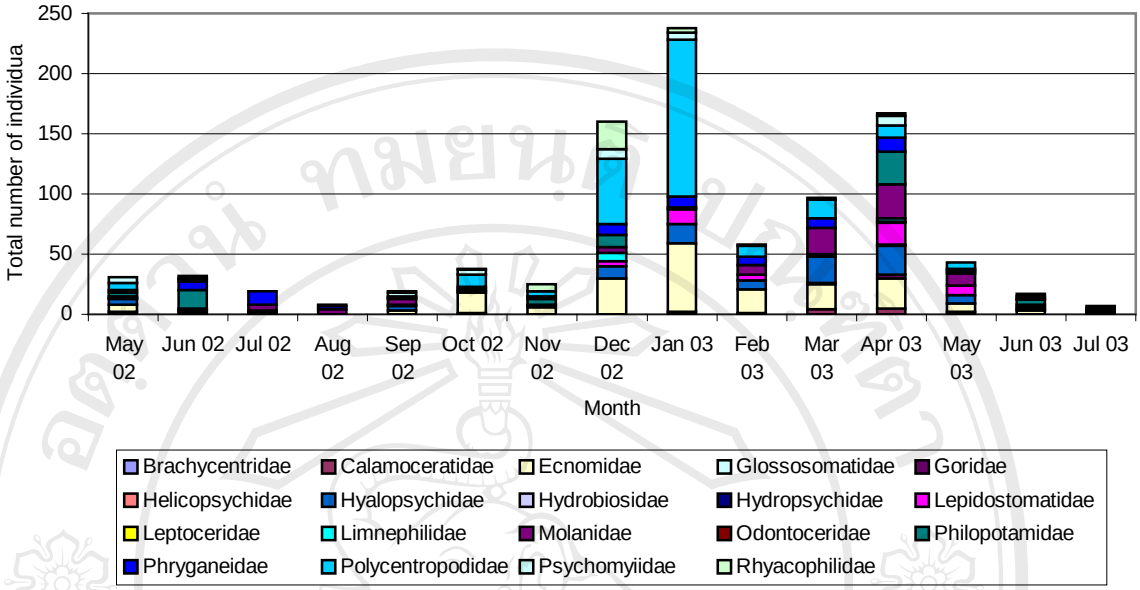

Figure 12 Trichoptera larvae found in Man Dang Noi Stream from May 2002-July 2003

4.1.2 Adult Trichoptera at four stream sites (May 2002-July 2003)

A total of 3,043 male Trichoptera specimens were identified into 19 families, 32 genera and 64 species. Thirteen certain new species and 3 unknown (possibly new species) were found. Adult Trichoptera, which were collected by black light traps at all sites, are shown in Table 6-9. Adult specimens, which were collected by Malaise trap at Mun Dang Noi Stream, are shown in Table 10. List of new species are shown in Table 11. Figures 16-18 show the drawing of unknown species terminalia.

The occurrence of adult Trichoptera decreased from November 2002-March 2003 (Figure 13), which was consistent with the trend of water discharge which was very low from February-April 2003.

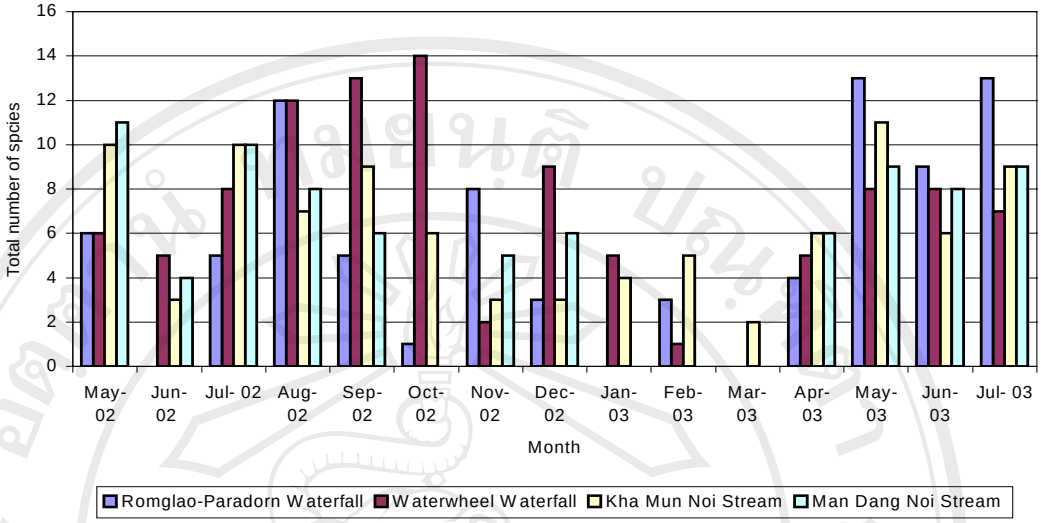

Figure 13 Species richness of adult Trichoptera at four stream sites observe from May 2002-July 2003

Romglao-Paradorn Waterfall

High abundant families at Romglao-Paradorn Waterfall were Hydropsychidae 43%, Rhyacophilidae 29%, and Philopotamidae 21% (Figure 14). In family Hydropsychidae, *Chumatopsyche schwendingeri* was the highest abundant species (56 %). *Hydropsuche truncatus* (35 %), *Hydropsyche battos* (4%) and the others (5%) were present in lesser abundance. *Rhyacophila suthepensis* 76%, *Rhyacophila scissoides* 19% and others at 5% were the highest, the second highest and the least abundant of the Family Rhyacophilidae, respectively. Family Philopotamidae, *Chimarra shiva* 84%, *Kisaura sura* 14% and others at 2% were the highest, the second highest and the least abundant, respectively.

Table 6 List of number of adult Trichoptera species collected in black light trap at Romglao - Paradorn Waterfall from May 2002-July 2003

Family	Species	May 02	Jun 02	Jul 02	Aug 02	Sep 02	Oct 02	Nov 02	Dec 02	Jan 03	Feb 03	Mar 03	Apr 03	May 03	Jun 03	Jul 03
Brachycentridae	*Micrasema turbo*		N/A		1					N/A		N/A				
Calamoceratidae	*Anisocentropus janus*		N/A							N/A		N/A				
	Ganonema extensum		N/A							N/A		N/A				
Ecnomidae	*Ecnomus hyakinthos n.sp.*		N/A							N/A		N/A		7		
Goeridae	*Goera antigone*		N/A							N/A		N/A				
Hyalopsychidae	*Phylocentropus narumonae*		N/A		2					N/A		N/A			1	
Hydrobiosidae	*Apsilochorema malickyi*		N/A							N/A		N/A				
Hydropsychidae	*Cheumatopsyche schwendingeri*	3	N/A							N/A		N/A	90	21		
	Cheumatopsyche jiriana		N/A							N/A		N/A				
	Cheumatopsyche peirithoos n.sp.		N/A							N/A		N/A				
	Cheumatopsyche danae															
	Diplectrona aurovittata		N/A					1		N/A		N/A				
	Diplectrona eurydike		N/A							N/A		N/A				
	Diplectrona joannisi		N/A							N/A		N/A		1	1	
	Hydropsyche battos		N/A		1	1		4		N/A		N/A		1		1
	Hydromanicus truncatus	6	N/A	8	20	1		2	1	N/A	2	N/A	3	8	14	7
	Hydatomanicus klanklini		N/A							N/A		N/A		1		
	Hydatomanicus scotosius		N/A							N/A		N/A		1		
Lepidostomatidae	*Dinarthrum martius*		N/A		1					N/A		N/A				
	Dinarthrum februarius		N/A					1		N/A		N/A				
	Dinathrum kyllaros n.sp.		N/A		1					N/A		N/A			5	1
	Dinarthrum labdakos n.sp.		N/A							N/A		N/A				
	Lepidostoma latona n.sp.		N/A							N/A		N/A				

Table 6 (continued)

Family	Species	May 02	Jun 02	Jul 02	Aug 02	Sep 02	Oct 02	Nov 02	Dec 02	Jan 03	Feb 03	Mar 03	Apr 03	May 03	Jun 03	Jul 03
Lepidostomatidae	*Lepidostoma ianus*		N/A							N/A		N/A				
Limnephilidae	*Moropsyche inachos n.sp.*		N/A	1						N/A		N/A		1		3
Leptoceridae	*Adicella censicaca*		N/A							N/A		N/A				
	Adicella evadne		N/A		1					N/A		N/A			1	
	Adicella iuturna		N/A							N/A		N/A				
	Adicella longicerca		N/A							N/A		N/A				
	Adicella koronis		N/A							N/A		N/A				
	Leptocerus inventas n.sp.		N/A							N/A		N/A				
	Oecetis tripunctata		N/A							N/A		N/A				
Molanidae	*Molanna oglama*		N/A							N/A		N/A				
Odontoceridae	*Inthanopsyche trimerisuri*		N/A							N/A		N/A				
Philopotamidae	*Chimarra shiva*	1	N/A		1	1	3	20	2	N/A		N/A		4	1	1
	Chimarra spinifera		N/A		1					N/A		N/A				1
	Chimarra prisna		N/A							N/A		N/A				
	Chimarra ramakein		N/A							N/A		N/A				
	Chimarra devva		N/A							N/A		N/A				
	Chimarra khamuorum		N/A							N/A		N/A				
	Doloclanes gressiti		N/A							N/A		N/A				
	Doloclanes abas		N/A							N/A		N/A				
	Dolophilodes bicolor		N/A							N/A		N/A				
	Kisaura sura	4	N/A	8	4			6		N/A	1	N/A	3	27	4	3
	Kisaura longispina		N/A							N/A		N/A				1
	Wormaldia relicta		N/A							N/A		N/A				

Table 6 (continued)

Family	Species	May 02	Jun 02	Jul 02	Aug 02	Sep 02	Oct 02	Nov 02	Dec 02	Jan 03	Feb 03	Mar 03	Apr 03	May 03	Jun 03	Jul 03
Phryganeidae	*Eusabilissa maclachlani*		N/A							N/A		N/A				
	Phryganopsyche latipenis ssp. elongatus		N/A							N/A		N/A				
Polycentropodidae	*Nyctiophylax mentor n.sp.*		N/A							N/A		N/A				
	Plectrocnemia eccingoma		N/A							N/A		N/A				
	Plectrocnemia luna n.sp.		N/A							N/A		N/A				
	Polyplectropus hyllos n.sp.		N/A							N/A		N/A				
	Polyplectropus ipleicles n.sp.		N/A							N/A		N/A				
	Pseudoneureclipsis lykurgos n.sp		N/A							N/A		N/A		4		
Psychomyiidae	*Lype atnia*		N/A							N/A		N/A				
	Eoneureclipsis alekto		N/A							N/A		N/A		2		
Rhyacophilidae	*Rhyacophila inaequalis*		N/A							N/A		N/A				
	Rhyacophila suthepensis	2	N/A	6	26	2		4	1	N/A		N/A	1	16	33	13
	Rhyacophila kyimdongpa		N/A							N/A		N/A				1
	Rhyacophila lyssa n.sp.		N/A							N/A		N/A			1	1
	Rhyacophila scissoides	1	N/A	1	2	1		1		N/A	4	N/A		12	3	1
	Rhyacophila moneta n.sp.		N/A							N/A		N/A				3
	Rhyacophila peterosum		N/A							N/A		N/A				
	Rhyacophila gyamo		N/A							N/A		N/A	1			
Sericostomatidae	*Gumaga orientanis*		N/A							N/A		N/A				

Note: N/A, Not Available

In this site, five species of *Ecnomus hyakinthos, Dinarthrum kyllalos, Moropsyche inachos, Psudoneureclipsis lykurgos* and *Rhyacophila lyssa* were found as new species. These new species were proportionate to 39% of all new species and 8% of all total species (Table 6).

Bedrock with small pools at Romglao-Paradorn Waterfall was predominant. This kind of habitat is a favorite of Hydropsychidae, which constructs the retreat on hard surfaces in streams because of its requirement for oxygen saturation and food particles (Dudgeon, 1999). Lepidostomatids, the highest larva abundance, were found as only 2% of adult specimens. This difference may be explained by the clumped distribution, and were easy to capture in high numbers.

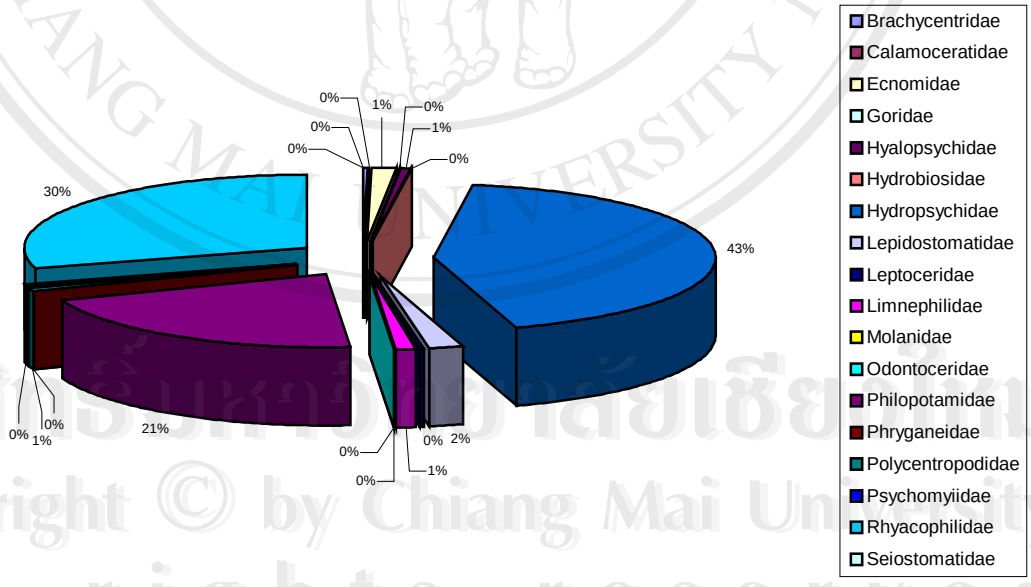

Figure 14 Adult Trichoptera collected by black light trap at Romglao-Paradorn Waterfall

Waterwheel waterfall

Waterwheel and Romgloa-Paradorn Waterfalls which are situated at the same stream, showed the similarity of community structures in a high abundance of Hydropsychidae (37%), Philopotamidae (22%) and Rhyacophilidae (7%), respectively (Figure 15). However, two families of Hyalopsychidae (15%) and Ecnomidae (7%) were slightly different in species numbers, in that these numbers slightly increased. Hyalopsychids and Ecnomids seemed to prefer slow flowing streams. They burrow into fine-grained stream sediments where a silken tube covered with sand grains is constructed (Dudgeon, 1999). As in Table 1, sand is predominant at the lower parts of Waterwheel Waterfall. Case construction and its materials may explain the increasing proportion of these two families in Waterwheel Waterfall.

Family Hydropsychidae had the highest diversity of *Hydropsyche battos* (92%). *Diplectona aurovitata* (4%), *Chumatopsyche schwendingeri* (2%), and others (2%) were the minor species of the family. Philopotamidae had the highest diversity of *Chimarra shiva* (87%). *Chimarra ramakein (*5%), *Kisaura sura (*2%) and others (6%) were the minor groups of species. Family Rhyacophilidae, *Rhyacophila suthepensis* (97%) showed the highest abundance, while the second highest diversity species was *Rhyacophila inaequalis* (3%). *Ecnomus hyakinthos* and *Phylocentropus narumonae* were found as the single species represented for families Ecnomidae and Hyalopsychidae.

Six species of *Ecnomus hyakinthos, Dinarthrum kyllalos, Cheumatopsyche peirithoos, Moropsyche inachos, Leptocerus invanta* and *Polyplectropus ipleicles* were found as new species at Waterwheel Waterfall. These were proportionate to 39 % of all new species and 8% of all total species (Table 7).

Table 7 List of number of adult Trichoptera species collected by black light trap at Waterwheel Waterfall from May 2002-July 2003

Family	Species	May 02	Jun 02	Jul 02	Aug 02	Sep 02	Oct 02	Nov 02	Dec 02	Jan 03	Feb 03	Mar 03	Apr 03	May 03	Jun 03	Jul 03
Brachycentridae	*Micrasema turbo*		1	1		1	1								1	1
Calamoceratidae	*Anisocentropus janus*	1														
	Ganonema extensum												2	1		
Ecnomidae	*Ecnomus hyakinthos n.sp.*	2			13	8			2					2		1
Goeridae	*Goera antigone*				1	1										
Hyalopsychidae	*Phylocentropus narumonae*	16	6	5	10	6	2			2				7	4	2
Hydrobiosidae	*Apsilochorema malickyi*						1		1							
Hydropsychidae	*Cheumatopsyche schwendingeri*	1											1	1		
	Cheumatopsyche jiriana				1	1										
	Cheumatopsyche peirithoos n.sp.				1											
	Cheumatopsyche danae			1												
	Diplectrona aurovittata						4		1							
	Diplectrona eurydike															
	Diplectrona joannisi															
	Hydropsyche battos		1	19	22	13	9	40	24	4	2			1	3	1
	Hydromanicus truncatus															
	Hydatomanicus klanklini				1											
	Hydatomanicus scotosius															
Lepidostomatidae	*Dinarthrum martius*									1						
	Dinarthrum februarius															
	Dinathrum kyllaros n.sp.															
	Dinarthrum labdakos n.sp.															
	Lepidostoma latona n.sp.															

Table 7 (continued)

Family	Species	May 02	Jun 02	Jul 02	Aug 02	Sep 02	Oct 02	Nov 02	Dec 02	Jan 03	Feb 03	Mar 03	Apr 03	May 03	Jun 03	Jul 03
Lepidostomatidae	*Lepidostoma ianus*															
Limnephilidae	*Moropsyche inachos n.sp.*				2	1										
Leptoceridae	*Adicella censicaca*															
	Adicella evadne												3			
	Adicella iuturna															
	Adicella longicerca															
	Adicella koronis												1			
	Leptocerus inventas n.sp.			1											1	1
	Oecetis tripunctata					1	2									
Molanidae	*Molanna oglama*					1	1									
Odontoceridae	*Inthanopsyche trimerisuri*															
Philopotamidae	*Chimarra shiva*			2		6	58	2	1	2				1	5	
	Chimarra spinifera						1									
	Chimarra prisna															
	Chimarra ramakein			1		1	1								1	
	Chimarra devva															
	Chimarra khamuorum	2														
	Doloclanes gressiti						1		1							
	Doloclanes abas															
	Dolophilodes bicolor															
	Kisaura sura				1		1									
	Kisaura longispina															
	Wormaldia relicta				1				1							

Table 7 (continued)

Trichoptera Family	Species	May 02	Jun 02	Jul 02	Aug 02	Sep 02	Oct 02	Nov 02	Dec 02	Jan 03	Feb 03	Mar 03	Apr 03	May 03	Jun 03	Jul 03
Phryganeidae	*Eusabilissa maclachlani*															
	Phryganopsyche latipenis ssp. elongatus															
Polycentropodidae	*Nyctiophylax mentor n.sp.*															
	Plectrocnemia eccingoma												1			
	Plectrocnemia luna n.sp.															
	Polyplectropus hyllos n.sp.															
	Polyplectropus ipleicles n.sp.													1		
	Pseudoneureclipsis lykurgos n.sp															
Psychomyiidae	*Lype atnia*				1				1							
	Eoneureclipsis alekto		5	8		1								1	3	1
Rhyacophilidae	*Rhyacophila inaequalis*						1									
	Rhyacophila suthepensis	1	3		16	2	1		1	1					2	1
	Rhyacophila kyimdongpa															
	Rhyacophila lyssa n.sp.															
	Rhyacophila scissoides															
	Rhyacophila moneta n.sp.															
	Rhyacophila peterosum															
	Rhyacophila gyamo															
Sericostomatidae	*Gumaga orientanis*											1				

Note: *, N/A, Not available

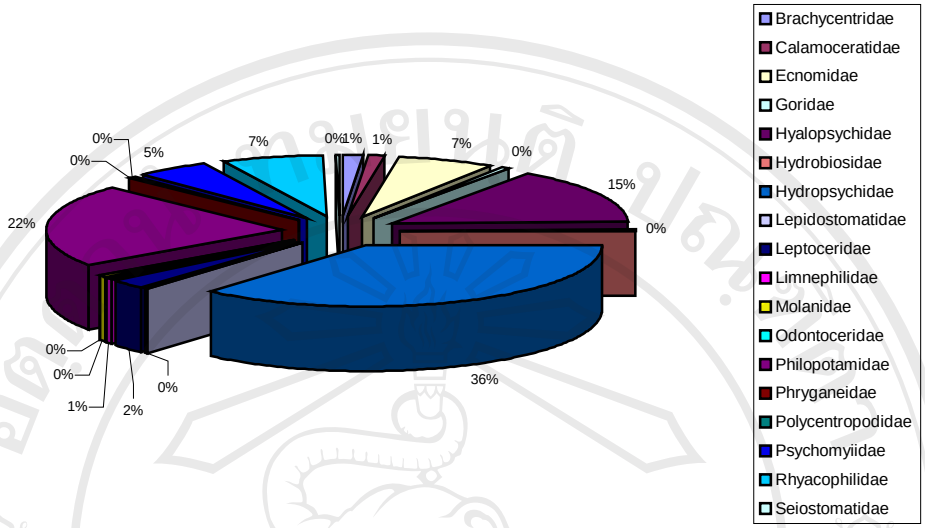

Figure 15 Adult Trichoptera collected by black light trap at Waterwheel Waterfall

Kha Mun Noi Stream

The community and distribution of adult Trichoptera at Kha Mun Noi Stream was similar to the Waterwheel and Romglao-Paradorn Waterfalls. The dominant families of this site were Philopotamidae (35%), Psychomyiidae (16%), Hydropsychidae (15%) and Rhyacophilidae (10%) (Figure 16), which was slightly different from RGW and KMS. The similarity of these three sites was assumed by the similarity of the streambed as being predominately bedrock.

Family Philopotamidae, *Chimarra shiva* had the highest abundance with 91% of total species. *C. khamuorum* (7%), and other species (2%) were less abundant and the least abundant, respectively. Two species of *Eoneureclipsis alekto* and *Lyp atnia* were found as being the highest and the second highest species present of family Psychomyiidae, respectively. In family Hydropsychidae, *Hydropsyche battos* had the

highest abundance with 48% of total species. *Chumatopsyche aurovitata* (34%), *Chumatopsyche schwendingeri* (17%) and others at (1%) were less abundant. Family Rhyacophilidae, *Rhyacophila suthepensis* had the highest abundance with 56% of total species and *Rhyacophila scissoides* (37%) where other species (7%) had less abundance.

According to the survey at Kha Mun Noi Stream, four species of *Ecnomus hyakinthos* , *Lepidostoma latona* , *Leptocerus invantas* , and *Rhyacophila moneta* were found as new species. These new species were proportionate to 31 % of all new species and 6% of all species (Table 8).

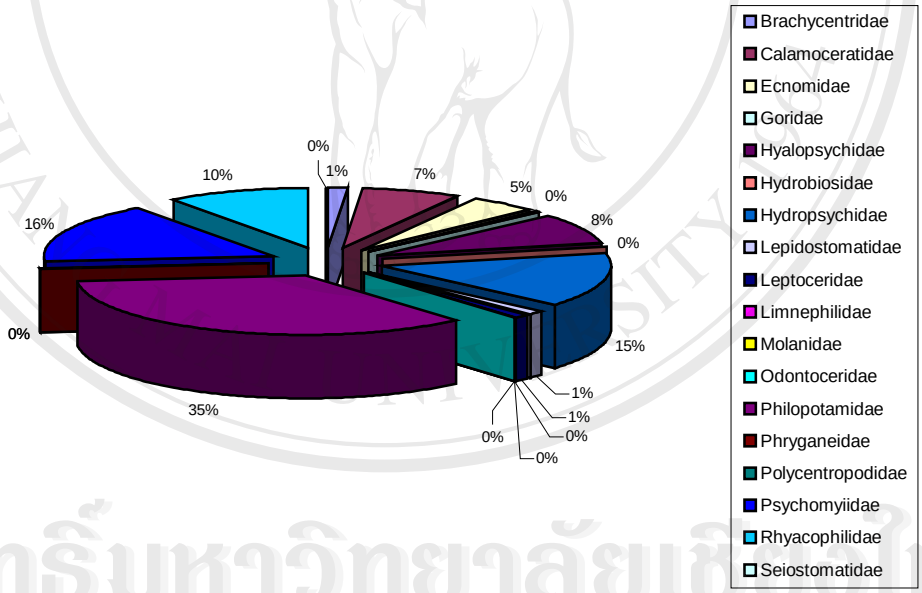

Figure 16 Adult Trichoptera collected by black light trap at Kha Mun Noi Stream

Table 8 List of number of adult Trichoptera species collected in black light trap at Kha Mun Noi Stream from May 2002-July 2003

Family	Species	May 02	Jun 02	Jul 02	Aug 02	Sep 02	Oct 02	Nov 02	Dec 02	Jan 03	Feb 03	Mar 03	Apr 03	May 03	Jun 03	Jul 03
Brachycentridae	*Micrasema turbo*			1	2		1									
Calamoceratidae	*Anisocentropus janus*	1								1					3	1
	Ganonema extensum		1	1									1	5	4	1
Ecnomidae	*Ecnomus hyakinthos n.sp.*	2	1	1	1	1							2	1	3	1
Goeridae	*Goera antigone*													1		
Hyalopsychidae	*Phylocentropus narumonae*	2		1	7	1				1	1	1		7		2
Hydrobiosidae	*Apsilochorema malickyi*															
Hydropsychidae	*Cheumatopsyche schwendingeri*	3				1							3			
	Cheumatopsyche jiriana															
	Cheumatopsyche peirithoos n.sp.															
	Cheumatopsyche danae															
	Diplectrona aurovittata													14		
	Diplectrona eurydike															
	Diplectrona joannisi															
	Hydropsyche battos			4		2		4	2	1	1					6
	Hydromanicus truncatus															
	Hydatomanicus klanklini															
	Hydatomanicus scotosius															
Lepidostomatidae	*Dinarthrum martius*						1									
	Dinarthrum februarius															
	Dinathrum kyllaros n.sp.															
	Dinarthrum labdakos n.sp.															
	Lepidostoma latona n.sp.						1									

Table 8 (continued)

Family	Species	May 02	Jun 02	Jul 02	Aug 02	Sep 02	Oct 02	Nov 02	Dec 02	Jan 03	Feb 03	Mar 03	Apr 03	May 03	Jun 03	Jul 03
Lepidostomatidae	*Lepidostoma ianus*	1														
Limnephilidae	*Moropsyche inachos n.sp.*															
Leptoceridae	*Adicella censicaca*															
	Adicella evadne															
	Adicella iuturna															
	Adicella longicerca															
	Adicella koronis															
	Leptocerus inventas n.sp.	2												1		
	Oecetis tripunctata															
Molanidae	*Molanna oglama*															
Odontoceridae	*Inthanopsyche trimerisuri*															
Philopotamidae	*Chimarra shiva*	14		1	1	8	35	3	2		1	2	9	1	8	2
	Chimarra spinifera															
	Chimarra prisna											1				
	Chimarra ramakein			1		1										
	Chimarra devva															
	Chimarra khamuorum	6														
	Doloclanes gressiti															
	Doloclanes abas															
	Dolophilodes bicolor															
	Kisaura sura															
	Kisaura longispina															
	Wormaldia relicta															

Table 8 (continued)

Trichoptera Family	Species	May 02	Jun 02	Jul 02	Aug 02	Sep 02	Oct 02	Nov 02	Dec 02	Jan 03	Feb 03	Mar 03	Apr 03	May 03	Jun 03	Jul 03
Phryganeidae	*Eusabilissa maclachlani*															
	Phryganopsyche latipenis ssp. elongatus															
Polycentropodidae	*Nyctiophylax mentor n.sp.*															
	Plectrocnemia eccingoma															
	Plectrocnemia luna n.sp.															
	Polyplectropus hyllos n.sp.															
	Polyplectropus ipleicles n.sp.															
	Pseudoneureclipsis lykurgos n.sp													1		
Psychomyiidae	*Lype atnia*	2			3	1							4	3		
	Eoneureclipsis alekto	1	11	6										4	6	4
Rhyacophilidae	*Rhyacophila inaequalis*															
	Rhyacophila suthepensis				5	1	2		2	1	1		1	2		
	Rhyacophila kyimdongpa															
	Rhyacophila lyssa n.sp.															
	Rhyacophila scissoides	1		1	1	1	1				2			1		2
	Rhyacophila moneta n.sp.			1				1								1
	Rhyacophila peterosum															
	Rhyacophila gyamo															
Sericostomatidae	*Gumaga orientanis*															

Man Dang Noi Stream

In Man Dang Noi Stream, adults Trichoptera were collected by two different methods; black light trap and Malaise trap. The diversity of adult Trichoptera collected by black light trap was different from the three former sites (Romglao-Paradon Waterfall, Waterwheel Waterfall and Kha Mun Noi Stream). The highest abundant family was Ecnomidae (37%), while Psychomyiidae (18%), Polycentropodidae (16%) were less abundant families, respectively (Figure 17).

Family Ecnomidae was found as only one representative species: *Ecnomus hyakinthos*. Family Psychomyiidae, *Eoneureclipsis alekto* was found as the highest abundance with 92% of total species and *Lype atnia* was less abundant (8%.). Family Polycentropodidae, *Plectrocnemia eccingoma* was found as the highest abundance with 85% of total species, while *Polplectropus hyllos* (6%), *Nyctiophylax mentor* (6%) and other species (3%) were less abundant. Family Philopotamidae, *Warmaldia relicta* (70%) had the highest abundance and *Kisaura sura* was less abundant (11%) (Table 9).

In June and August 2002, all study sites were flooded. This caused Romglao-Paradorn Waterfall to provide no data in June and October 2002. January 2003 was a very low period of activity for adult caddisfly. Only a few females were caught by black light trap. In Man Dang Noi Stream, only females were caught in October 2002 and January-February 2003.

The diversity of adult Trichoptera collected by Malaise trap mainly showed the similar trend to the result of the black light trap in that there was a high abundance of Ecnomidae and Psychomyiidae. Ecnomidae was the highest abundant family

(26%) and Philopotamidae (21%), Hyalopsychidae (20%) and Psychomyiidae (17%) were less abundant (Figure 18).

Ecnomus hyakinthos and *Phylocentropus narumona*e were found as the single species represented for families Ecnomidae and Hyalopsychidae. Family Psychomyiidae, *Lype atnia* had the highest abundance (63%) and *Eoneureclipsis alekto* was less abundant (37%). Family Polycentropodidae, *Plectrocnemia eccingoma* had the highest abundance (58%), *Polyplectropus hyllos* (40%), *Nyctiophylax mentor* (2%) were less abundant, respectively. Family Philopotamidae, *Warmaldia relicta* had the highest abundance (84%), *Doloclanes abas* (11%), *Dolophilodes bicolor* (3%), and other families (2%) were less abundant, respectively. *Moropsyche inachos* was the only species of *Limnephilidae* (Table 10).

Nine species: *Ecnomus hyakinthos, Dinarthrum labdakos, Lepidostoma latona, Moropsyche inachos, Nyctiophylax mentor, Plectrocnemia luna, Polplectropus hyllos, Rhyacophila lyssa* and *Rhyacophila moneta* were found as new species. These new species were proportionate to 69 % of all new species and 14% of all total species (Table 9-10). Moreover only family Phryganeidae was found at this site.

The comparison of Malaise trap and black light trap indicated that the number of adult Trichoptera was higher in Malaise trap than the black light trap (Figure 19). This can be explained by the period of operation for each trap. The Malaise trap was set throughout the study period, while the black light trap was only operated overnight, once a month for 15 months. But the black light trap produced higher species richness than the Malaise trap, 30 species were collected by black light trap and 26 species were collected by Malaise trap because black light trap used a direct

method in which it is easy for insects to see from a distance from the trap and it is an easy method to entrap species. Both methods were used to collect insects which is better than using only one method because there is a non response from insects with the black light trap. These two different types of traps are recommended to operate in order to obtain broader results from both day and night of these active species.

Data from Huai Sai Lueng Waterfall indicated that the abundance and species diversity of the adult Trichoptera were higher in the black light trap than in the Malaise trap. 1942 male Trichoptera were found and identified into 103 species. While 346 male Trichoptera were identified into 75 species (Thamsenanupap, 2005). This showed a dissimilar trend from Man Dang Noi Stream in that 1587 male Trichoptera were collected by the Malaise trap and identified into 26 species. While 298 male Trichoptera were collected by the black light trap and were identified into 30 species

Table 9 List of number of adult Trichoptera species collected by black light trap at Man Dang Noi Stream from May 2002-July 2003

Family	Species	May 02	Jun 02	Jul 02	Aug 02	Sep 02	Oct 02	Nov 02	Dec 02	Jan 03	Feb 03	Mar 03	Apr 03	May 03	Jun 03	Jul 03
Brachycentridae	*Micrasema turbo*				1		N/A			N/A	N/A	N/A				
Calamoceratidae	*Anisocentropus janus*	2					N/A			N/A	N/A	N/A				
	Ganonema extensum						N/A			N/A	N/A	N/A		3		
Ecnomidae	*Ecnomus hyakinthos n.sp.*	10	6	28	1	1	N/A		2	N/A	N/A	N/A	12	14	28	7
Goeridae	*Goera antigone*						N/A			N/A	N/A	N/A				
Hyalopsychidae	*Phylocentropus narumonae*			1			N/A	1	1	N/A	N/A	N/A		9		
Hydrobiosidae	*Apsilochorema malickyi*						N/A			N/A	N/A	N/A				
Hydropsychidae	*Cheumatopsyche schwendingeri*						N/A			N/A	N/A	N/A				1
	Cheumatopsyche jiriana						N/A			N/A	N/A	N/A				
	Cheumatopsyche peirithoos n.sp.						N/A			N/A	N/A	N/A				
	Cheumatopsyche danae						N/A			N/A	N/A	N/A				
	Diplectrona aurovittata						N/A			N/A	N/A	N/A				
	Diplectrona eurydike		1				N/A			N/A	N/A	N/A				
	Diplectrona joannisi						N/A			N/A	N/A	N/A				
	Hydropsyche battos						N/A			N/A	N/A	N/A			1	1
	Hydromanicus truncatus						N/A			N/A	N/A	N/A				
	Hydatomanicus klanklini						N/A			N/A	N/A	N/A				
	Hydatomanicus scotosius						N/A			N/A	N/A	N/A				
Lepidostomatidae	*Dinarthrum martius*						N/A			N/A	N/A	N/A				
	Dinarthrum februarius						N/A			N/A	N/A	N/A				
	Dinathrum kyllaros n.sp.						N/A			N/A	N/A	N/A				
	Dinarthrum labdakos n.sp.						N/A			N/A	N/A	N/A		1		
	Lepidostoma latona n.sp.						N/A			N/A	N/A	N/A	1			

Table 9 (continued)

Family	Species	May 02	Jun 02	Jul 02	Aug 02	Sep 02	Oct 02	Nov 02	Dec 02	Jan 03	Feb 03	Mar 03	Apr 03	May 03	Jun 03	Jul 03
Lepidostomatidae	*Lepidostoma ianus*						N/A			N/A	N/A	N/A				
Limnephilidae	*Moropsyche inachos n.sp.*	2		4			N/A			N/A	N/A	N/A	3	1		
Leptoceridae	*Adicella censicaca*						N/A			N/A	N/A	N/A				
	Adicella evadne						N/A			N/A	N/A	N/A				
	Adicella iuturna						N/A			N/A	N/A	N/A				
	Adicella longicerca			1			N/A			N/A	N/A	N/A				
	Adicella koronis						N/A			N/A	N/A	N/A				
	Leptocerus inventas n.sp.						N/A			N/A	N/A	N/A				
	Oecetis tripunctata						N/A			N/A	N/A	N/A				
Molanidae	*Molanna oglama*						N/A			N/A	N/A	N/A				
Odontoceridae	*Inthanopsyche trimerisuri*						N/A			N/A	N/A	N/A		5		
Philopotamidae	*Chimarra shiva*						N/A			N/A	N/A	N/A				
	Chimarra spinifera						N/A			N/A	N/A	N/A				
	Chimarra prisna						N/A			N/A	N/A	N/A				
	Chimarra ramakein						N/A			N/A	N/A	N/A				
	Chimarra devva						N/A			N/A	N/A	N/A		1		
	Chimarra khamuorum						N/A			N/A	N/A	N/A				
	Doloclanes gressiti					1	N/A			N/A	N/A	N/A				
	Doloclanes abas						N/A		1	N/A	N/A	N/A				
	Dolophilodes bicolor			1			N/A			N/A	N/A	N/A				1
	Kisaura sura	2			1		N/A			N/A	N/A	N/A				
	Kisaura longispina						N/A			N/A	N/A	N/A				
	Wormaldia relicta	1	2	8	2	2	N/A	1	1	N/A	N/A	N/A			2	

Table 9 (continued)

Family	Species	May 02	Jun 02	Jul 02	Aug 02	Sep 02	Oct 02	Nov 02	Dec 02	Jan 03	Feb 03	Mar 03	Apr 03	May 03	Jun 03	Jul 03
Phryganeidae	*Eusabilissa maclachlani*	1		3	2		N/A	1		N/A	N/A	N/A			3	
	Phryganopsyche latipenis ssp. elongatus	1		1		1	N/A	1	1	N/A	N/A	N/A			2	1
Polycentropodidae	*Nyctiophylax mentor n.sp.*	2					N/A			N/A	N/A	N/A	1			
	Plectrocnemia eccingoma	5		2	2	1	N/A	1	2	N/A	N/A	N/A	15	6	2	4
	Plectrocnemia luna n.sp.						N/A			N/A	N/A	N/A		1		
	Polyplectropus hyllos n.sp.						N/A			N/A	N/A	N/A	1			2
	Polyplectropus ipleicles n.sp.						N/A			N/A	N/A	N/A				
	Pseudoneureclipsis lykurgos n.sp						N/A			N/A	N/A	N/A				
Psychomyiidae	*Lype atnia*	2				2	N/A			N/A	N/A	N/A				
	Eoneureclipsis alekto	13	6	8			N/A			N/A	N/A	N/A		9	13	1
Rhyacophilidae	*Rhyacophila inaequalis*				1		N/A			N/A	N/A	N/A			2	
	Rhyacophila suthepensis						N/A			N/A	N/A	N/A				
	Rhyacophila kyimdongpa						N/A			N/A	N/A	N/A				
	Rhyacophila lyssa n.sp.						N/A			N/A	N/A	N/A				2
	Rhyacophila scissoides						N/A			N/A	N/A	N/A				
	Rhyacophila moneta n.sp.						N/A			N/A	N/A	N/A				
	Rhyacophila peterosum				1		N/A			N/A	N/A	N/A				
	Rhyacophila gyamo						N/A			N/A	N/A	N/A				
Sericostomatidae	*Gumaga orientanis*						N/A			N/A	N/A	N/A				

Note: N/A, not available

Table 10 List of number of adult Trichoptera species collected in Malaise trap at Man Dang Noi Stream from May 2002-July 2003

Family	Species	May 02	Jun 02	Jul 02	Aug 02	Sep 02	Oct 02	Nov 02	Dec 02	Jan 03	Feb 03	Mar 03	Apr 03	May 03	Jun 03	Jul 03
Brachycentridae	*Micrasema turbo*		1	3	2											
Calamoceratidae	*Anisocentropus janus*	2												1		
	Ganonema extensum															
Ecnomidae	*Ecnomus hyakinthos n.sp.*	34	108	74	15	12			2				23	51	62	22
Goeridae	*Goera antigone*															
Hyalopsychidae	*Phylocentropus narumonae*	34	19	2	20	3		11	1			14	46	43	78	46
Hydrobiosidae	*Apsilochorema malickyi*		2	1		1									1	2
Hydropsychidae	*Cheumatopsyche schwendingeri*															
	Cheumatopsyche jiriana															
	Cheumatopsyche peirithoos n.sp.															
	Cheumatopsyche danae															
	Diplectrona aurovittata															
	Diplectrona eurydike						1							1		
	Diplectrona joannisi															
	Hydropsyche battos															
	Hydromanicus truncatus															
	Hydatomanicus klanklini															
	Hydatomanicus scotosius															
Lepidostomatidae	*Dinarthrum martius*															
	Dinarthrum februarius															
	Dinathrum kyllaros n.sp.															
	Dinarthrum labdakos n.sp.															
	Lepidostoma latona n.sp.	1			1				1	1			1			

Table 10 (continued)

Family	Species	May 02	Jun 02	Jul 02	Aug 02	Sep 02	Oct 02	Nov 02	Dec 02	Jan 03	Feb 03	Mar 03	Apr 03	May 03	Jun 03	Jul 03
Lepidostomatidae	*Lepidostoma ianus*															
Limnephilidae	*Moropsyche inachos n.sp.*		7	3		2		2				1		1	3	
Leptoceridae	*Adicella censicaca*						1									
	Adicella evadne															
	Adicella iuturna															
	Adicella longicerca															
	Adicella koronis															
	Leptocerus inventas n.sp.															
	Oecetis tripunctata															
Molannidae	*Molanna oglama*	2		2		1	1	8								
Odontoceridae	*Inthanopsyche trimerisuri*															
Philopotamidae	*Chimarra shiva*															
	Chimarra spinifera															
	Chimarra prisna															
	Chimarra ramakein															
	Chimarra devva															
	Chimarra khamuorum															
	Doloclanes gressiti			2		1			1			1		1		
	Doloclanes abas			1		1	35							1		
	Dolophilodes bicolor	1					5	1			1	1			1	
	Kisaura sura		1													
	Kisaura longispina															
	Wormaldia relicta	1	44	56	48	26		45	2	2		1			4	52

Table 10 (continued)

Family	Species	May 02	Jun 02	Jul 02	Aug 02	Sep 02	Oct 02	Nov 02	Dec 02	Jan 03	Feb 03	Mar 03	Apr 03	May 03	Jun 03	Jul 03
Phryganeidae	*Eusabilissa maclachlani*							1				9	1			1
	Phryganopsyche latipenis ssp. elongatus		3			1	2	2				3			2	1
Polycentropodidae	*Nyctiophylax mentor n.sp.*			1			1							1		
	Plectrocnemia eccingoma	2	25	3	2	1	6	9	2		1	2	2	2	3	16
	Plectrocnemia luna n.sp.															
	Polyplectropus hyllos n.sp.	1	7				7	8	1		1	3	1	4	10	10
	Polyplectropus ipleicles n.sp.															
	Pseudoneureclipsis lykurgos n.sp															
Psychomyiidae	*Lype atnia*	12	25	24	22	23	42					6	20	23	10	4
	Eoneureclipsis alekto	2	15	9	2	4								3	8	8
Rhyacophilidae	*Rhyacophila inaequalis*				1											
	Rhyacophila suthepensis															
	Rhyacophila kyimdongpa						1									
	Rhyacophila lyssa n.sp.			5	13	2							4	1	1	
	Rhyacophila scissoides															
	Rhyacophila moneta n.sp.		1			1			1							
	Rhyacophila peterosum															
	Rhyacophila gyamo															
Sericostomatidae	*Gumaga orientanis*															

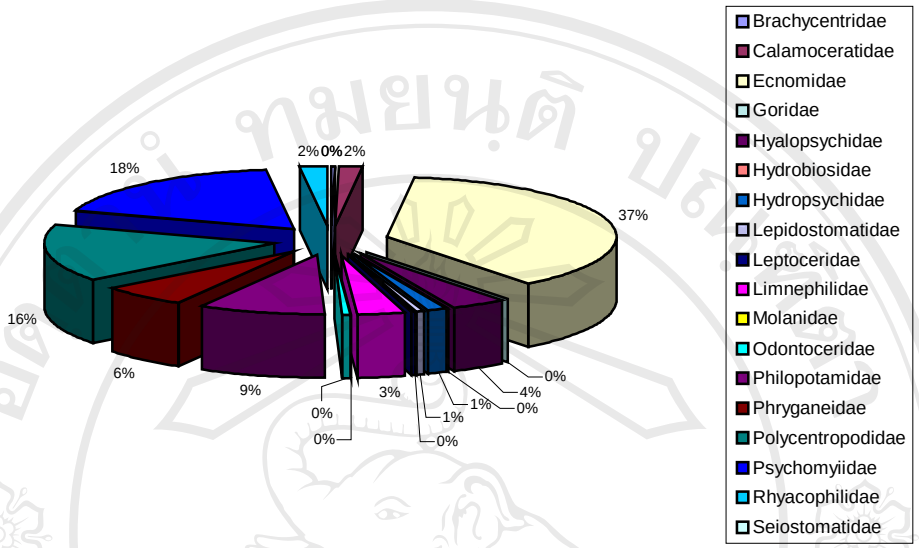

Figure 17 Adult Trichoptera collected by black light trap at Man Dang Noi Stream

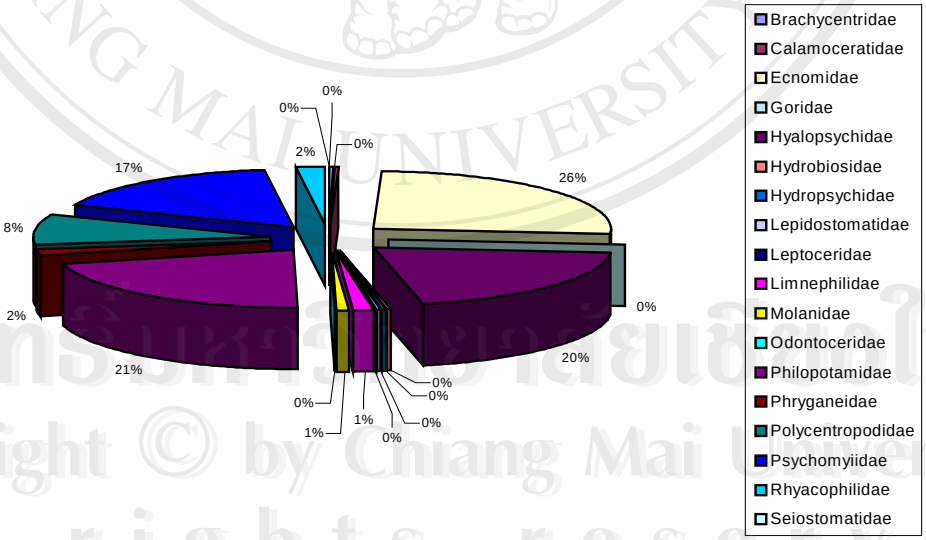

Figure 18 Adult Trichoptera found in Man Dang Noi Stream collected by Malaise trap

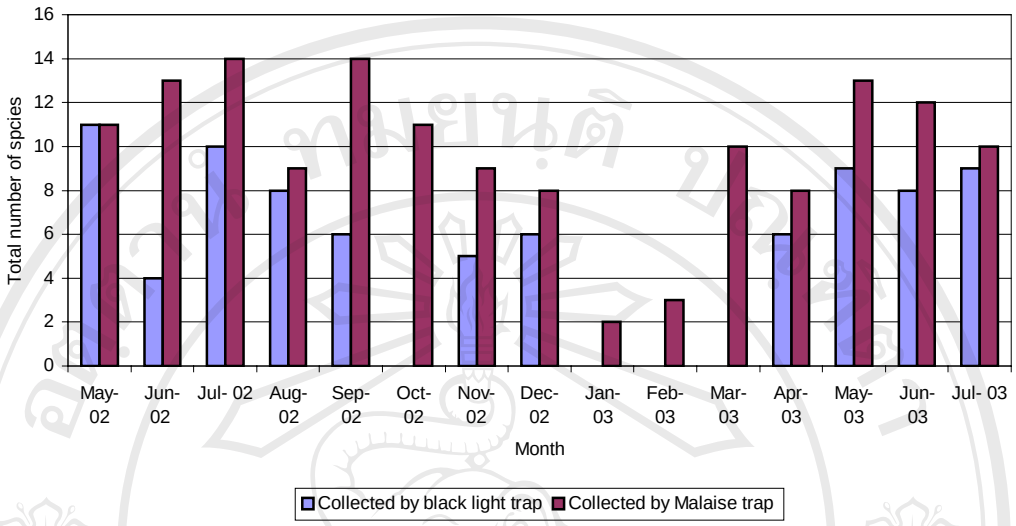

Figure 19 The comparison of adult Trichoptera collected by black light trap and Malaise trap from May 2002-July 2003

New species of adult Trichoptera reported

According to the results of taxonomy study, 13 species of the total 64 species recorded (20.3 %) were new to science, with three unknown species. New species have been included in the publication series no. 36-38 of Thai caddisfly studies (Malicky *et al*, 2004; 2005a, b). For the unknown species, they are verified by Prof. Dr. Hans Malicky. In the event they are proved to be new species, they will be described following article 8.2 of the International Code of Zoological Nomenclature (1999) for the purpose of zoological nomenclature. A list of thirteen new species is shown in Table 11, including their collecting details and publications. Terminalia of adult caddisfly that are expected to be new species are shown in Figure 20-22.

Table 11 List of thirteen new species with details of sites, collection date and publications

Species Name	Site and collection date	***
Rhyacophila lyssa Malicky and Changthong, 2004	MDS, 17 January, 2003	36
Rhyacophila moneta Malicky and Changthong, 2004	KMS Stream, 20-21 July, 2002	36
Nyctiophylax mentor Malicky and Changthong, 2004	MDS, 27 September-21 October, 2002	36
Polyplectropus iphicles Malicky and Changthong, 2004	WWW, 20-21 October 2003	36
Ecnomus hyakinthos Malicky and Changthong, 2004	WWW, 20-21 October 2003	36
Lepidostoma latona Malicky and Changthong, 2004	MDS, 14 December 2002-17 January 2003	36
Leptocerus iuventas Malicky and Changthong, 2004	WWW, 20-21 July 2002	36
Plectrocnemia luna Malicky and Changthong, 2005	MDS, 4-5 June 2002	37
Pseudoneureclipsis lykurgor Malicky and Changthong, 2005	RPW, 4-5 May 2003	37
Cheumatopsyche peirithoos Malicky and Changthong, 2005	WWW, 22-23 August 2002	37
Dinarthrum kyllaros Malicky and Changthong, 2005	RPW, 22-23 August 2002	37
Dinarthrum labdakos Malicky and Changthong, 2005	MDS, 4-5 June 2002	37
Oecetis orthos Malicky and Changthong, 2005	MDS, 27 March-24 April 2003	38

Note: ***, publication

36, publication series number 36 which published by Malicky *et al.*, 2004

37, publication series number 37 which published by Malicky *et al.*, 2005

38, publication series number 38 which published by Malicky, 2005

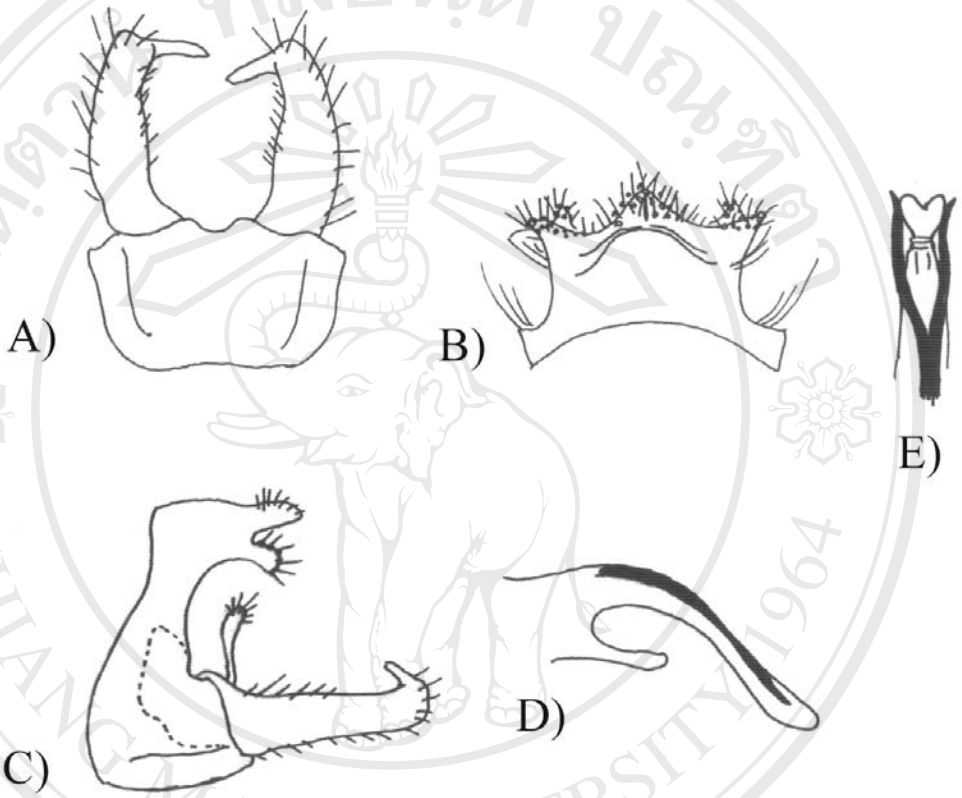

Figure 20 Terminalia of *Lepidostoma sp*. A) genitalia, ventral, B) genitalia, Dorsal, C) genitalia, lateral, D)adeagus, lateral, E) adeagus, dorsal

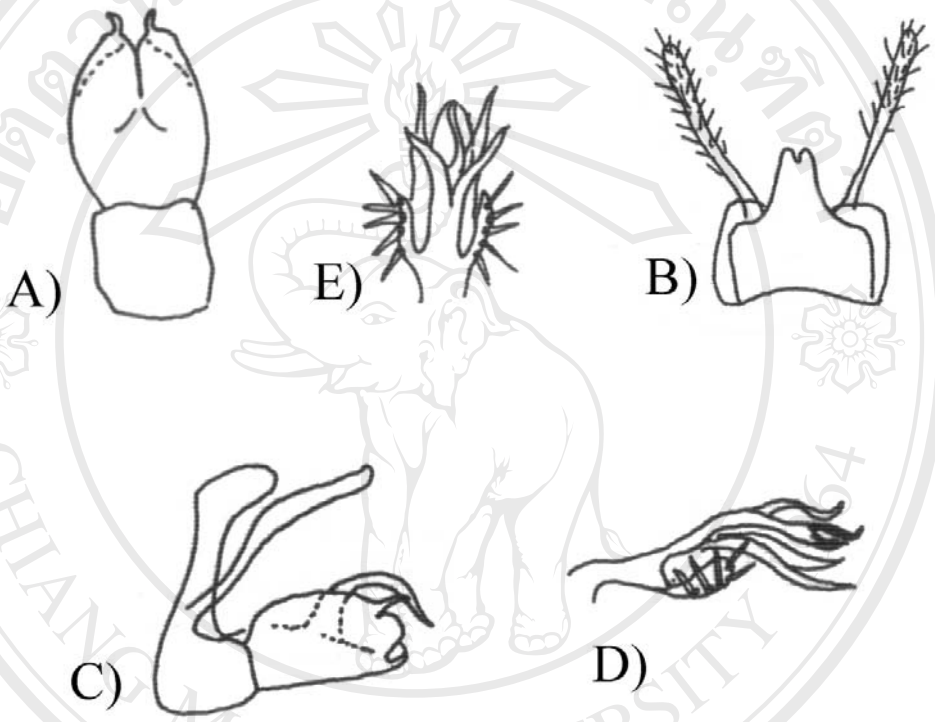

Figure 21 Terminalia of *Tinodes sp*. A) genitalia, ventral, B) genitalia, Dorsal, C) genitalia, lateral, D)adeagus, lateral, E) adeagus, dorsal

A) **B)** **C)**

Figure 22 Terminalia of *Polyplectropus sp.* A) genitalia, ventral, B) genitalia, Dorsal, C) genitalia, lateral

4.2 Physical and chemical parameters

1 Air and water temperature

Mean air temperature at the Romglao-Paradorn Waterfall, Waterwheel Waterfall, Kha Mun Noi Stream and Man Dang Noi Stream, were 19.2, 20.5, 20.2 and 18.1 ^{0}C, respectively (Figure 23 and Appendix A). The average air temperature of all sites did not show a significant difference ($p<0.05$). However, the trend of temperature was clearly observed at Man Dang Noi Stream, where the air temperature was lower than the other sites, because this site had greater forest canopy cover than other sites.

Mean water temperature at the Romglao-Paradorn Waterfall was 17.3 ^{0}C, Waterwheel Waterfall was 18.1 ^{0}C, Kha Mun Noi Stream was 18.4 ^{0}C and Man Dang Noi Stream was 16.5 ^{0}C (Figure 24). Water temperature was not significantly different ($p<0.05$). The lowest average water temperature was 16.5 ^{0}C in the Man Dang Noi Stream and was similar to the air temperature levels, that varied between seasons.

This is because of a high density vegetation canopy which caused the temperature to be lower than other groups, Sangpradub *et al.*, (1997). High mountains have a relationship with temperature change and are affected by the general atmospheric pressure, creating areas of high and low pressure. (Kroemer *et al*., 1980).

Table 12 Average values of water quality variables in four study sites (Abbreviation: RGW, Romgla-Paradorn Waterfall; WWW, Waterwheel Waterfall; KMS, Kha Mun Noi Stream; MDS, Man Dang Noi Waterfall; Ave, Average values; SD, Standard Deviation; Min, Minimum value; Max, Maximum value)

Water Parameters	**Study site**															
	RGW				**WWW**				**KMS**				**MDS**			
	Ave	**SD**	**Min**	**Max**	**Ave**	**SD**	**Min**	**Max**	**Ave**	**SD**	**Min**	**Max**	**Ave**	**SD**	**Min**	**Max**
Air temperature (^{0}C)	19.2	3.75	9	26	20.47	2.69	15	26	20.22	3.15	13	28	18.13	2.19	14	21
Water temperature(^{0}C)	17.30	2.99	9	20	18.13	2.34	13	22	18.36	2.23	14	22	16.52	1.83	13	18.50
pH	7.7	0.7	6.5	9.2	7.6	0.5	6.6	8.3	7.5	0.5	6.4	8.6	5.8	1.2	3.8	7.8
Conductivity(*u*S/cm)	19.83	8.22	0.83	31.8	24.21	7.59	10.33	36.90	26.75	14.71	9.74	69.90	19.65	14.71	10.59	68.80
TDS (mg/l)	10.36	4.52	0.40	16.90	12.21	4.33	5.10	21.20	14.71	9.36	4.86	45.00	10.52	7.38	5.31	34.20
Dissolved oxygen (mg/l)	8.62	0.71	7.80	9.80	8.74	0.61	7.50	9.80	8.46	0.92	7.10	10.00	7.40	1.27	5.20	9.20
Alkalinity (mg/l)	6.53	1.93	2.00	9.00	8.74	5.59	2.00	19.5	8.41	3.14	2.00	11.5	2.26	1.22	1.0	6.0
Nitrate (mg/l)	1.17	0.22	0.60	1.40	1.12	0.22	0.70	1.40	1.10	0.24	0.50	1.40	0.95	0.31	0.40	1.40
Phosphate (mg/l)	0.02	0.01	0.01	0.09	0.07	0.05	0.01	0.17	0.04	0.04	0.01	0.18	0.04	0.04	0.01	0.16
Ammonia (mg/l)	0.09	0.05	0.01	0.17	0.09	0.05	0.01	0.17	0.14	0.11	0.02	0.41	0.31	0.18	0.03	0.61
Sulfate (mg/l)	0.26	0.45	0	1.00	0.40	0.82	0	3.00	0.20	0.77	0	3.00	0	0	0	0
Turbidity (FTU)	11.26	5.37	7.00	29.00	12.73	7.06	2.00	27.00	11.80	6.46	5.00	26.00	15.93	6.88	10.00	34.00

Note: Water discharge was not analyzed by Statistical Package for Social Science Program (SPSS/PC).

Table 13 One-way ANOVA test based on water quality parameters

Parameters	Water	D.F.	Sum of square	Mean square	F	sig
Air Temperature	Between Group	3	51.15	17.05	1.89	0.14
	Within Group	56	504.93	9.01		
	Total	59	556.08			
Water Temperature	Between Group	3	31.74	10.58	1.85	0.14
	Within Group	56	319.73	5.7		
	Total	59	351.48			
pH	Between Group	3	37.8	12.6	21.2	0
	Within Group	56	33.27	0.59		
	Total	59	71.08			
Conductivity	Between Group	3	542.69	180.89	1.29	0.28
	Within Group	56	7812.04	139.5		
	Total	59	8354.73			
TDS	Between Group	3	183.99	61.33	1.35	0.26
	Within Group	56	2538.58	45.33		
	Total	59	27722.58			
DO	Between Group	3	17	5.66	6.75	0
	Within Group	56	46.99	0.83		
	Total	59	63.99			
Alkalinity	Between Group	3	399	133	11.44	0
	Within Group	56	650.64	11.62		
	Total	59	1049.64			
Nitrate	Between Group	3	0.39	0.1329	2.05	0.11
	Within Group	56	3.63	0.0648		
	Total	59	4.02			
Phosphate	Between Group	3	0.01	0	3.15	0.03
	Within Group	56	0.09	0		
	Total	59	0.1			
Ammonia	Between Group	3	0.48	0.16	12.19	0
	Within Group	56	0.74	0.01		
	Total	59	1.22			
Sulfate	Between Group	3	1.25	0.41	1.11	0.35
	Within Group	56	20.93	0.37		
	Total	59	22.18			
Turbidity	Between Group	3	196.53	65.51	1.56	0.2
	Within Group	56	2351.2	41.98		
	Total	59	2547.73			

Note: Water discharge was not analyzed by Statistical Package for Social Science Program (SPSS/PC).

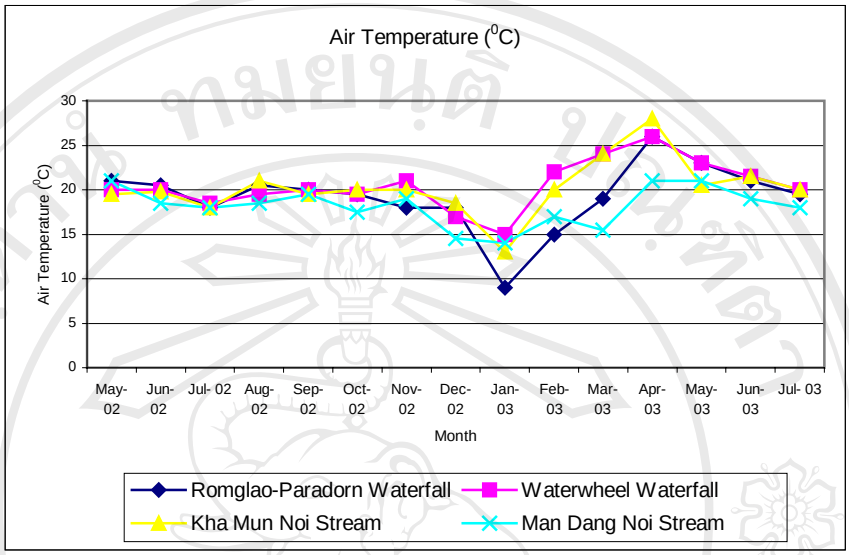

Figure 23 Air Temperatures at all four sites from May 2002-July 2003

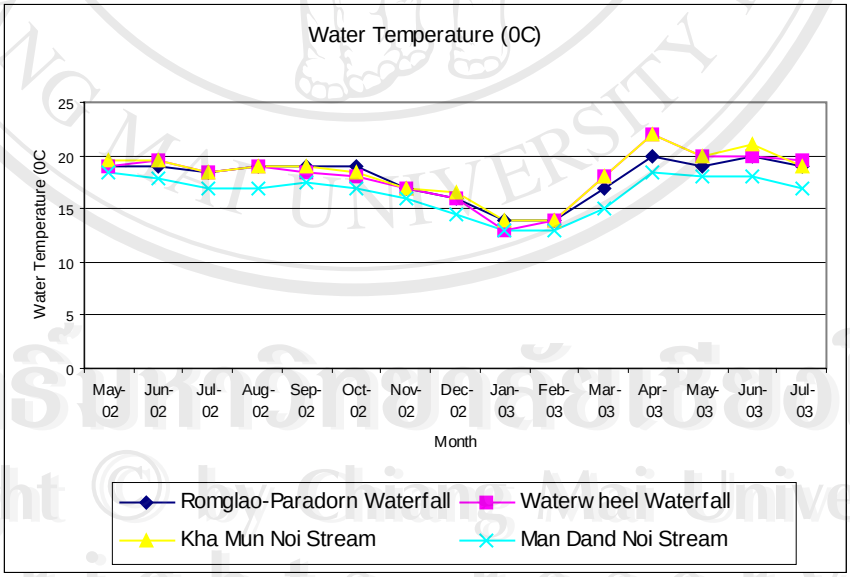

Figure 24 Water temperatures at all four sites from May 2002-July 2003

2 pH

The average pH at Romglao-Paradorn Waterfall was 7.7, WaterWheel Waterfall was 7.6, Kha Mun Noi Stream was 7.5 and Man Dang Noi Stream was 5.8. (Figure 25 and Appendix A). The average pH of all sites were significantly different ($p<0.05$). Man Dang Noi Stream had the lowest pH because the humus in soil around this site was continually being digested by bacteria. Therefore within a few days the bacteria began to colonize the leaves leading to a process known as "microbial conditioning" (Benfield, 1996) and was absorbed in the water. So it caused the pH in this site to be lower than the other sites.

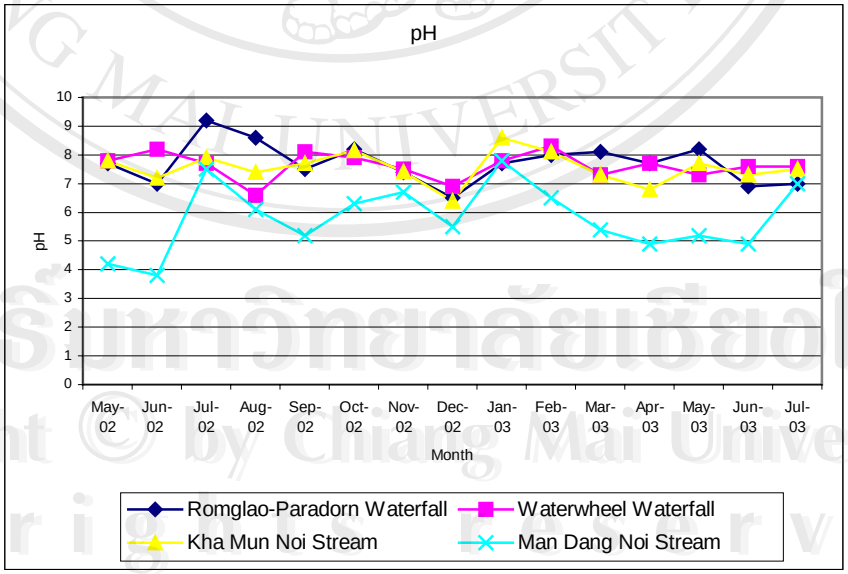

Figure 25 pH value at all four sites from May 2002-July 2003

3 Conductivity and Total Dissolved Solids (TDS)

Conductivity and TDS levels did not show significant differences ($p<0.05$), while the level in December 2002 was higher than in the other months (Figure 26 and Figure 27). The average conductivity at Romglao-Paradorn Waterfall, Waterwheel Waterfall, Kha Mun Noi Stream and Man Dang Noi Stream were 19.83 *u*S/cm, 24.21 *u*S/cm, 26.75 *u*S/cm, 19.65 *u*S/cm, respectively (see in appendix A). The average conductivity positively correlated to TDS. The average TDS at Romglao-Paradorn Waterfall was 10.36 *u*S/cm, Waterwheel Waterfall was 12.22 *u*S/cm, Kha Mun Noi Stream was 14.71 *u*S/cm and Man Dang Noi Stream was 10.52 *u*S/cm. Conductivity readings were variable with the amount of concentrated ion in the water (Kochasenee, 1993)

4 Dissolved Oxygen (DO)

Dissolved oxygen values depended on the physical, chemical and biological factors at each site. The average dissolved oxygen of all sites were significantly different ($p<0.05$), Romglao-Paradorn Waterfall was 8.6, Waterwheel Waterfall was 8.7, Kha Mun Noi Stream was 8.5 and Man Dang Noi Stream was 7.4. (Figure 28 and Appendix A). In Man Dang Noi Stream had the lowest average DO due to low flow and low water turbulence (due especially to an absence of waterfall) than other sites.

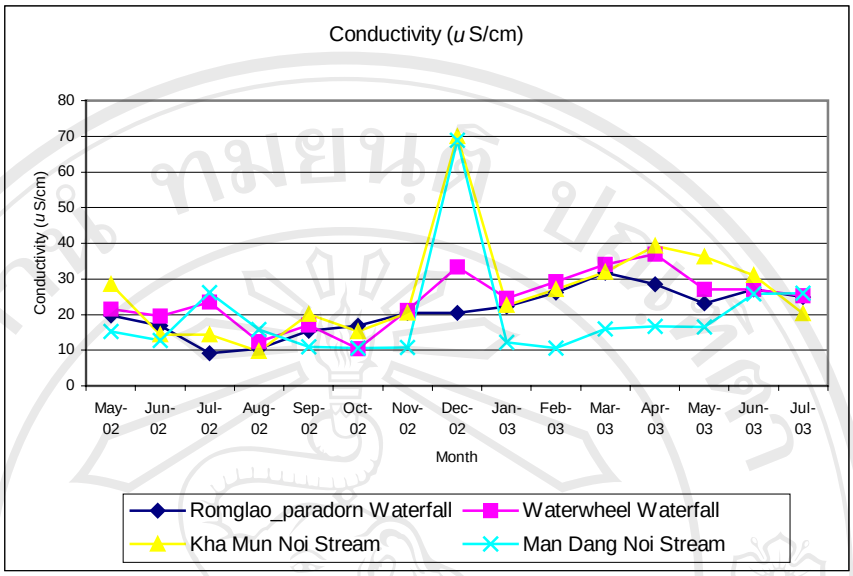

Figure 26 Conductivity values at all four sites from May 2002-July 2003

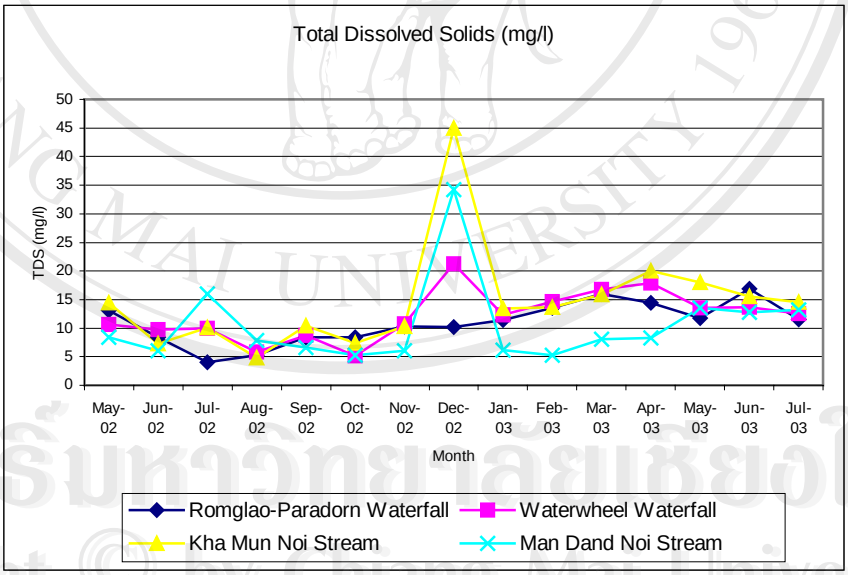

Figure 27 Total Dissolved Solids values at four sites from May 2002-July 2003

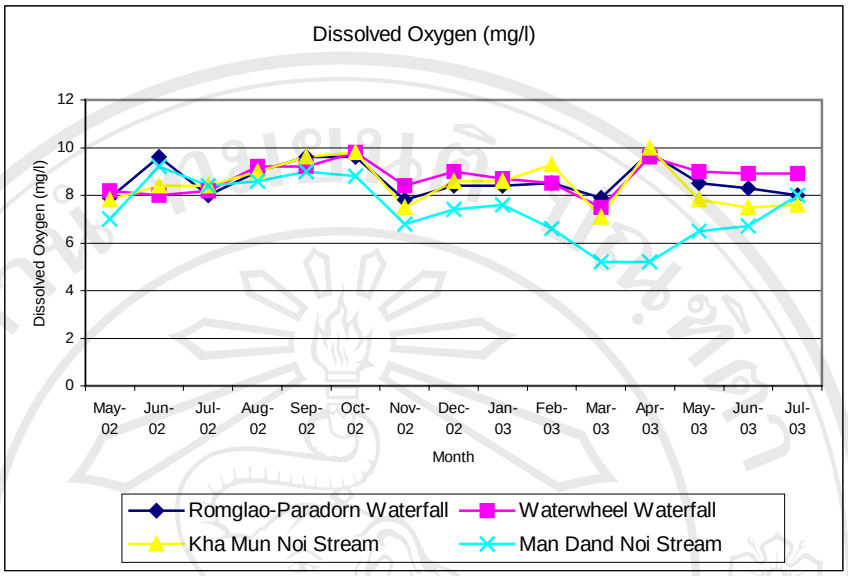

Figure 28 Dissolved Oxygen values at all four sites from May 2002-July 2003

5 Alkalinity

The average alkalinity value at Romglao-Paradorn Waterfall was 6.53 mg/l, Waterwheel Waterfall was 8.74 mg/l, Kha Mun Noi Stream was 8.41 mg/l and Man Dang Noi Stream was 2.27 mg/l. (Figure 29 and Appendix A). The average alkalinity of all sites were significantly different ($p<0.05$) Waterwheel Waterfall in February 2003-April 2003 had higher levels than the other sites.

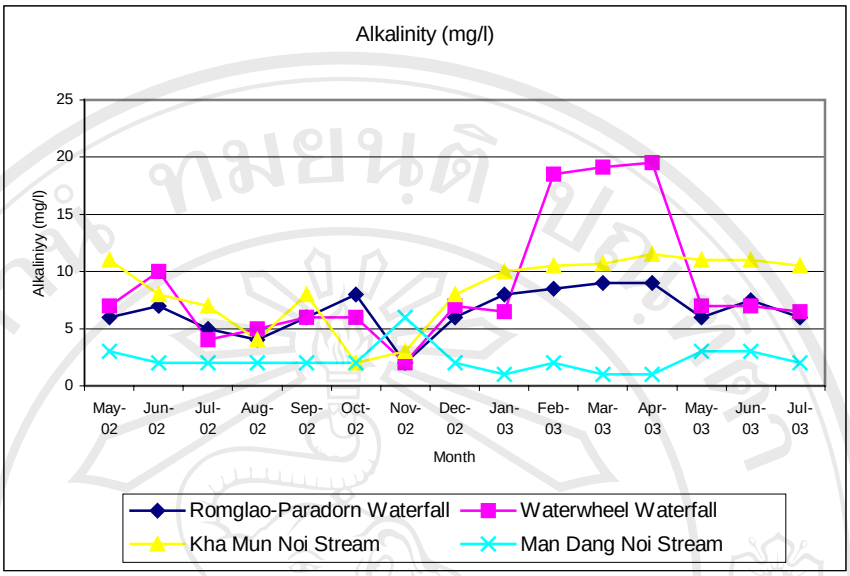

Figure 29 Alkalinity value at all four sites from May 2002-July 2003

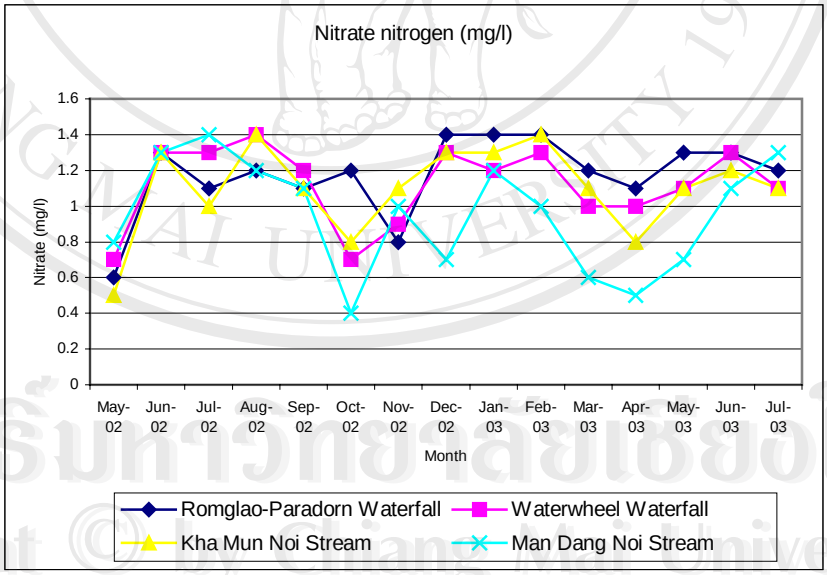

Figure 30 Nitrate nitrogen concentration at all four sites from May 2002-July 2003

6. Nitrate

Nitrate nitrogen levels did not show to be significantly different ($p<0.05$), the average nitrate at Romglao-Paradorn Waterfall was 1.17, Waterwheel Waterfall was 1.12 mg/l, Kha Mun Noi Stream was 1.10 mg/l and Man Dang Noi Stream was 0.95 mg/l (Figure 30 and Appendix A). As for Man Dang Noi, the value was lower than the other sites.

7. Phosphate

Phosphate levels in each site were significantly different ($p<0.05$), In the rainy season during June to October 2002 there were high phosphate level in every site, but in February-July 2003 Waterwheel Waterfall and Kha Mun Noi Stream had higher phosphate levels than the other sites. The average phosphate value was 0.026 mg/l in Romglao-Paradorn Waterfall, 0.071 mg/l in Waterwheel Waterfall, 0.047 in Kha Mun Noi Stream, and 0.043 mg/l in Man Dang Noi Stream (Figure 31 and Appendix A).

Phosphate value did not have a distinct pattern, nor change with season and water volume because each factor was different in each month.

8. Ammonium

Ammonia nitrogen levels were significantly different ($p<0.05$). The average ammonia nitrogen at the Romglao-Paradorn Waterfall was 0.092 mg/l, Waterwheel Waterfall was 0.092 mg/l, Kha Mun Noi Stream was 0.140 mg/l, and Man Dang Noi Stream was 0.311 mg/l (Figure 32 and Appendix A). Man Dang Noi Stream had the highest ammonia nitrogen level; possibly because of nitrogen from the soil surface of

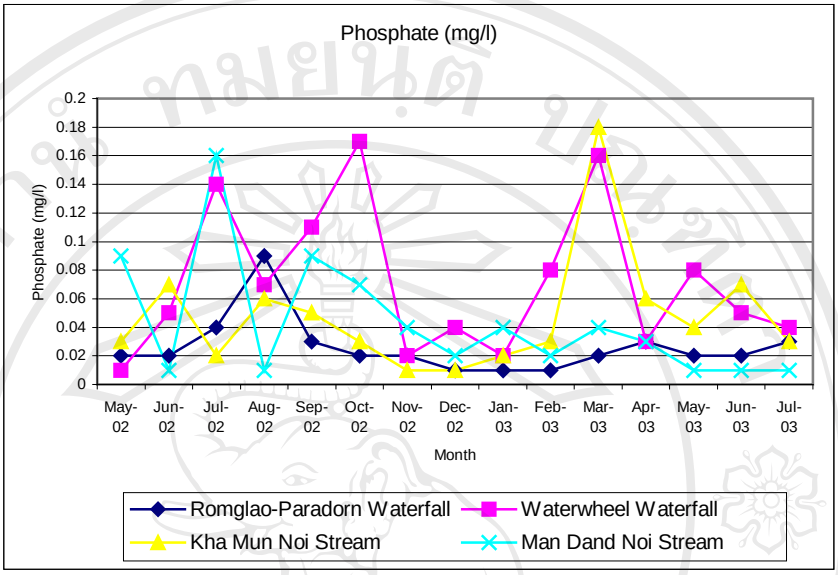

Figure 31 Phosphate concentration at all four sites from May 2002-July 2003

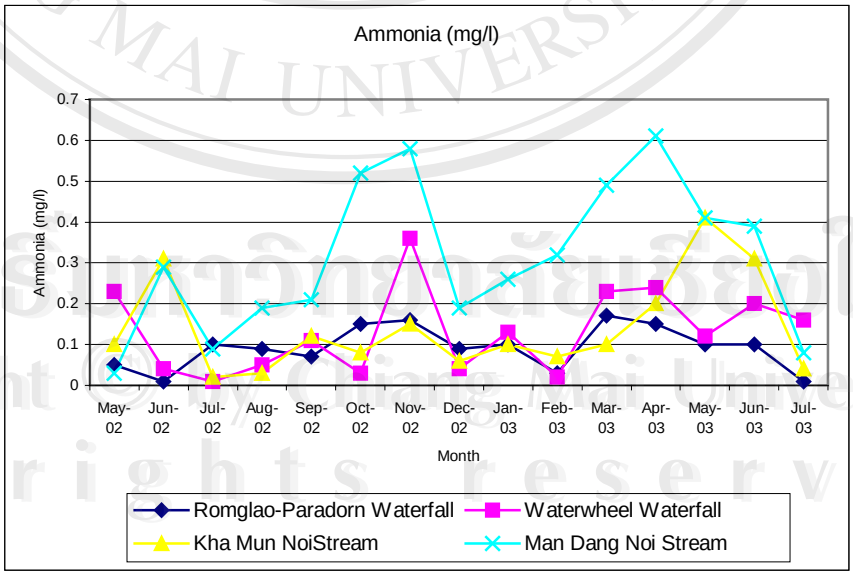

Figure 32 Ammonia concentration at all four sites from May 2002-July 2003

Leaf-litter decomposition which runs off into the water. Ammonia nitrogen contain animal feces product, moreover bacterial oxidation results in material with high organic content from vegetation, debris and the forest canopy (Goldman & Horne, 1983)

9. Sulfate

The sulfate levels did not show significant differences ($p<0.05$). The average sulfate levels at Romglao-Paradorn Waterfall was 0.266 mg/l, Waterwheel Waterfall was 0.400 mg/l, Kha Mun Noi Stream was 0.200 and Man Dang Noi Stream was 0.000 mg/l, respectively. (Figure 33 and Appendix A).

10. Turbidity

The turbidity depends on suspended solids and settable solids present in the water. The average turbidity level at Romglao-Paradorn Waterfall was 11.27 FTU, Waterwheel Waterfall was 12.73 FTU, Kha Mun Noi Stream was 11.80 FTU, and Man Dang Noi Stream was 15.93 FTU (Figure 34 and Appendix A).

Turbidity levels were not significantly different ($p<0.05$) at all sites. The average turbidity levels of all sites had the highest two readings in June 2002 and June 2003 which was during the rainy season. But in Man Dang Noi Stream turbidity was higher in December 2002- May 2003, when there was had lower erosion. In general, turbidity from streams was usually high after rainfall and could be settled in the next 2-3 days. Turbidity in Man Dang Noi Stream was high because of organic and inorganic runoff from plant and debris on the stream bank (Kochasenee, 1993).

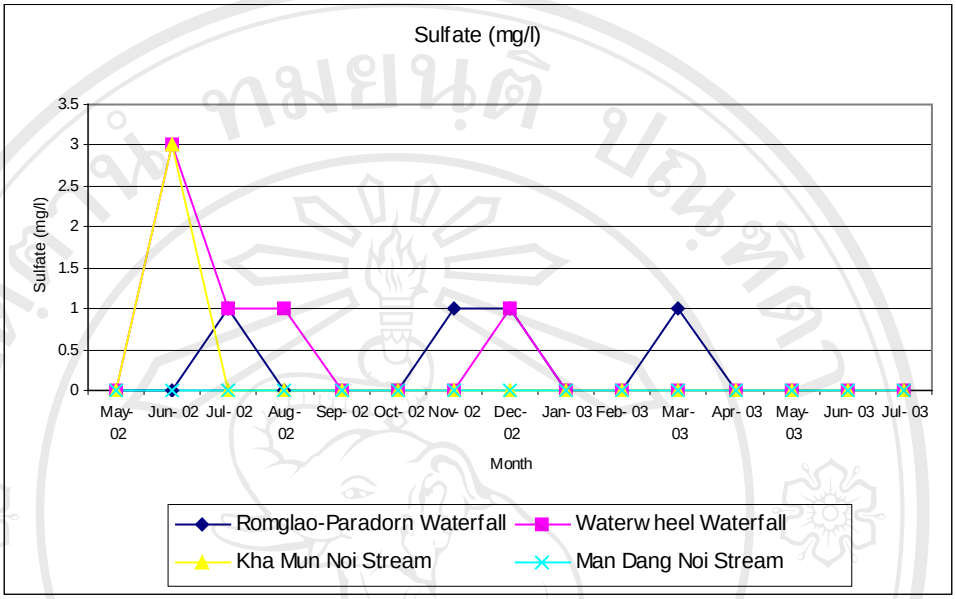

Figure 33 Sulfate (mg/l) concentration at all four sites from May 2002-July 2003

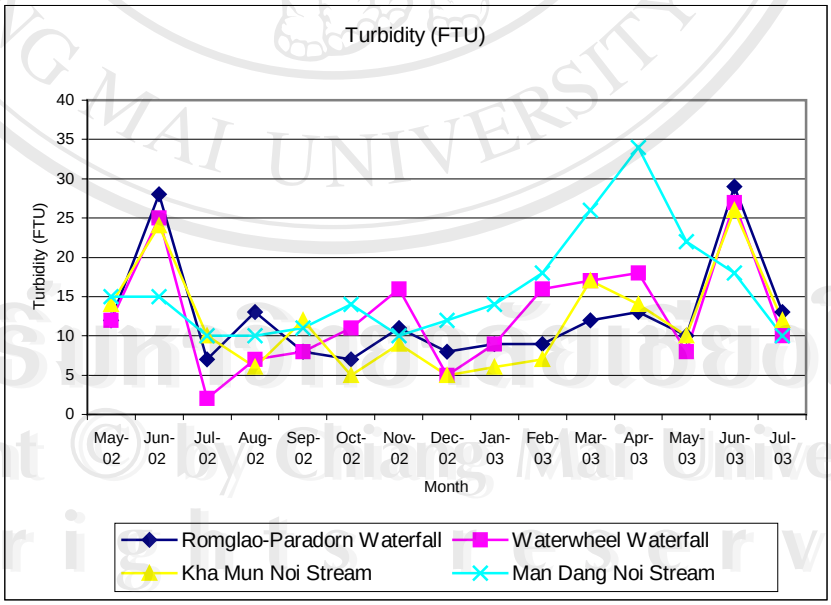

Figure 34 Turbidity (FTU) value at all four sites from May 2002-July 2003

11. Discharge

Water discharge levels were measured in three sites: Waterwheel Waterfall, Kha Mun Noi Stream, and Man Dang Noi Stream. Romglao-Paradorn Waterfall discharge levels could not be measured easily because the bedrock surface there was significantly different from water discharge levels among all sites. The average discharge in Waterwheel Waterfall, Kha Mun Noi Stream and Man Dang Noi Stream were 2.514 m^3/S, 1.014 m^3/S, 0.648 m^3/S, respectively.

Annual patterns of stream flow determine many of the physical and biological properties of lotic systems. It is dependent on rainfall, catchment geology, area, bed slope, and dam control by vegetation and most importantly human beings. Water movement in streams are spatially non uniform (Goldman and Horne, 1983).

4.3 Trichoptera diversity and relationship to water quality

The 13 water quality parameters were used to study samples from four sites at Phu Hin Rongkla National Park. The five parameters of pH, DO (Dissolved Oxygen), alkalinity, phosphate and ammonia-nitrogen produced significantly different ($p<0.05$) results.

The averages of the nine parameters in Man Dang Noi Stream were lower than the other three sites; air temperature, water temperature, pH, DO, conductivity, TDS, nitrate-nitrogen, alkalinity, and sulfate. This site also had the highest species richness and number of new species than the other sites. For example, *Inthanopsyche trimerisusi* and *Eusabilissa maclachlani* were only found at Man Dang Noi Stream, and were also found in Doi Inthanon at Siriphum Waterfall (Thamsenanupap, 2005). Man Dang Noi Stream had different environmental factors. The values of air temperature ($\bar{X}$ =18.3 ^{0}C) and water temperature ($\bar{X}$ = 16.52 ^{0}C) were similar to Siriphum Waterfall, where the average air and water temperatures were 20.48 ^{0}C and 17.73 ^{0}C, respectively. These two sites are the high mountain sites with the altitude of 1,380 m. at Siriphum and 1,600 m. at Man Dang Noi Stream**.** The pH was acid at Man Dang Noi Stream ($\bar{X}$ = 5.8) and was lower than Siriphum ($\bar{X}$ = 7.91). Air and water temperature, and pH were the parameters that were expected to affect the occurrence of these two species at both two sites.

Other factors that also were expected to effect the diversity of Trichoptera were DO, conductivity, TDS, alkalinity and nitrate-nitrogen. Man Dang Noi Stream had lower mean value of these parameters but had higher diversity of Trichoptera than other sites. Because this stream flow was quite slow, it permitted organic material

accumulation. These materials decay and become the primary food resource for invertebrate inhabiting the streambed.

Turbidity and ammonia were at higher levels than other sites. The high level of ammonia came from the bacterial decomposition process with high organic resources in Man Dang Noi Stream (Kochasenee, 1993). The high turbidity was a result of leaves breaking down into the stream and the low discharge (Kochasenee, 1993). Phosphate could not be analyzed for related data with its high variation in each month.

The high organism level in the stream was mainly food sources for aquatic insects and other living things in the stream (Benfield, 1996). Insects used the streams to inhabit, for mating and larvae development. Man Dang Noi had a higher range of diversity of Trichoptera than other sites.

The results of Trichoptera diversity and spatial variability indicated that a similarity at Romglao-Paradorn Waterfall (RPW), Waterwheel Waterfall (WWW) and Kha Mun Noi Stream (KMS) because all three sites had the similarity of habitat heterogenity and a similarity in physical parameters such as bedrock, small pool, debris pool and water discharge. Water quality study strongly showed the similar trend according to the sites grouping. Man Dang Noi Stream (MDS) was different than those three sites.

Thapanya (2004) reported 345 species of Trichoptera from Doi Suthep-Pui National Park and Doi Inthanon National Parks (199 species from Doi Suthep-Pui and 249 from Doi Inthanon). From this study different species were found. It may be because of the difference of the geological artributes. Phu Hin Rongkla National Park is comprised of sedimentary and metamorphic rock (Forest land resources Division, 2002)