

The Species Assassin Bugs (Heteroptera: *Reduviidae*) and their Preys in the Mountainous Region of Northern Vietnam

Truong Xuan Lam^{1,2*}

¹Institute of Ecology and Biological Resources, Vietnam Academy of Science and Technology, Nghia Do, Vietnam; ²Institute of Science and Technology, Vietnam Academy of Science and Technology, Nghia Do, Vietnam

ABSTRACT

In the mountainous region of Northern Vietnam, field surveys in 2 National Parks, 7 Nature Reserves, Lao Cai, Cao Bang, Hoa Binh, Son La, Bac Kan and Lang Son provinces shows that the 76 species of 43 genera, 7 subfamilies of family *Reduviidae* (Heteroptera) were recorded, among them 5 species are newly recorded in Vietnam. The Lao Cai (Bat Xat, Hoang Lien) has the highest diversity index and Bac Kan (Nam Xuan Lac), Lang Son (Huu Lien) have the lowest diversity index. The index of similarity of species composition at 6 surveyed sites were divided into group 1, Lao Cai (Bat Xat, Hoang Lien) and Cao Bang (Phia Oac-Phia Den); group 2, Hoa Binh (Thuong Tien, Hoang Kia-Pa Co) and Son La (Xuan Nha, Copia) and group 3, Bac kan (Nam Xuan Lac) and Lang Son (Huu Lien). The number of species in higher montane evergreen forest and lower montane evergreen forest is the biggest (69 species), in the lowland evergreen forest and lowland semi-evergreen forest have 28 species, in agricultural ecosystems is containing 26 species, the buffer zone is containing 13 species and grassland is containing 17 species. The prey of 60 species of the family *Reduviidae* was recorded.

Keywords: Assassin bugs; *Reduviidae*; Prey; Heteroptera

INTRODUCTION

The species of the assassin bugs (Heteroptera: *Reduviidae*) is documented with approximately 7000 species of 29 subfamilies. Many species play an important role in the food chain of animals and plants, as well as the ecological balance. Many species are either known as predators of many dangerous pests or their indicative role for forest habitats except species blood-sucking bugs (about 139 species) are dangerous vectors of disease to humans and animals [1]. The mountainous region of Northern Vietnam is fairly particular; it is adjacent to Guangdong, Guangxi and Yunnan of China to the north, Laos to the west, Red River Delta and Central North to the south, and Gulf of Tonkin to the east. Administratively, this region includes 11 provinces of Ha Giang, Cao Bang, Lao Cai, Bac Kan, Lang Son, Tuyen Quang, Yen Bai, Lai Chau, Dien Bien, Son La and Hoa Binh. The mountainous region of Northern Vietnam includes the Northwest mountainous region and the Northeast mountainous region. Northwest mountainous region is a region consisting mainly of medium and high mountains. This is the place with the highest, most fragmented and most dangerous terrain in Vietnam. The common terrain types here are high mountain ranges, deep valleys or canyons, limestone plateaus of medium elevation. The highest and most massive mountain range is the Hoang Lien Son range with many peaks over 2500 m, the highest peak is Fansipan of

Hoang Lien National Park (3143 m). The Northeast mountainous region consists mainly of medium and low mountains. The massif upstream of the Chay River has many peaks above and below 2000 m, which is the highest area of the region [2].

So far, the study on the species of the family *Reduviidae* in Vietnam only focused on the Central Highlands of Vietnam and some provinces of Northern Vietnam such as check listed 138 species of 9 subfamilies. Discovered 2 new genera, 8 new species. New recorded for Vietnam 01 subfamily (*Centrocneminae*), 15 genera and 40 species. Identified 59 species with 15 species are their prey. The identified 2 common species of the genus *Sycanus* have an important role in protecting crops. Some biological characteristics of species *Sycanus falleni*, *Coranus fuscipennis* (*Harpactorinae*) were recorded. Identify species of blood-sucking bugs are *Triatoma rubrofasciata* in the North and with the increase in number in Ha Noi city [3-8]. However, the study on the species of assassin bugs and their preys in the mountainous region of Northern Vietnam is very little conducted. Many new taxon for science and the new record is not discovered and published. The information and data about the species diversity, their prey, as well as the relationship between them with their prey are not interesting and attentive.

Correspondence to: Truong Xuan Lam, Institute of Ecology and Biological Resources, Vietnam Academy of Science and Technology, Nghia Do, Vietnam, Tel: 0915935888; E-mail: txlam.iebr@gmail.com

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MATERIALS AND METHODS

Field surveys

The larvae were reared at $25^{\circ}\text{C} \pm 1^{\circ}\text{C}$ and 60%-70% Relative Humidity (RH) with a 14:10 photoperiod on an artificial diet at the College of Agriculture, Yangtze University (20). The adults were fed with 10% honey. In bio-assay, the larvae were transferred to tobacco leaves gently.

1. Bat Xat Nature Reserve (Lao Cai province) with an area of 18,637 ha, spreading $22^{\circ}23' - 22^{\circ}37' \text{ N}$; $103^{\circ}31' - 103^{\circ}43' \text{ E}$ which is located on five communes (Y Ty, Den Sang, Trung Leng Ho, Sang Ma Sao and Nam Pung). Y Ty is located at an altitude of about 2,000 m above sea level and is covered with mist all year round. Nature Reserve belongs to the beginning of Hoang Lien Son Range and connects with Hoang Lien National Park [2].

2. Hoang Lien National Park (Lao Cai province) is situated at a height of 1,000-3,000 m above sea level in the Hoang Lien Son Mountain Range, including Fansipan peak 3,143 m high in Sa Pa and Van Ban districts with an area of 29,845 ha, spreading $21^{\circ}30' - 21^{\circ}46'20'' \text{ N}$; $106^{\circ}35'48'' - 106^{\circ}48'15'' \text{ E}$ [2].

3. Pa Co-Hang Kia nature reserve is located in the extreme west of Hoa Binh province, on the border with Son La province. Spreading $20^{\circ}40'30'' - 20^{\circ}45'30'' \text{ N}$ and $104^{\circ}05'20'' - 105^{\circ}00'35'' \text{ E}$. The site lies in the limestone range that extends south-east from the Son La

plateau to Cuc Phuong National Park. The main physical feature within Pa Co-Hang Kia is a high ridge, which reaches 1,536 m in the north-west of the nature reserve and gradually decreases in altitude to the east. Most of the nature reserve lies above 500 m [2].

4. Thuong Tien Nature Reserve (Hoa Binh province) with spreading $20^{\circ}36' - 20^{\circ}41' \text{ N}$, $105^{\circ}24' - 105^{\circ}29' \text{ E}$ and covering more than 6,000 ha. Thuong Tien Nature Reserve spreads across the three communes of Kim Tien, Thuong Tien (Kim Boi district), and Quy Hoa (Lac Son district). Thuong Tien commune lies in a core zone of more than 5,000 ha. Khu hamlet, inhabited by the Muong ethnic group, has the largest wild forested area in the province [2].

5. Xuan Nha Nature Reserve with spreading $20^{\circ}41'58'' - 20^{\circ}51'26'' \text{ N}$ and $104^{\circ}40'54'' - 104^{\circ}55'35'' \text{ E}$ in Moc Chau district in the southwest of Son La province. To the south and east the nature reserve is bordered by Hoa Binh and Thanh Hoa provinces, while, to the west, it is bordered by Laos. The highest point in the nature reserve, Mount Pha Luong at 1,970 m, lies on the mountain ridge that forms the international border with Laos [2].

6. Copia Nature Reserve with spreading $21^{\circ}15' - 21^{\circ}25' \text{ N}$ and $103^{\circ}30' - 103^{\circ}44' \text{ E}$ in Thuan Chau district in the southwest of Son La province. The Copia Nature Reserve is located in 4 communes (Co Ma, Long He, Chieng Bom and Nam Lau) with a total area of 19,745 ha, of which the natural forest area is 13,426 ha as shown in Figure 1 [2].

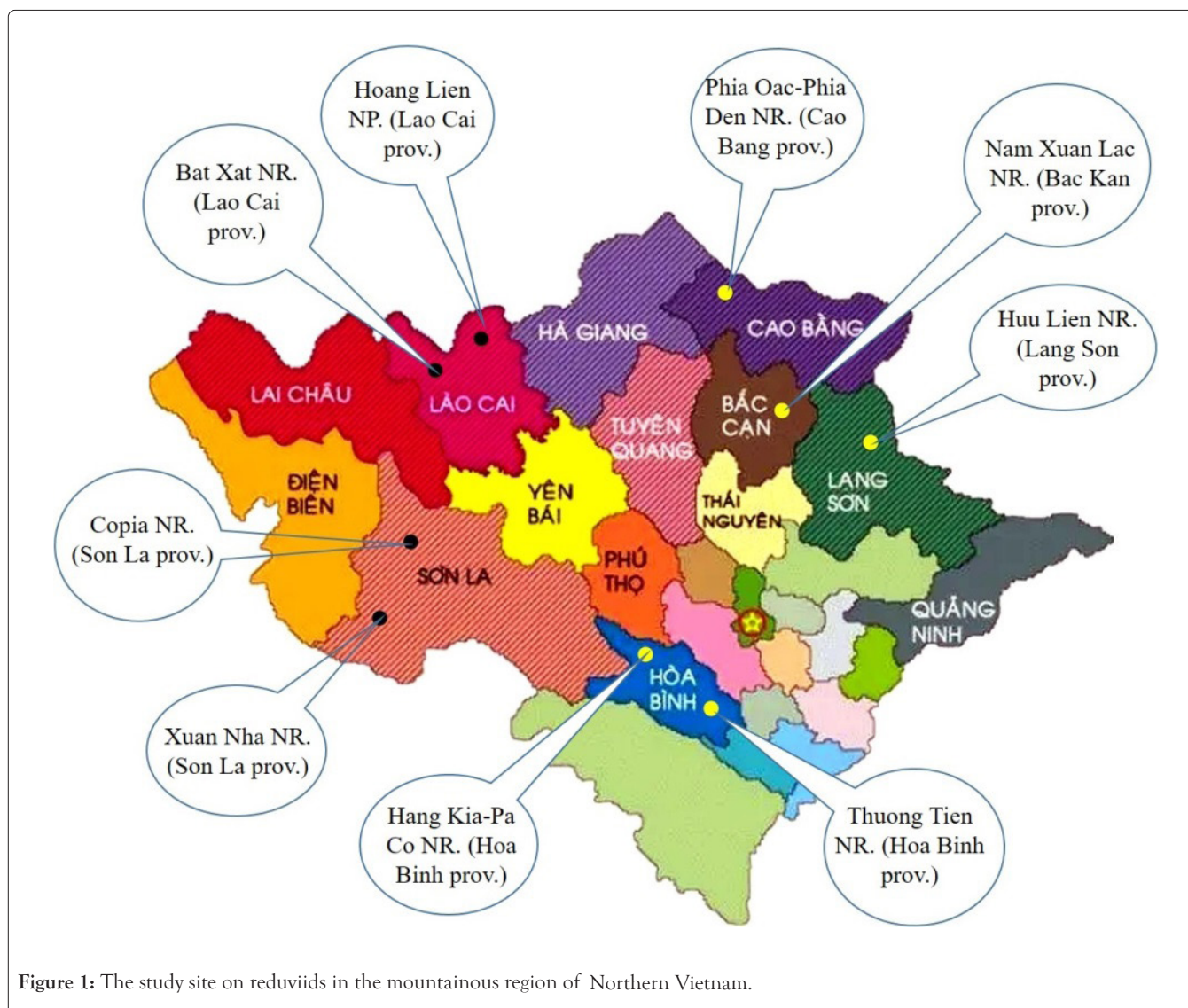


Figure 1: The study site on reduviids in the mountainous region of Northern Vietnam.

7. Huu Lien Nature Reserve lies about 90 km due north of Ha Noi and includes all of Huu Lien commune and a part of Yen Thinh commune, Huu Lung district, Lang Son province with spreading 21030'21046'20" N and 106035'48"-106048'15" E. The landscape of the nature reserve is dominated by limestone karst. According to the investment plan [2].

8. Nam Xuan Lac is situated in western Bac Kan province. To the west, the site is contiguous with the Ban Bung sector of Na Hang proposed nature reserve. The topography of the site is characterized by steep limestone karst formations, separated by flat-bottomed valleys with spreading 22017'12"-22019'45" N and 105028'31"-105033'20" E [2].

9. Phia Oac-Phia Den National Park (Cao Bang province) stretches through the communes of Thanh Cong, Quang Thanh, Phan Thanh, and Hung Dao and the town of Tinh Tuc in Nguyen Binh district. The park has a total area of over 10,500 ha, with its highest peak at nearly 2,000 meters above sea level with spreading 22°35'-22°55' N; 105°53'-106°13' E [2].

The study on habitats and preys

Investigation assassin bugs were conducted in some habitats as the higher montane evergreen forest and lower montane evergreen forest (EM); Lowland evergreen forest and lowland Semi-Evergreen Forest (SF); The buffer zone (Ecosystem transitional buffer zone between forest, regenerated forests and agricultural ecosystems) (ES); Grassland (GL) and Agricultural ecosystems focus on the important group of plants like fruit trees and industrial crops (AE) following methods of collecting specimens by Steyskal, Schuh and Slater, including sweep net, lights trap, pitfall traps, beating net and the aspirator can also be used effectively when collecting from the light trap, beating net, sweeping net when sorting litter by hand and very many other similar situations. The experimental study [9] with adults and nymph instars of reduviids were collected from different habitats, they will be tested in the laboratory on the plastic bottle (h=20 cm, d=10 cm; 8 x 6 x 4 cm) or the cage (50 x 50 x 100 cm; 40 x 40 x 40 cm) by different preys both in the field condition and in the laboratory. The preys of assassin bugs were the larvae of some pests of order Lepidoptera, Homoptera, Coleoptera and Orthoptera include *Anomis flava* (1), *Helicoverpa armigera* (2), *Spodoptera litura* (3), *Plusia* sp.(4), *Nephotettix bipunctatus* (5), *Empoasca biguttula* (6), *Empoasca flavescens* (7), *Erianthus spp.* (8), *Pieris brassicae* (9), *Aphis* sp. (10), *Aulacophora spp.* (11), *Chrysomela spp.* (12), *Rhopalosiphum spp.* (13), *Oxya* spp. (14) and *Corcyra cephalonica* (15).

Taxonomy

By morphology of species of *Reduviidae* and their prey basis on morphological characteristics, the analysis of morphology was conducted with an SZX7 Olympus microscope. The morphological structure was painted on SZX7 Olympus. The documents for reference and comparative morphological description are based on [10-16]

Statistics

The experimental data with the tracking indicators will be analysis and calculate the probability level ($P < 0.05$) by Primer-e

RESULTS AND DISCUSSION

The species reduviid in the mountainous region of Northern Vietnam

The research on assassin bugs (*Reduviidae*) is conducted based on

the specimens in the Institute of Ecology and Biological Resources were collected from April to July (2019-2021 year) on 5 habitats in the mountainous region of Northern Vietnam with nearly 593 specimens of reduviids of 7 subfamilies (*Harpactorinae*, *Saicinae*, *Reduviinae*, *Ectrichodinae*, *Emesinae*, *Peiratinae* and *Stenopodainae*), and preys of some species of them.

Table 1 shows that: 76 species of assassin bugs of 43 genera, 7 subfamilies (family *Reduviidae*) in the mountainous region of Northern Vietnam were recorded. Among 76 species of assassin bugs with 5 species are newly recorded in Vietnam (*Parascadra rubida* [5], *Peirates turpis* Walker, 1873, *Brachytonus nigripes* [5], *Durganda rubra* Amyot and Serville and *Petalochirus spinosissimus* Distant, 1903). The genera *Peirates*, *Ectomocoris*, *Oncocephalus* and *Ectomocoris* have 4 species, genera *Acanthaspis*, *Reduvius*, *Polytoxus*, *Lisarda*, *Canthesancus*, *Pygolampis*, *Biasticus*, *Vesbius* and *Sycanus* have 3 species, remaining genera have 1-2 species. Among the 7 subfamilies recorded in the northern mountainous region of Vietnam, the subfamily *Harpactorinae* is the largest subfamily of scarlet beetles with 23 species, among them 6 species are recorded in agricultural ecosystems (*Biasticus flavinotus*, *Biasticus flavus*, *Coranus fuscipennis*, *Rhynocoris fuscipes*, *Sycanus croceovittatus* and *Sycanus falleni*) [3,4]. The results of this study are also consistent with [5,6] as the subfamily *Harpactorinae* is the largest reduviid subfamily in Vietnam, including more than 34 genera and 62 species. In agricultural ecosystems, a few species of the subfamily *Harpactorinae* have been studied for biological control of pests in the field as *Coranus fuscipennis*, *Coranus spiniscutis*, *Sycanus croceovittatus* and *Sycanus falleni*.

Table 1: The list of species reduviid, distribution and their preys in the mountainous region of Northern Vietnam.

No	Name of species	Distribution	Habitats	Their preys
Subfamily <i>Ectrichodiinae</i> Amy. and Ser. 1843				
1.	<i>Ectrychotes andreae</i> Thunberg, 1784	SL, CB	EM, ES	4,8,9
2.	<i>Ectrychotes comottoi</i> Lethierry, 1883	HB, BK, LC	EM, GL	4,8,9
3.	<i>Ectrychotes lingnanensis</i> China, 1940	SL, CB	EM, ES	8,9
4.	<i>Mendis rufus</i> Hsiao and Ren, 1981	HB, LC	EM, SF	5, 15
5.	<i>Bayerus pilosus</i> Hsiao, 1973	CB, LC	EM, SF	15
6.	<i>Neoirta orientalis</i> Distant, 1919	CB	EM, ES	15, 11
7.	<i>Parascadra rubida</i> Hsiao, 1973*	CB, LC	EM	15
8.	<i>Vilius melanopterus</i> Stal, 1863	CB, LC	EM	5, 11
Subfamily <i>Peiratinae</i> Amyot and Serville, 1843				
9.	<i>Sirthena dimidiata</i> Horvath, 1911	LC	EM, ES	15, 13
10.	<i>Sirthena flavipes</i> Stal, 1855	HB, SL, BK, LS, CB	EM, GL, AE	3,4
11.	<i>Sirthena nigra</i> Cai et Tomokuni, 2004	LC	EM, GL, AE	3,4
12.	<i>Lestomerus affinis</i> Serville, 1831	CB	EM, GL, AE	3,4,12
13.	<i>Peirates arcuatus</i> Stal, 1871	HB, SL, BK, LS, CB, LC	EM, GL, AE	3,4,12

14.	<i>Peirates leptidoides</i> Wolff, 1804	CB, LC	EM, GL, AE	4,12
15.	<i>Peirates atromaculatus</i> Stal, 1870	LC	EM, SF	unknown
16.	<i>Peirates turpis</i> Walker, 1873*	CB	-	unknown
17.	<i>Ectomocoris atrox</i> Stal, 1855	LC	EM, AE	3,4,12
18.	<i>Ectomocoris elegans</i> Fabricius, 1803	CB	EM, AE	3,4,12
19.	<i>Ectomocoris</i> <i>yunnanensis</i> Ren, 1990	LC	EM, SF	unknown
20.	<i>Ectomocoris biguttulus</i> Stal, 1870	CB, LC	EM, GL, AE	3,12
Subfamily Reduviinae Latre., 1807				
21.	<i>Acanthaspis geniculata</i> Hsiao, 1976	CB	EM, AE, ES	3,4,12
22.	<i>Acanthaspis ruficeps</i> Hsiao, 1976	HB, SL, BK, LS, CB, LC	EM, GL, AE	3,12
23.	<i>Acanthaspis collaris</i> Hsiao, 1976	LC	EM, GL, AE	3,12, 15
24.	<i>erbelius typicus</i> Distant	CB, LC	EM, AE	3,4,12
25.	<i>Brachytonus nigripes</i> Hsiao*	CB	EM, SF	unknown
26.	<i>Durganda rubra</i> Amyot & Serville*	LC	EM, SF	unknown
27.	<i>Reduvius tenebrosus</i> Stal, 1863	CB	EM, SF	5, 12, 14
28.	<i>Reduvius decliviceps</i> Hsiao, 1976	LC	EM, SF	2, 12,14
29.	<i>Reduvius gregoryi</i> China, 1925	CB, LC	EM, ES	12,14
Subfamily Saicinae Stal, 1859				
30.	<i>Polytoxus femoralis</i> Distant ,1903	CB, LC	GL, AE	1, 2, 5, 6, 7
31.	<i>Polytoxus fuscipennis</i> Hsiao, 1965	HB, SL, BK, LS, CB, LC	GL, AE	1, 2, 6, 7
32.	<i>Polytoxus ruficeps</i> Hsiao, 1965	CB, LC	EM,AE	1, 2, 6, 7, 12, 15
Subfamily Stenopodanae Amyot and Ser., 1843				
33.	<i>Lisarda pilosa</i> Hsiao, 1974	CB, LC	EM, AE	3,4,12
34.	<i>Lisarda uniformis</i> Distant, 1903	CB, LC	EM, SF	3, 4, 14
35.	<i>Lisarda rhypara</i> Stal, 1859	BK, CB	EM, SF	1, 2, 3
36.	<i>Petalochneius</i> <i>spinosissimus</i> Distant, 1903*	LC	EM, SF	unknown
37.	<i>Valentia hoffmanni</i> China, 1940	HB, SL, BK, LS, CB, LC	EM, AE	1, 2, 3
38.	<i>Aulacogenia comiculata</i> Stal, 1870	CB	EM	unknown
39.	<i>Canthesancus</i> <i>geniculatus</i> Distant, 1902	LC	EM, AE	1, 2, 3, 4, 14, 15
40.	<i>Canthesancus helluo</i> Stål, 1863	HB, BK, CB, LC	EM, SF	1, 2, 3,14, 15
41.	<i>Canthesancus</i> <i>trimaculatus</i> Amyot and Serville, 1843	HB, BK, CB, LC	EM, SF	1, 2, 3,14, 15
42.	<i>Pygolampis biguttata</i> Reuter, 1887	CB, LC	EM, AE	10, 11
43.	<i>Pygolampis longipes</i> Hsiao, 1977	CB, LC	EM,SF, AE	1, 2, 10, 13
44.	<i>Pygolampis rufescens</i> Hsiao, 1977	HB, CB, LC	EM, AE	unknown
45.	<i>Oncocephalus pudicus</i> Hsiao, 1977	HB, SL, LS, CB, LC	EM, AE	1, 2, 3, 4, 14, 15
46.	<i>Oncocephalus purus</i> Hsiao, 1977	LC	EM, SF	12, 11
47.	<i>Oncocephalus scutellaris</i> Reuter, 1882	CB, LC	ES, GL, AE	1, 2, 12, 15
48.	<i>Oncocephalus lineosus</i> Distant, 1903	CB	ES, GL, AE	12, 15
49.	<i>Staccia diluta</i> Stal, 1859	CB	EM, ES	unknown
50.	<i>Staccia plebea</i> Stal, 1866	HB, SL, BK, LS, CB, LC	EM, ES	unknown
Subfamily Emesinae Amyot and Serville, 1834				
51.	<i>Emesopsis nubilus</i> Uhler, 1984	CB	EM	unknown
52.	<i>Empicoris</i> <i>rubromaculatus</i> Blackburn, 1889	CB, LC	EM, SF	unknown
53.	<i>Ploiaria glabella</i> Wygodzinsky, 1966	LC	SF, ES	unknown
Subfamily Harpactorinae Amy. and Serv., 1843				
54.	<i>Astinus siamensis</i> Distant, 1903	SL, LS, CB, LC	EM	9, 10
55.	<i>Blasticus confucuss</i> Hsiao, 1979	SL, CB, LC	EM	1, 2,3
56.	<i>Blasticus flavinotus</i> <i>atsumura</i>	HB, SL, CB, LC	EM, GL, AE	unknown
57.	<i>Blasticus flavus</i> Distant, 1903	SL, LS, LC	EM, SF, AE	1, 2,3
58.	<i>Coranus fuscipennis</i> Reuter, 1881	HB, SL, BK, LS, CB, LC	EM, ES GL, AE	1, 2,3
59.	<i>Endochus nigricornis</i> Stal, 1859	BK, LS	EM, GL	3
60.	<i>Euagoras plagiatus</i> Burmeister, 1834	HB, BK, LS, CB, LC	EM, SF	9, 11
61.	<i>Rhynocoris marginellus</i> Fabricius, 1803	HB, CB, LC	EM	1, 2,3
62.	<i>Rhynocoris fuscipes</i> Fabricius	HB, SL, LC	EM, AE	6, 7,8
63.	<i>Isyndus reticulatus</i> Stål, 1868	HB, SL, BK, CB, LC	GL	1, 2, 3
64.	<i>Panthous ruber</i> Hsiao, 1979	CB, LC	EM	3, 13
65.	<i>Poliditus armatissimus</i> Stal, 1859	CB, LC	EM, SF	4
66.	<i>Rihirbus trochantericus</i> Stal, 1861	CB, LC	EM	5
67.	<i>Sphedanoletes</i> <i>impressicollis</i> Stal, 1861	CB, LC	EM, SF	2
68.	<i>Scycanus croceus</i> Hsiao, 1979	HB, SL, CB, LC	EM, SF	1, 2, 3

69.	<i>Sycanus croceovittatus</i> Dohrn, 1859	HB, SL, BK, LS, CB, LC	EM, SF, AE	1, 2, 3
70.	<i>Sycanus falleni</i> Stal, 1863	HB, SL, BK, LS, CB, LC	EM, SF, AE	1, 2, 3
71.	<i>Vesbius purpureus</i> Thunberg, 1783	HB, SL, BK, LS, CB, LC	EM	1, 2, 3
72.	<i>Vesbius sanguinosus</i> Stal	LC	EM, SF	-
73.	<i>Velinus malayus</i> Stal, 1863	HB, CB	EM, SF	1, 13
74.	<i>Velinus annulatus</i> Distant	HB, CB, LC	EM, SF	unknown
75.	<i>Velinus rufiventris</i> Hsiao	HB, SL, LC	EM, SF	unknown
76.	<i>Villanovanus nigrorufus</i> Hsiao, 1982	LC	EM	3, 13

Note: *Newly recorded for Vietnam. Lao Cai: LC; Cao Bang: CB; Hoa Binh: HB; Son La: SL; Bac Kan: BK; Lang Son: LS.

The species diversity of reduviid in surveyed sites

The diversity index reflects the difference in species composition between surveyed sites. This difference is also related to the number of individuals in each species and the distribution of the number of individuals in each species of the whole community. The Shannon-Weiner diversity index (H') of each study site is shown in (Table 2). The Lao Cai (Bat Xat, Hoang Lien) has the highest diversity index ($H'=3.598$) and the number of species ($N=59$). Cao Bang

(Phia Oac-Phia Den); Hoa Binh (Thuong Tien, Hoang Kia-Pa Co), Son La (Xuan Nha, Copia), Bac kan (Nam Xuan Lac) and Lang Son (Huu Lien) have the diversity index and the number of species ($H'=3.547$, $N=56$), ($H'=2.681$, $N=25$), ($H'=2.598$, $N=21$), ($H'=2.553$, $N=17$) and ($H'=2.536$, $N=15$), respectively (Table 2).

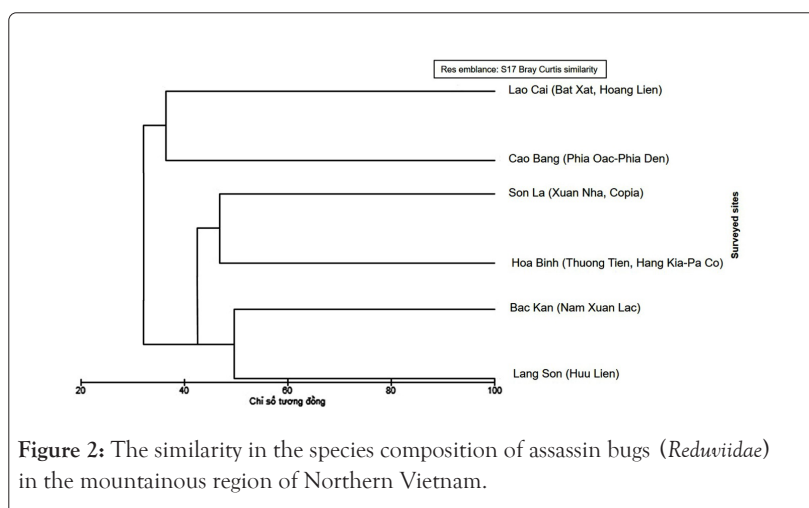
At 6 surveyed sites in the mountainous region of Northern Vietnam shows that: The index of similarity in species composition at 6 surveyed sites was divided into different groups (Figure 2). Group 1, Lao Cai (Bat Xat, Hoang Lien) and Cao Bang (Phia Oac-Phia Den) achieved 58%. Group 2, Hoa Binh (Thuong Tien, Hoang Kia-Pa Co) and Son La (Xuan Nha, Copia) nearly 65%. The similarity index between group 1 and group 2 reached nearly 43%. Group 3, Bac kan (Nam Xuan Lac) and Lang Son (Huu Lien) nearly 64%. The similarity index between group 3 and group 4 reached nearly 50%. The similarity index of groups 1, 2 and groups 3 and 4 only reached about 38%.

The prey and habitat of assassin bugs

In habitats in the mountainous region of Northern Vietnam, the higher montane evergreen forest and lower montane evergreen forest (EM) was the highest recorded 69 species (rate 45.39%); the lowland evergreen forest and lowland semi-evergreen forest (SF) were the second highest recorded 28 species (rate 18.42%); The buffer zone (ES) recorded 12 species (rate 7.89%); Grass-land (GL) recorded 17 species (rate 11.18%) and agricultural ecosystems (AE) recorded 26 species (rate 17.11%) (Figure 3).

Table 2: Index Shannon-Weiner (H') in surveyed sites.

Surveyed sites	Number of species	Number of individuals	Index (J')	Index Shannon-Weiner (H')
Lao Cai Bat Xat Nature Reserve Hoang Lien National Park	59	189	0.9375	3.598
Cao Bang Phia Oac - Phia Den National Park	56	176	0.9255	3.547
Hoa Binh Thuong Tien Nature Reserve Hang Kia - Pa Co Nature Reserve	25	58	0.9815	2.681
Son La Xuan Nha Nature Reserve Copia Nature Reserve	21	55	0.9766	2.598
Bac Kan Nam Xuan Lac Nature Reserve	17	59	0.9466	2.553
Lang Son Huu Lien Nature Reserve	15	56	0.9287	2.536
LC	LC	LC	LC	LC



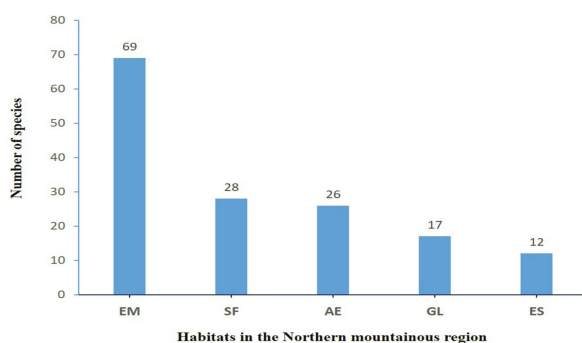


Figure 3: The species composition of assassin bugs in the mountainous region of Northern Vietnam.

In Agricultural ecosystems (AE), the numbers of species of assassin bugs that attack preys have been recorded in Figure 4. The prey of assassin bugs is the larvae of 15 species of pest insects of order Lepidoptera, Homoptera, Coleoptera and Orthoptera. Among 76 species of assassin bugs were recorded the prey of 60 species (Table 1).

The prey of 31 species is the *Spodoptera litura* species (rate 19.02%), of 22 species is *Helicoverpa armigera* (rate 13.50%), of 21 species is *Anomis flava* (rate 12.88%), of 17 species is *Chrysomela* sp. (rate 10.43%), of 15 species is *Plusia* sp. (rate 9.20%), of 14 species is *Corcyra cephalonica* (rate 8.59%) and the prey of 3-8 species of assassin bugs are the *Oxya* spp., *Nephotettix bipunctatus*, *Empoasca*

biguttula, *Empoasca flavescens*, *Erianthus* spp., *Pieris brassicae*, *Aphis* spp., *Aulacophora bicolor*, *Rhopalosiphum* spp. species (rate 1.81%-4.91%).

The results of this study are also consistent with [7,8] as the prey of assassin bugs in the Central Highlands of Vietnam are the larvae of 15 species of pest insects of order Lepidoptera, Homoptera, Coleoptera and Orthoptera. The prey of 19 species is the *Anomis flava*, the prey of 17 species is *Helicoverpa armigera*, the prey of 22 species is *Spodoptera litura*, the prey of 10 species is *Plusia* sp. and the prey of 16 species is *Corcyra cephalonica* (Figure 5).

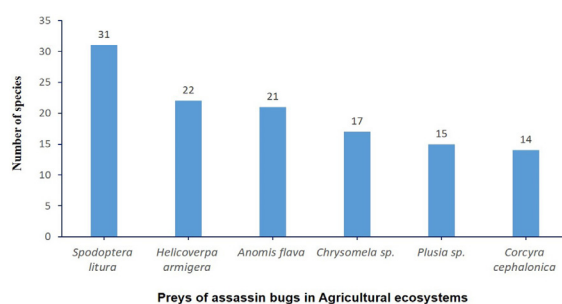


Figure 4: The prey of assassin bugs in Agricultural ecosystems in the mountainous region of Northern Vietnam.



Figure 5: The assassin bugs catch prey in agricultural ecosystems.

CONCLUSION

In the mountainous region of Northern Vietnam, 76 species of assassin bugs of 43 genera, 7 subfamilies of family *Reduviidae* in the mountainous region of Northern Vietnam were recorded with 5 species are newly recorded in Vietnam.

The Lao Cai (Bat Xat, Hoang Lien) has the highest diversity index, and Bac Kan (Nam Xuan Lac), Lang Son (Huu Lien) have the lowest diversity index. The index of similarity of species composition at 6 surveyed sites were divided into group 1, Lao Cai (Bat Xat, Hoang Lien) and Cao Bang (Phia Oac-Phia Den); group 2, Hoa Binh (Thuong Tien, Hoang Kia-Pa Co) and Son La (Xuan Nha, Cogia) and group 3, Bac Kan (Nam Xuan Lac) and Lang Son (Huu Lien).

The number of species on the higher montane evergreen forest and lower montane evergreen forest (EM) was the highest and the buffer zone (ES) recorded the lowest. In Agricultural Ecosystems (AE), the prey of assassin bugs is the larvae of 15 species of pest insects. The prey of 60 species of the family *Reduviidae* were recorded

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CONFLICT OF INTEREST

We declare that we have no conflict of interest.

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