

Diversity of butterflies in a tropical rain forest of Van Ban Nature Reserve, Lao Cai Province, Vietnam (Lepidoptera: Rhopalocera)

Разнообразие дневных бабочек в дождевом тропическом лесу заповедника Ван-Бан (провинция Лао-Кай, Вьетнам) (Lepidoptera: Rhopalocera)

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КЛЮЧЕВЫЕ СЛОВА. Бабочка, обилие, вид, разнообразие, высота, лес, берег реки, луг.

ABSTRACT. Diversity of butterfly communities of a tropical rain forest of Van Ban Nature Reserve in North Vietnam was studied in different habitat types (natural forests, stream sides in the forest, and grassy areas) at low (400–500 m a.s.l.) and high altitudes (800–900 m a.s.l.) in March and April 2005. A total of 1,115 individuals from 170 butterfly species were recorded. The stream sides have the greatest, while the grassy areas the lowest, species and individual numbers. Low elevations yield more species and individuals than higher ones. Similarity of the species composition of butterfly communities is greater between similar habitats (natural forests at low and high altitudes, stream sides at low and high altitudes, and grassy areas at low and high altitudes). The habitat appears to be the main factor to affect the similarity of species composition between areas. Stream sides in forests play an important role in conserving the high species richness and the abundance of butterfly communities.

РЕЗЮМЕ. Разнообразие сообществ дневных бабочек дождевого тропического леса в заповеднике Ван-Бан в Северном Вьетнаме изучали в разных типах биотопов (естественный лес, берег реки и луг) низко (400–500 м н.у.м.) и высоко в горах (800–900 м н.у.м.) в марте–апреле 2005 г. Всего собрано 1115 экземпляров бабочек 170 видов. Наибольшее разнообразие видов и обилие отмечены по берегам рек, а самые низкие — на лугах. Для низкогорий отмечен максимум как видового, так и численного обилия. Сходство видового состава сообществ бабочек выше в однотипных биотопах (естественные леса, берега рек, а также луга в низкогорье и высокогорье, соответственно). Биотоп оказывается главным фактором, влияющим на сходство видового состава между территориями. Берега рек в лесу играют важную роль в сохранении большого видового богатства и обилия сообществ бабочек.

Introduction

Tropical forests are long known to contain great biodiversity levels, with insects playing important roles in forest ecosystems. Butterflies as well as other insects are distributed differently in different habitat types. Their diversity mainly depends on

vegetation. In general, insect diversity is the highest in habitats with the highest plant diversity, being the lowest in grassy and open areas [DeVries, 1992]. Different insect groups show different diversity trends. Some groups such as beetles and moths have high diversity levels in natural forests, but lower ones in secondary forests [Morse et al., 1988; Barlow & Woiwod, 1989]. In contrast, butterflies tend to show low diversity levels in natural forests, but higher ones in disturbed forests [Brown, 1991; Blair & Launer, 1997; Schulze et al., 2004; Fermon et al., 2005; Bobo et al., 2006]. Further studies yield that the numbers of butterfly species and individuals are higher in secondary and regenerating forests, again lower in natural forests [Spitzer et al., 1993; Vu & Yuan, 2003], being the highest at forest edges and the lowest in agricultural lands [Vu, 2009].

There are plenty of streams in tropical forest. Open habitats in forest support more butterfly species than the forest canopy does [Hill et al., 2001]. Stream sides with open spaces may have more butterfly species and individuals than the natural closed forest, because many butterflies visit and take water and nutrients from sand and rocks along stream sides in forests.

The diversity of butterfly communities has been studied in different habitat types in different parts of the world. However, there have been few studies on the diversity of butterfly communities along stream sides in tropical forest. These habitats may play important roles in conserving a portion of tropical biodiversity, of which insects are a major part. Yet little data are available.

Forest edges with more exposure to the open also show the greatest diversity of butterflies [Vu, 2009]. Gaps in forest sustain higher diversity levels of butterflies than closed forest areas do [Spitzer et al., 1997]. Stream sides with more open spaces could therefore be expected to support higher diversity levels of butterflies.

The present study suggests that stream sides in tropical forest may have more butterflies, both their abundance and species diversity, than natural forests and grassy areas do. Both shrub and grassy habitats are already known to maintain higher levels of butterfly diversity than both natural forest and agricultural lands [Vu, 2009]. But what is the situation concerning the diversity of butterfly communities in grassy areas alone? Our hypothesis is that grassy habitats support a lower level of butterfly diversity than the natural forest does.

Materials and methods

Research site

Research was carried out in Nam Xay commune of the Van Ban Nature Reserve, Van Ban District, Lao Cai Province, Vietnam (21°58'N, 104°02'E) from March 15 to April 14, 2005. The study area is located on a mountain, with elevations ranging from 400 to more than 2,000 m a.s.l.

Six different 500-m transects were set up in different habitat types and at two different altitudes, covering natural closed forests, stream sides in the forest, and grassy areas, one each at low altitudes of 400–500 m and at high altitudes at 800–900 m a.s.l. The habitats are as following:

Natural forests at the lower (NFI) and higher altitudes (NFh), with forest canopy reaching the heights of up to 30 m and 25 m, respectively. The vegetation cover is over 70%, consisting of natural forests with some small natural gaps, characterized by the presence of trees of various families in the climax forests. The major plant species are in the families of Lauraceae, Fagaceae, Theaceae, Magnoliaceae, Ericaceae, Myrtaceae, Rubiaceae and some others.

Stream sides at the lower (SSI) and higher altitudes (SSh), situated along a local stream 10–15 m wide. The vegetation is broad leaf evergreen plants, the canopy height up to 25 m. The main plant species are in the families Lauraceae, Fagaceae, Magnoliaceae, Theaceae, Rubiaceae, with shrubs and grasses spread along stream sides. The forest canopy along them is 30%.

Grassy areas at the lower (GRI) and higher altitudes (GRh), characterized by the presence of grasses and some small shrubs. The main species are in the families Poaceae, Melastomaceae, and some others.

Sampling methods

Butterflies were counted to assess the species richness and abundance in habitats to reveal both the presence and abundance of butterfly species in different habitat types at different altitudes. The transect count method was used to record butterflies. A number of butterflies were collected on different sites beyond the transects using butterfly hand nets for identification.

The transect work was performed between 8:00 a.m. to 4:00 p.m. on fine days. To cover each 500-m transect, it took about 40–50 minutes. The sampling times for each transect were altered from day to day to reduce the effect of different times of the day on the data recorded. Each transect was repeated in 25 counts. This method was applied in some of the previous studies on the butterflies of tropical forests in Vietnam [Spitzer et al., 1997; Vu, 2007, 2009].

Data analysis

The diversity of butterfly communities and the similarity of species composition between different habitat types were calculated using Cluster Analysis [Primer, 2001]. Butterfly diversity was measured with the use of the following indices: species number, individuals, species richness index (d), evenness index J' , and diversity index H' . The identification of butterflies follows Chou [1994], Osada et al. [1999], D'Abrera [1982–1986], Monastyrskii [2005].

Results

A total of 170 species were recorded during the study period. The species list and their abundance are presented in Table 1. There are two species listed in the Red List of Vietnam: *Troides aeacus* and *Byasa crassipes* [Ministry of Science and Technology, 2007]. The former species is also listed in CITES [New & Collins, 1991]. Most of the species yielded 1–5 individuals in all of the habitats (112 species, 66% of all species); the species represented by more than 10 individuals are 8 (16.5% of all species). The most abundant species is *Zemeros flegyas* (11.5% of all individuals), followed by *Delias belladonna* (6%).

Table 1. Species list of the butterflies and their abundance in the Van Ban Nature Reserve in March and April 2005.
Таблица 1. Видовой список бабочек и их численность в заповеднике Ван-Бан в марте–апреле 2005 г.

No.	Species	Below 700 m			Above 700 m		
		NFI	SSI	GRI	NFh	SSh	GRh
Papilionidae							
1	<i>Troides aeacus</i> (C.Felder et R.Felder, 1860)	1	1		1		
2	<i>Byasa crassipes</i> (Oberthür, 1879)	1			1		
3	<i>Atrophaneura dasarada</i> (Moore, 1857)	2			1		
4	<i>Atrophaneura varuna</i> (White, 1868)					2	
5	<i>Chilasa clytia</i> (Linnaeus, 1758)			2		2	

Table 1. Continue.
Таблица 1. Продолжение.

No.	Species	Below 700 m			Above 700 m		
		NFI	SSI	GRI	NFh	SSh	GRh
6	<i>Chilasa slateri</i> (Hewitson, 1857)	1		1			1
7	<i>Chilasa agestor</i> (Gray, 1831)	2	2		1	2	
8	<i>Chilasa epycides</i> (Hewitson, 1862)	1	1		4	3	
9	<i>Chilasa paradoxa</i> (Zinken, 1831)		1				
10	<i>Papilio helenus</i> (Linnaeus, 1758)	3	2	2	1	4	1
11	<i>Papilio nephelus</i> (Boisduval, 1836)		2				
12	<i>Papilio polytes</i> (Linnaeus, 1758)		2	2		2	1
13	<i>Papilio memnon</i> Linnaeus, 1758	2		1	1	1	1
14	<i>Papilio paris</i> Linnaeus, 1758	3	2	4		1	1
15	<i>Papilio bianor</i> (Cramer, 1777)	1	2	1		2	
16	<i>Papilio protenor</i> Cramer, 1775	2	2		1	2	1
17	<i>Papilio bootes nigricans</i> (Rothschild, 1895)		14			2	
18	<i>Meandrusa sciron</i> Leech, 1890				1		
19	<i>Meandrusa payeni</i> (Boisduval, 1836)	1			1		
20	<i>Graphium antiphates</i> (Cramer, 1775)				1		1
21	<i>Graphium doson</i> (C.Felder et R.Felder, 1864)		3				
22	<i>Graphium xenocles</i> (Doubleday, 1842)	1	2		2	2	2
23	<i>Graphium megarus</i> (Westwood, 1844)		1				
24	<i>Graphium macareus</i> (Godart, 1819)		1				
25	<i>Graphium chironides</i> (Honrath, 1884)		3				
26	<i>Graphium agamemnon</i> (Linnaeus, 1758)		1	2		1	1
27	<i>Graphium sarpedon</i> (Linnaeus, 1758)	2	2	1	1	2	1
28	<i>Graphium agetes</i> (Westwood, 1843)		6				
29	<i>Graphium cloanthus</i> (Westwood, 1841)		1				
30	<i>Graphium eurous</i> (Leech, 1893)		6			4	
31	<i>Lamprotera meges</i> (Zinken-Sommet, 1831)					1	
Pieridae							
32	<i>Delias pasithoe</i> (Linnaeus, 1767)	1	1		1		
33	<i>Delias hyparete</i> (Linnaeus, 1758)	1	1		2		
34	<i>Delias belladonna</i> (Fabricius, 1793)	8	30		2	35	
35	<i>Prioneris thestylis</i> (Doubleday, 1842)		2	2		2	1
36	<i>Artogeia napi</i> (Linnaeus, 1758)			1			
37	<i>Pieris canidia</i> (Linnaeus, 1768)		2	9			7
38	<i>Talbotia naganum</i> (Moore, 1884)		2				
39	<i>Hebomoia glaucippe</i> (Linnaeus, 1758)	1	1	1	1		1
40	<i>Appias albina</i> (Boisduval, 1836)	1		1			1
41	<i>Appias lyncida</i> (Cramer, 1777)			1			
42	<i>Appias indra</i> (Moore, 1857)	1	1				
43	<i>Appias lalage</i> (Doubleday, 1842)		1			1	
44	<i>Dercas verhuelli</i> (van de Hoeven, 1839)	1	1		2	1	
45	<i>Catopsilia pomona</i> (Fabricius, 1775)	6	2			4	3
46	<i>Eurema andersonii</i> (Moore, 1886)		1	1			1
Danaidae							
47	<i>Parantica sita</i> (Kollar, 1844)				4	5	1
48	<i>Parantica melaneus</i> (Cramer, 1775)	2	1	2	3	2	1
49	<i>Parantica aglea</i> (Stoll, 1782)	1		1			
50	<i>Ideopsis similis</i> (Linnaeus, 1758)			1			
51	<i>Euploea mulciber</i> (Cramer, 1777)	2	1	3	1	1	1

Table 1. Continue.
Таблица 1. Продолжение.

No.	Species	Below 700 m			Above 700 m		
		NFI	SSI	GRI	NFh	SSh	GRh
Satyridae							
52	<i>Melanitis leda</i> (Linnaeus, 1758)	1	1		1		
53	<i>Elymnias hypermnestra</i> (Linnaeus, 1763)			1			
54	<i>Lethe siderea</i> Marshall, 1880				2		
55	<i>Lethe dura</i> (Marshall, 1882)				2	1	
56	<i>Lethe confusa</i> Aurivillius, 1897	1	1	2		1	
57	<i>Lethe verma</i> (Kollar, 1844)	1	1		1		1
58	<i>Lethe chandica</i> (Moore, 1858)				2		
59	<i>Lethe syrcis</i> (Hewitson, 1863)	2	1		1	2	
60	<i>Lethe insana</i> (Kollar, 1844)	1	1		2		
61	<i>Lethe vyndhia</i> (C.Felder et R.Felder, 1859)	1			3	1	
62	<i>Lethe mekara</i> (Moore, 1858)				2		
63	<i>Lethe sinorix</i> (Hewitson, 1863)	2					
64	<i>Lethe kansa</i> (Moore, 1857)	1			1		
65	<i>Lethe naga</i> Doherty, 1889	6	4		7		
66	<i>Lethe gulnihal</i> de Nicéville, 1887				3		
67	<i>Lethe berdievi</i> Monastyrskii, 2005				2		
68	<i>Neope muirheadi</i> (C.Felder et R.Felder, 1862)	6	1		7	1	
69	<i>Neope bhadra</i> (Moore, 1857)	4			3		
70	<i>Neope pulaha</i> (Moore, 1858)				1		
71	<i>Mycalesis anaxias aemate</i> Fruhstorfer, 1911	5			6		
72	<i>Mycalesis adamsonii</i> Watson, 1897	2					
73	<i>Mycalesis misenus</i> de Nicéville, 1901	6		1	8		
74	<i>Mycalesis francisca</i> (Stoll, 1780)	3	1	3	7		2
75	<i>Ragadia crisilda</i> Hewitson, 1862	1			2		
76	<i>Ypthima baldus</i> (Fabricius, 1775)			7			7
77	<i>Ypthima frontier</i> Uémura et Monastyrskii, 2000						3
78	<i>Callerebia narasingha</i> (Moore, 1857)		15			2	
Amathusiidae							
79	<i>Aemona amathusia</i> (Hewitson, 1867)	2			3		
80	<i>Enispe euthymius</i> (Doubleday, 1845)	2			1		
81	<i>Discophora sondaica</i> Boisduval, 1836	1	1				
Nymphalidae							
82	<i>Ariadne merione</i> (Cramer, 1777)		3				2
83	<i>Argyreus hyperbius</i> (Linnaeus, 1763)			6			5
84	<i>Vagrans egista</i> (Cramer, 1780)			2			1
85	<i>Vanessa cardui</i> (Linnaeus, 1758)	1					
86	<i>Symbrenthia lilaea</i> (Hewitson, 1864)			1			
87	<i>Lasippa tiga</i> (Moore, 1858)		2			2	2
88	<i>Pantoporia hordonia</i> (Stoll, 1790)		1			1	
89	<i>Hypolimnas bolina</i> (Linnaeus, 1758)	1	1				
90	<i>Kallima inachus</i> (Boisduval, 1846)	2	1		3		1
91	<i>Cyrestis thyodamas</i> Boisduval, 1836		2			2	
92	<i>Chersonesia risa</i> (Doubleday, 1848)	1			1	1	
93	<i>Neptis clinia</i> (Moore, 1872)		2			2	
94	<i>Neptis miah</i> Moore, 1858		1				
95	<i>Neptis ananta</i> Moore, 1858		2			2	
96	<i>Neptis namba</i> Tytler, 1915		4			5	3
97	<i>Neptis yerburii</i> Butler, 1886		2		2	1	3

Table 1. Continue.
Таблица 1. Продолжение.

No.	Species	Below 700 m			Above 700 m		
		NFI	SSI	GRI	NFh	SSh	GRh
98	<i>Neptis harita</i> Moore, 1875		2			2	
99	<i>Athyma selenophora</i> (Kollar, 1844)		1			1	
100	<i>Athyma ranga</i> Moore, 1857					1	1
101	<i>Athyma cama</i> Moore, 1858		2			2	
102	<i>Athyma nefte</i> (Cramer, 1780)		2				
103	<i>Athyma asura</i> Moore, 1858		1			1	
104	<i>Athyma zeroa</i> Moore, 18725		3			2	
105	<i>Athyma pravara</i> Moore, 1857					1	
106	<i>Sumalia daraxa</i> (Doubleday, 1848)				2	2	2
107	<i>Moduza procris</i> (Cramer, 1777)	1	1			2	
108	<i>Tanaecia julii</i> (Lesson, 1837)		1				
109	<i>Euthalia franciae</i> (Gray, 1846)				1		
110	<i>Lexias dirtea</i> (Fabricius, 1793)	2			1	2	
111	<i>Auzakia danava</i> (Moore, 1858)	2			1		
112	<i>Eulacera osteria</i> (Westwood, 1850)	2					
113	<i>Hestina nama</i> (Doubleday, 1844)						2
114	<i>Stibochiona nicea</i> (Gray, 1846)	2					
115	<i>Dichorragia nesimachus</i> (Doyere, 1840)	1					
116	<i>Charaxes bernardus</i> (Fabricius, 1793)		1				
117	<i>Charaxes aristogiton</i> C.Felder, 1867				2		
118	<i>Polyura athamas</i> (Drury, 1773)		2		1	2	
119	<i>Polyura nepenthes</i> (Grose-Smith, 1883)		4				
120	<i>Polyura narcaea</i> (Hewitson, 1854)		15			2	1
121	<i>Polyura dolon</i> (Westwood, 1848)		15			4	
122	<i>Polyura eudamippus</i> (Doubleday, 1843)		12			6	
123	<i>Calinaga buddha</i> (Moore, 1857)		2	1			
Riodinidae							
124	<i>Abisara fylla</i> (Westwood, 1851)	7	6		8	6	
125	<i>Abisara neophron</i> (Hewitson, 1861)				3		
126	<i>Abisara burnii</i> (de Nicéville, 1895)		1		1		
127	<i>Zemeros flegyas</i> (Cramer, 1843)	18	30	45	10	22	35
128	<i>Stiboges nymphidia</i> (Butler, 1876)	2			2		
129	<i>Dodona ouida</i> (Hewitson, 1865)	6			2		
130	<i>Dodona egeon</i> (Westwood, 1851)			1		2	
131	<i>Dodona dipoea</i> (Hewitson, 1865)		1			1	
132	<i>Dodona adonira</i> (Hewitson, 1865)				1		
Lycaenidae							
133	<i>Miletus chinensis</i> C.Felder, 1862	3			2		
134	<i>Neopithecops corvus</i> Fruhstorfer, 1919		1				
135	<i>Neopithecops zalmora</i> (Butler, 1870)		1				
136	<i>Acytolepis puspa</i> (Horsfield, 1828)		3			2	
137	<i>Celastrina argiolus</i> (Linnaeus, 1758)	2	12		1	2	
138	<i>Celastrina lavendularis</i> (Moore, 1877)	3	4				
139	<i>Zizeeria maha</i> (Kollar, 1844)			3			2
140	<i>Udara dilecta</i> (Moore, 1879)		7			2	
141	<i>Jamides alecto</i> (C.Felder, 1860)					1	
142	<i>Jamipes bochus</i> (Stoll, 1782)		2				
143	<i>Ancema ctesia</i> (Hewitson, 1865)		1				
144	<i>Heliophorus ila</i> (de Nicéville et Martin, 1896)			1		1	1

Table 1. Continue.
Таблица 1. Продолжение.

No.	Species	Below 700 m			Above 700 m		
		NFl	SSl	GRI	NFh	SSh	GRh
145	<i>Surendra quercetorum</i> (Moore, 1857)	2	3		2	1	
146	<i>Tajuria</i> sp. (? <i>maculata</i> Moore, 1883)	1					
147	<i>Tajuria diaeus</i> (Hewitson, 1865)	1			1		
148	<i>Chliaria kina kina</i> (Hewitson, 1869)	1			1	2	
149	<i>Curetis bulis</i> Westwood, 1851		12	1		6	
Hesperiidae							
150	<i>Choaspes benjaminii</i> (Guérin-Méneville, 1843)					1	
151	<i>Celaenorrhinus inaequalis</i> Elwes et Edwards, 1897					1	
152	<i>Celaenorrhinus vietnamicus</i> Devyatkin, 1998		1				
153	<i>Tagiades menaka</i> (Moore, 1865)		2	1	3	1	
154	<i>Tagiades parra</i> Fruhstorfer, 1910			1			
155	<i>Seseria doherlyi</i> Watson, 1893		1				
156	<i>Gerosis phisara</i> Moore, 1884	1					
157	<i>Mooreana trichoneura</i> (C.Felder et R. Felder, 1860)	1					
158	<i>Odontoptilum angulata</i> (C.Felder, 1862)		2				
159	<i>Thoressa gupta</i> de Nicéville, 1886		7			13	
160	<i>Halpe frontieri</i> Devyatkin, 1997		2		6	3	1
161	<i>Iambrix salsala</i> (Moore, 1865)	1	1	1	1	1	
162	<i>Koruthaialos sindu</i> C.Felder et R. Felder, 1860		1				
163	<i>Notocrypta curvifascia</i> (C.Felder et R. Felder, 1860)	2	2				1
164	<i>Potanthus mingo</i> (Edwards, 1866)	1		2		1	
165	<i>Ochlodes siva</i> Moore, 1878		12			15	
166	<i>Pithauria stramineipennis</i> Wood-Mason et de Nicéville, 1868	2	10	3			
167	<i>Satarupa gopala</i> Moore, 1865				1		
168	<i>Ampitia dioscorides</i> (Fabricius, 1793)		1				
169	<i>Barba bicolor</i> (Oberthür, 1896)		1				
170	<i>Creteus cyrina</i> (Hewitson, 1876)					1	

NOTE: NFl/NFh — Natural forest at low/high altitude; SBl/SSh — stream sides in forest at low/high altitude; GRI/GRh — grassy areas at low/high altitude.

ПРИМЕЧАНИЕ: NFl/NFh — естественные леса в низко/высокогорье; SBl/SSh — берега рек в низко/высокогорье; GRI/GRh — луга в низко/высокогорье.

The diversity of butterfly communities per habitat is presented in Table 2. Stream sides appear to support the greatest number of species and individuals: 97 species and 342 individuals, and 68 species and 223 individuals at the lower and higher altitudes, respectively. The most abundant species along the stream sides are *D. belladonna*, *Z. flegyas*, *Ochlodes siva*, *Thoressa gupta*, *Callerebia narasingha*, *Polyura narcaea*, *P. dolon*, *P. eudamippus*, *Celastrina argiolus*, *Curetis bulis*, and *Papilio bootes*. They make 50% of all individuals recorded in stream side habitats at both altitudes compared.

Grassy habitats show the least species and individual numbers: 39 species and 122 individuals, and 39 species and 104 individuals at the lower and higher altitudes, respectively. The most abundant species in these habitats are *Z. flegyas*, *Pieris canidia*, *Ypthima baldus*, and *Argyreus hyperbius*. They make 53% of all individuals recorded in the grassy habitats at both altitudes compared.

Natural forests yield more species and individual numbers than the grass habitats: 71 species and 165

individuals, and 68 species and 159 individuals at the lower and higher altitudes, respectively. The most abundant species of the natural forest habitats are *Z. flegyas*, *Mycalesis misenus*, *M. anaxias*, *Lethe naga* and *Neope muirrheadi*. They compose 46% of all individuals recorded in the natural forest habitats at both altitudes compared.

The abundance index of butterfly communities is the highest along stream sides at both altitudes: 16.45 and 13.32, respectively. Grassy habitats have the least abundance index. The highest evenness index of butterfly communities is in natural forests, while the lowest evenness indices are in grassy habitats. The diversity indices of butterfly communities both along stream sides and in natural forests are similar: 3.91 and 3.93 in natural forest at the lower and higher altitudes, versus 3.95 and 3.68 along stream sides at the lower and higher altitudes, respectively.

The habitats at the lower elevations yield more species and individuals than those at the higher altitude,

Table 2. Butterfly diversity in different habitat types at Van Ban.

Таблица 2. Разнообразие дневных бабочек в разных типах биотопов в Ван-Бан.

Habitats	Species number	Individuals	Species richness index d	Evenness index J'	Diversity index H'
NFI	71	165	13.71	0.92	3.91
SSI	97	342	16.45	0.86	3.95
GRI	39	122	7.91	0.76	2.78
NFh	68	159	13.22	0.93	3.93
SSh	73	223	13.32	0.86	3.68
GRh	39	104	8.19	0.79	2.89

NOTE: habitats as in Table 1.

ПРИМЕЧАНИЕ: обозначения биотопов как в Табл. 1.

with the exception of species in grassy habitats: 71 and 68 species in natural forests at the lower and higher altitudes, and 97 and 73 species along stream sides at the lower and higher elevations, respectively. The number of species recorded in all habitats at the lower altitude is higher than that revealed in all habitats at the higher elevation, totaling 144 and 126 species, respectively. The abundance levels show the same trend: 629 and 486 individuals, respectively.

The similarity of species compositions between different habitats and altitudes is presented in Figure. The species composition appears to be similar in similar habitats: stream sides at both altitudes, natural forests at both altitudes, and grassy habitats at both altitudes.

Discussion

Natural tropical forests support less butterfly species and individuals than stream sides, being darker, with thick canopies and less gaps. In addition, the areas under the forest canopy are almost devoid of flowering plants which support numerous butterflies. Warren [1985] emphasized fewer butterfly species occurring in habitats with thick forest canopies, as opposed to more numerous butterfly species found in the habitats with less dense forest canopies. Indeed, natural tropical forests fail to show high levels of species diversity, but most of the species living there are forest-dwellers with small geographical distributions [Spitzer et al., 1997; Vu, 2007, 2009]. Thus, natural forests at Van Ban contain many species in the mainly sylvicolous families Satyridae and Amathusiidae: 27 and 30 species, respectively.

Stream sides in the forest yield more species and individuals of butterflies than both natural forest and the grassy areas. The environment along stream sides is especially diversified with vegetation, rocks, sand, mud and water which all attract more butterflies as they land for taking water and nutrients. Generally, wet areas are long known to attract more butterflies than dry sites do [Janzen & Schoener, 1968]. In addition, stream sides in the forest have openings which support more butterflies. Gaps in the forest have higher butterfly diversity levels than closed forest does [Spitzer et al., 1997]. Along streams, shrub and grass with flowering plants also sustain more butterflies. Expectedly, stream sides show fewer species from the basically sylvicolous families Satyridae and Amthusiidae: 12 and 30 species, respectively.

Grassy habitats support less butterfly species and individuals than both natural forests and stream sides, because they are very simple, with most of the grasses

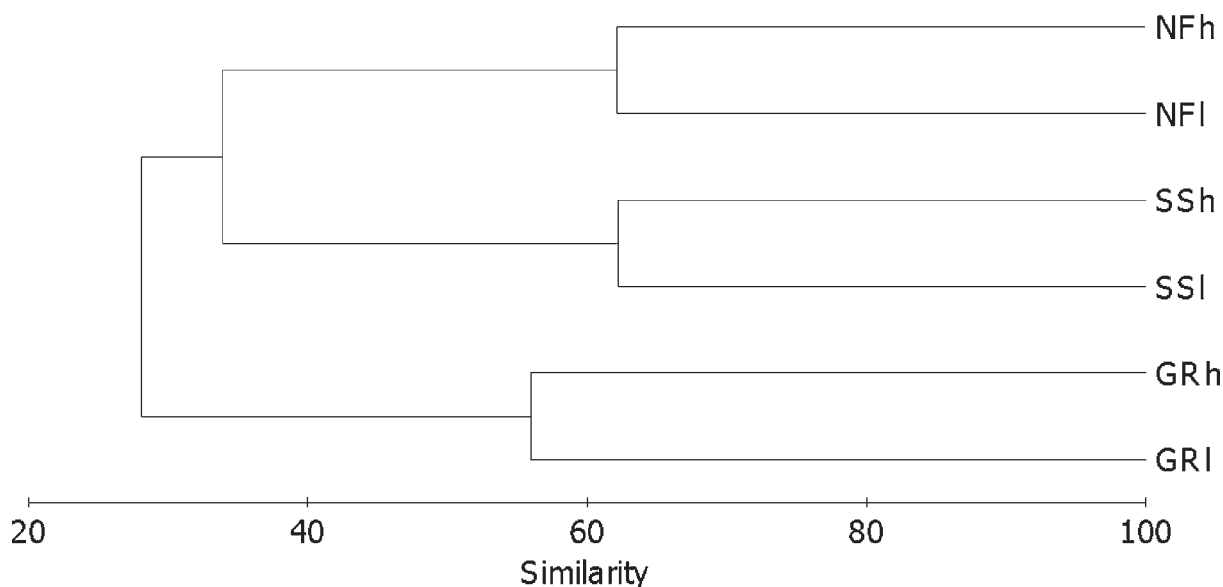


Figure. Similarity of butterfly species composition in different habitat types.

Рисунок. Сходство видового состава бабочек в разных типах биотопов.

giving home to only few butterflies. Unsurprisingly, there are very few species from the families Satyridae and Amthusiidae living in grassy habitats at Van Ban: 8 and 30 species, respectively. The lower diversity of vegetation leads to lower diversity levels of butterflies: as other studies show, the greater the diversity of plants, the higher the diversity of butterflies and other insects [Spitzer et al., 1987; DeVries, 1992]. These results correspond well to our previous work as well [Vu 2009; Vu & Yuan, 2003], emphasizing that shrub and grassy habitats have the species and abundance levels of butterfly communities lower than those in natural forests.

Lower altitudes appear to harbour more species and individuals of butterflies than higher ones do. Such results correspond well to the theory and practice demonstrated in previous work, indicating that the diversity of insects or butterflies decreases with an increasing latitude or altitude [Sparrow et al., 1994; Vu and Yuan, 2003].

Species composition was dissimilar among all habitats, but rather similar between similar habitats: natural forests at both altitudes, stream sides at both altitudes, and grassy areas at both altitudes. This proves that habitat is the main factor to affect the similarity or dissimilarity of butterfly communities between habitats [Vu, 2008; Vu et al., 2008]. The butterfly species composition differed between habitat types. This result is similar to those obtained by Steffan-Dewenter & Tschardt [1997] and Vu [2009].

The results of the present study support the hypothesis that the environment of forest stream sides supports particularly high diversity levels of butterfly species and abundance, as opposed to those observed in grassy habitats. Thus, stream sides are highly important environments for butterfly conservation.

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