

COMPOSITION AND DISTRIBUTION CHARACTERISTICS OF BUTTERFLY SPECIES (*Lepidoptera: Rhopalocera*) AT CO LUNG COMMUNE OF PU LUONG NATURE RESERVE, BA THUOC DISTRICT, THANH HOA PROVINCE

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Abstract. The research was carried out on the composition and distribution characteristics of the butterfly species (*Lepidoptera: Rhopalocera*) in different habitats (residential habitat and agricultural land; stream, grassland, and shrub habitat; and natural forest habitat) in Co Lung commune, Pu Luong nature reserve, Ba Thuoc district, Thanh Hoa province. The result has shown the identification of 73 species, 47 genera, and 6 families. Among them, the *Appias*, *Euploea*, *Junnonia*, and *Papilio* genera have more common species, while the *Leptosia*, *Lexias*, *Potanthus*, and *Ypthima* genera have less common species. The Nymphalidae family has the highest number of genera and species, with 26 genera and 37 species. However, the Riodinidae family has just 1 genus and 1 species. Among the habitats, the Natural forest habitat was recorded as the most abundant butterfly species (42 species), then followed by the Residential habitat and agricultural land with 37 species and the least number of species, while there were only 18 species found in Stream, grassland, and shrub habitat. Moreover, there are two species, *Danaus genutia* of the Nymphalidae family, and *Graphium sarpedon* of the Papilionidae family, which appear widely in two habitats: residential and agricultural land habitat, Stream grassland and shrub habitat.

Keywords: species composition, distribution, butterfly, *Lepidoptera*, Co Lung.

1. Introduction

Co Lung commune is located in the core area of Pu Luong nature reserve, northwest of Ba Thuoc district, on the left bank of Ma river, Thanh Hoa province, Vietnam (located in the North Central region). Co Lung commune has a total area of km² of 49.08 km². Co Lung is a high mountain commune 18 km northwest of the district center, with mountain peaks nearly 2,000 meters above sea level, covered with clouds all year round, and a stable year-round temperature of 18 - 22 °C is like a miniature Sa Pa. The flora and fauna

here are quite diverse and rich, and it is a favorite destination for backpackers and tourists from Vietnam and the world. It has Am Hieu village is known as a place to develop community tourism [1], [2].

Lepidoptera is a diverse order of insects in terms of species composition with a number of 180,000 species, divided into 2 groups: butterflies with a number of about 19,500 species, and moths (Vu Van Lien, Vu Quang Con, 2020) [3], [4]. Butterflies are usually active during the day, colorful, and play an important role in the forest ecosystem and human life. They are abundant, diverse in habitat, and adaptable, so they are often used as indicator organisms for a certain type of habitat to evaluate the good or bad level of that habitat Le Thi Dien et al., 2014; Hung Ngoc Hoang et al., 2020; Vu Van Lien et al., 2007) [5]-[7].

Butterflies are a group of "model" organisms used to investigate and study biology, evolution, adaptation, and genetics. The habitats of Co Lung commune are like a wildlife garden with many butterflies where tourists visit and relax. Currently, many species are threatened by human impact. Many butterfly species are being hunted and traded, and are in decline due to habitat change and loss, forest exploitation, land conversion, climate change, widespread pesticide use, and community tourism [8]. This article provides information about the species composition and distribution of butterfly species in different habitats in Co Lung commune, Pu Luong Nature Reserve.

2. Content

2.1. Research methods

The research was carried out in different habitats in Co Lung commune, Pu Luong nature reserve, Ba Thuoc district, Thanh Hoa province, including residential habitat and agricultural land (SC1); stream, grassland, and shrub habitat (SC2); and natural forest habitat (SC3). Butterfly samples were collected by using insect nets combined with observing and recording the presence of species and their abundance in the investigation area according to the method of Vu Van Lien and Luu Hoang Yen (2011) [10].

The time for surveying and collecting samples in the field is conducted in 3 phases, each lasting 5 days, specifically as follows: Phase 1: from August 15 - 20, 2022; Phase 2: from June 16 - June 20, 2023; Phase 3: from October 13 to 17, 2023. The dry season is from October to April of the following year; the rainy season is from May to September.

After being collected, specimens are processed and preserved at the Department of Zoology, Hanoi National University of Education. Specimens were dried by drying (avoiding direct exposure to sunlight) or drying at a temperature of 40-45⁰C, for 1-2 days. Dried samples are stored in a sealed box with preservative chemicals to prevent insect damage (mothballs) and kept in a dry place. Scientific names of specimens are based on published documents by Chou (1994), Monastyrskii & Devyatkin (2015), Monastyrskii (2005), Osada et al., (1999) [11]-[14]. The name and the classification system are done according to the document of Monastyrskii & Devyatkin (2015) [13].

2.2. Research results

We have recorded 73 butterfly species belonging to 6 families: Papilionidae, Pieridae, Nymphalidae, Lycaenidae, Hesperidae, and Riodinidae in three different habitats (residential habitat and agricultural land - SC1); stream, grassland, and shrub habitat - SC2; and natural forest habitat - SC3) (Table 1).

Table 1. Butterfly species composition and distribution (Lepidoptera: Rhopalocera) in Co Lung commune, Pu Luong nature reserve, Ba Thuoc district, Thanh Hoa province

No.	Science name	Habitat		
		SC1	SC2	SC3
I	Family Papilionidae			
1	<i>Graphium doson</i> (C & R. Felder, 1864)	1		
2	<i>Graphium sarpedon</i> (Linnaeus, 1758)	5	7	
3	<i>Lamproptera curius</i> (Fabricius, 1787)	7	2	
4	<i>Papilio helenus</i> Linnaeus, 1758	8		3
5	<i>Papilio memnon</i> Linnaeus, 1758			3
6	<i>Papilio nephelus</i> Boisduval, 1836	2	2	5
7	<i>Papilio paris</i> Linnaeus, 1758	6		
8	<i>Papilio polytes</i> Linnaeus, 1758			5
9	<i>Papilio protenor</i> Cramer, 1775		4	
10	<i>Papilio</i> sp1.	1		
11	<i>Papilio</i> sp2.	1		
12	<i>Papilio</i> sp3.			1
II	Family Pieridae			
13	<i>Appias galba</i> (Wallace, 1867)	5		7
14	<i>Appias indra</i> (Moore, 1858)	10		3
15	<i>Appias</i> sp1.	8		3
16	<i>Appias</i> sp 2.	12		2
17	<i>Appias</i> sp.		2	
18	<i>Catopsilia pomona</i> (Fabricius, 1775)	6		
19	<i>Eurema andersonii</i> (Moore, 1886)			2
20	<i>Eremeria hecabe</i> (Linnaeus, 1758)	6		4
21	<i>Hebpmoia glaucippe</i> (Linnaeus, 1758)	6		
22	<i>Ixias pyrene</i> (Linnaeus, 1764)		2	1
23	<i>Leptosia nina</i> (Fabricius, 1793)			1

24	<i>Prioneris thestylis</i> (Doubleday,1842)	3		
III	Family Nymphalidae			
25	<i>Amblipodia anita</i> (Hewitson,1862)			2
26	<i>Argyreus hyperbius</i> (Linnaenus,1763)	2		
27	<i>Athyma pravara</i> (Moore,1857)			2
28	<i>Athyma selenophora</i> (Kollarr,1844)	3		
29	<i>Cupha erymanthis</i> (Drury,1773)			4
30	<i>Cyrestis themire</i> Honrath 1884			15
31	<i>Danaus genutia</i> (Cramer, 1779)	4	4	6
32	<i>Doleschallia bisaltide</i> (Cramer, 1777)	2		
33	<i>Euploea midamus</i> (Linnaeus, 1758)			4
34	<i>Euploea mulciber</i> (Cramer, 1777)	5	3	4
35	<i>Euploea tulliolus</i> (Fabricius, 1793)	3		
36	<i>Euploea</i> sp1.		2	
37	<i>Euploea</i> sp2.		2	
38	<i>Euthalia monina</i> (Moore, 1859)			5
39	<i>Faunis canens</i> (Hübner,1826)		3	
40	<i>Faunis eumeus</i> (Drury, 1773)			3
41	<i>Hypolimnias bolina</i> (Linnaenus,1758)	2	2	2
42	<i>Hypolimnias</i> sp.			1
43	<i>Junonia almana</i> (Linnaenus,1758)	3	3	
44	<i>Junonia atlites</i> (Linnaenus, 1763)	3		
45	<i>Junonia iphita</i> (Cramer,1779)	2		
46	<i>Junonia orithya</i> (Linnaenus,1763)			2
47	<i>Lexias cyanipardus</i> (Butler,1869)			1
48	<i>Melanitis leda</i> (Linnaenus, 1758)		3	
49	<i>Moduza procris</i> (Linnaenus, 1763)	3		
50	<i>Mycalesis mineus</i> (Linnaenus, 1758)			3
51	<i>Neptis hylas</i> (Linnaenus, 1758)	2		4
52	<i>Panantica melaneus</i> (Cramer, 1775)	3		
53	<i>Pantoporia hordonia</i> (Stoll, 1790)	3		
54	<i>Pantoporia</i> sp.			1
55	<i>Parantica aglea</i> (Stoll, 1782)	4	2	
56	<i>Rohana parisatis</i> (Westwood, 1850)		4	

57	<i>Stichophthalma fruhstorferi</i> (Röber, 1903)			6
58	<i>Thauria lathyi</i> (Fruhstorfer, 1902)			5
59	<i>Tirumala septentrionis</i> (Butler, 1874)	5		2
60	<i>Vindura erota</i> (Fabricius, 1793)	2	2	
61	<i>Ypthima confusa</i> (Shirôzu&Shima, 1977)			3
IV	Family Riodinidae			
62	<i>Zemeros flegyas</i> (Cramer, 1780)			3
V	Family Lycaenidae			
63	<i>Acytolepis puspa</i> (Fruhstorfer, 1910)	6		
64	<i>Anthena emolus</i> (Godart, 1823)	5		6
65	<i>Caleta roxus</i> (Godart, 1824)			1
66	<i>Hypolycaena</i> sp.	4		
67	<i>Jamides alecto</i> (C. Felder, 1860)			6
68	<i>Jamdes bochus</i> (Stoll, 1782)			11
69	<i>Megisba malaya</i> (Horsfield, 1828)	3		3
VI	Family Hesperidae			
70	<i>Koruthaialos sindu</i> (C& R. Felder, 1860)			4
71	<i>Koruthaialos</i> sp.		1	
72	<i>Lambrix salsala</i> (Moore, 1865)			3
73	<i>Potanthus flavus</i> (Murray, 1875)			3
Number (species)		37	18	42
Percentage (%)		38.14	18.56	43.30

Note: SC1: residential habitat and agricultural land; SC2: stream, grassland, and shrub habitat; SC3: natural forest habitat.

Table 1 results show that the Nymphalidae family has the highest number of 37 species, followed by the Papilionidae family and Pieridae family have the same number of 12 species, the Lycaenidae family has 7 species, the Hesperidae family has 4 species and the Riodinidae family has the least number, 1 species. Among the 73 species, 12 species form: 3 species belong to the *Papilio* genus of the family Papilionidae; 4 species form: *Euploea* sp1. *Euploea* sp2. *Hypolimnas* sp. *Pantoporia* sp. belongs to 3 genera of the family Nymphalidae; 3 species form: *Appias* sp1. *Appias* sp2. *Appias* sp. of the family Pieridae; 1 species form: *Hypolycaena* sp. of the family Lycaenidae and 1 species form: *Koruthaialos* sp. of the family Hesperidae.

Results of the investigation by authors Ta Huy Think et al., (2003) in two communes, Lung Cao and Thanh Son in Pu Luong nature reserve, Ba Thuoc district, Thanh Hoa province, have recorded 124 species of 10 families of Danaidae, Papilionidae, Nymphalidae, Pieridae, Satyridae, Lycaenidae, Hesperidae, Amathusiidae, Riodinidae,

and Libytheidae. In the recent system, Nymphalidae, Satyridae, Amathusiidae, and Libytheidae are in the family Nymphalidae (Monastryskii and Devyatkin, 2015). The results of the investigation of butterfly species composition in this study were investigated in Co Lung commune with a number of species 73, less than 51 species in comparison to Ta Huy Think's research [4].

The natural forest habitat has 42 species of 6 families. The Nymphalidae family has the highest number of species with 20 species. In this family, there are 9 species: *Cupha erymanthis*, *Cyrestis themire*, *Danaus genutia*, *Euploea midamus*, *Euploea mulciber*, *Euthalia monina*, *Neptis hylas*, *Stichopthalma fruhstorferi*, and *Thauria lathyi* appears frequently. The Pieridae family has 8 species, of which 2 species: *Appias galba* and *Eremeria hecabe* appear abundantly. The family Papilionidae has 5 species, of which 2 species *Papilio nephelus*, and *P. polytes* appear abundantly, and the species form: *Papilio* sp3. The Lycaenidae family has 5 species, of which 3 species of *Antenna emolus*, *Jamides alecto*, and *Jamdes bochus* appear abundantly. The Hesperidae family has 3 species, of which the species *Koruthaialos sindu* appears abundantly. Finally, the Riodinidae family has only one species appearing with 3 individuals.

The residential and agricultural habitat has 37 species of 4 families. The Nymphalidae family has the highest number of species, with 17 species. In this family, *Danaus genutia*, *Euploea mulciber*, *Parantica aplea*, and *Tirumala septentrionis* appear abundantly. The Pieridae family has 8 species, of which 7 species of *Appias galba*, *Appias indra*, *Appias* sp1., *Appias* sp2., *Catopsilia pomona*, *Eremeria hecabe*, and *Hebpmoia glaucippe* appear abundantly. The Papilionidae family has 8 species, of which 4 species of *Graphium sarpedon*, *Lamproptera curius*, *Papilio helenus*, and *Papilio paris* appear abundantly. The Lycaenidae family has 4 species, of which 3 species of *Acytolepis puspa*, *Antenna emolus*, and *Polyommatus* sp. appear abundantly.

Stream, grassland, and shrub habitats have 18 species of 4 families. The Nymphalidae family has the highest number of species, with 11 species. In this family, there are 2 species of *Danaus genutia* and *Rohana parisatis* appearing a lot. The Papilionidae family has 4 species, with 2 species of *Graphium sarpedon* and *Papilio protenor* appearing a lot. The Pieridae family has 2 species, and no species appears abundantly. The Hesperidae family has one species, *Koruthaialos* sp.

According to our research results, the natural forest habitat has the highest number of species (42 species), followed by the residential habitat and agricultural land (37 species), and at least, the stream, grassland, and shrub habitat (18 species). Among species, there are 2 species of *Danaus genutia* of the Nymphalidae family and *Graphium sarpedon* of the Papilionidae family that appear in the residential habitat and agricultural land, and the stream, grassland, and shrub habitat.

The number of butterfly species in the three habitats is different. The natural forest habitat has the highest number of species with 42 species, accounting for 43.3% of total species. This habitat is a suitable environment for butterflies. In this habitat, there are many plant species with different high and low canopy levels. This is a food source for butterflies and also a shelter and breeding place... The residential habitat and agricultural land have 37 species, accounting for 38.14%. This habitat has many species of butterflies in the Pieridae family, which often gather in large flocks close to the ground. The stream,

grassland, and shrub habitat have 18 species, accounting for 18.56%. This habitat has the lowest number of species in comparison to the above two habitats, probably due to the presence of many dry, unfertile lands that do not support many butterflies.

Table 2. The ratio of butterfly genus and species (Lepidoptera: Rhopalocera) in Co Lung commune, Pu Luong nature reserve, Ba Thuoc district, Thanh Hoa province

No.	Family	Genus		Species	
		Number	Percentage (%)	Number	Percentage (%)
1	Papilionidae	3	6.38	12	16.44
2	Nymphalidae	26	55.32	37	50.68
3	Pieridae	8	17.02	12	16.44
4	Lycaenidae	6	12.77	7	9.59
5	Hesperiidae	3	6.38	4	5.48
6	Riodinidae	1	2.13	1	1.37
Total		47	100	73	100

The results in Table 2 show that the number of genera and species of butterflies is different among families. The family with the most species and genera is the Nymphalidae family with 26 genera, accounting for 55.32% of the total number of genera, and 37 species, accounting for 50.68% of the total number of species. Next is the Pieridae family with 8 genera accounting for 17.02% of the total genera, 12 species accounting for 16.44%. Lycaenidae family with 6 genera accounting for 12.77% of the total number of genera, 7 species accounting for 9.59% of the total number of species. Hesperiidae family with 3 genera accounting for 6.38% of the total number of genera, 4 species accounting for 5.48% of the total number of species. At least is the Riodinidae family with 1 genus accounting for 2.13% of the total genera, 1 species accounting for 1.39% of the total species.

The results of the distribution of butterfly species by season are shown in Table 3. The number of butterfly species in Co Lung commune between the two seasons is the same, 42 species.

In the dry season, there are 42 species, of which the Nymphalidae family has 24 species, accounting for 57.14%; the Pieridae family has 8 species, accounting for 19.05%; the Papilionidae family has 6 species, accounting for 14.29%; the Lycaenidae family has 3 species, accounting for 7.14%. The Hesperiidae family has 1 species, accounting for 2.38%.

In the rainy season, there are 42 species, of which the Nymphalidae family has 20 species, accounting for 47.62%; the Papilionidae family has 7 species, accounting for 16.67%; the Pieridae family has 6 species, accounting for 14.29%; the Lycaenidae family has 5 species, accounting for 11.9%; the Hesperiidae family has 3 species, accounting for 7.14%; and the Riodinidae family has 1 species, accounting for 2.38%.

Table 3. Distribution of butterfly species (*Lepidoptera: Rhopalocera*) by season in Co Lung commune, Pu Luong Nature Reserve, Ba Thuoc district, Thanh Hoa province

No.	Family	Dry season		Rainy season	
		Number (species)	Percentage (%)	Number (species)	Percentage (%)
1	Papilionidae	6	14.29	7	16.67
2	Nymphalidae	24	57.14	20	47.62
3	Pieridae	8	19.05	6	14.29
4	Lycaenidae	3	7.14	5	11.9
5	Hesperiidae	1	2.38	3	7.14
6	Riodinidae	0	0	1	2.38
Total		42	100	42	100

3. Conclusions

73 species of butterfly (*Lepidoptera: Rhopalocera*) have been identified in three habitats in Co Lung commune, Pu Luong nature reserve, Ba Thuoc district, Thanh Hoa province. Among families, the Nymphalidae family has the highest number of genera and species, 26 genera and 37 species; the Pieridae family has 8 genera and 12 species; the Papilionidae family has 3 genera and 12 species; the Lycaenidae family has 6 genera and 7 species; the Hesperiidae family has 3 genera and 4 species; and the Riodinidae family has the lowest number of species and genera, 1 genus and 1 species.

The distribution of butterfly species is different in different habitats. The natural forest habitat has the highest number of species (42 species). The stream, grassland, and shrub habitat has the lowest number of species (18 species). There is no difference in species number in the dry season and the rainy season.

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