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SPECIES COMPOSITION AND DISTRIBUTION OF LEAFHOPPERS (HEMIPTERA: AUCHENORRHYNCHA: CICADELLIDAE) IN XUAN SON NATIONAL PARK, PHU THO PROVINCE

Nguyen Thi Thu Huong[1], Christopher H. Dietrich[2] and Bui Minh Hong[3,*]
[1,3]*Faculty of Biology, Hanoi National University of Education, Hanoi, Vietnam*
[2]*Illinois Natural History Survey, Prairie Research Institute, University of Illinois, Champaign, IL 61820, USA*
*Corresponding author: Bui Minh Hong, e-mail: hongbm@hnue.edu.vn

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Abstract. The species composition and distribution characteristics of leafhoppers (Hemiptera: Cicadellidae) were investigated in Xuan Son National Park, Phu Tho Province. Direct surveys were conducted across three distinct habitats (natural forest, plantation forest, and grassland-shrub) over four sampling periods corresponding to the four seasons of the year. A total of 36 species belonging to 19 genera, 11 tribes, and 6 subfamilies were recorded. The abundance of leafhopper species in Xuan Son National Park fluctuated seasonally, decreasing from summer to winter and recovering in spring; nevertheless, species evenness remained consistently high and stable (J' > 0.80), suggesting a relatively undisturbed ecosystem. Species diversity also varied by habitat: natural forest exhibited the highest diversity (H' = 2.95; S = 27 species, 75.0%), while plantation forest, despite fewer species, maintained high diversity and balance (H' = 2.95; S = 22; 61.1%; J' = 0.95). In contrast, the grassland-shrub habitat showed the lowest diversity and significant imbalance (H' = 2.36; S = 20; 55.6%; J' = 0.79). However, species composition across the three habitats was highly similar. Representative species were identified as follows: 11 species were recorded in all three habitats, 11 in two habitats, and 14 were unique to a single habitat.

Keywords: Hemiptera, Cicadellidae, species composition, distribution, Xuan Son National Park.

1. Introduction

Xuan Son National Park, located in Phu Tho province, was established based on Xuan Son Nature Reserve under Decision No. 49/2002/QD-TTg issued by the Prime Minister on April 17, 2002. With a total area of 15,048 hectares, the park comprises three functional zones: a strictly protected zone (9,099 ha), an ecological restoration zone (5,737 ha), and an administrative and service zone (212 ha) [1]. The area possesses rich

biodiversity; according to available statistics, Xuan Son National Park has recorded 1,217 plant species, 76 mammal species, 182 bird species, 44 reptile species, 27 amphibian species, and 554 insect species, including 12 species belonging to the leafhopper family (Cicadellidae) [2]. The leafhopper family (Cicadellidae) represents the most diverse group within the suborder Auchenorrhyncha, as well as within the order Hemiptera. Globally, 47,937 species of Auchenorrhyncha have been recorded, among which Cicadellidae predominates with 23,535 species, belonging to 2,866 genera, 128 tribes, and 23 subfamilies. In Vietnam, a total of 318 leafhopper species are currently known, comprising 171 genera, 36 tribes, and 16 subfamilies [3]. Equipped with piercing-sucking mouthparts, leafhoppers not only cause direct damage to host plants through sap feeding but also act as vectors of numerous phytopathogens, including bacteria, viruses, and phytoplasmas [4]-[6]. However, the majority of studies on Cicadellidae in Vietnam have primarily focused on species checklists, while data regarding their ecology and distribution remain limited and fragmented [7]. Therefore, this study was conducted to systematically investigate the species composition and distribution characteristics of Cicadellidae in Xuan Son National Park, Phu Tho province.

2. Content

2.1. Research methods

Adult leafhopper specimens were collected in three different habitats (natural forest, plantation forest, and shrubby-grassland) during four sampling periods: July 2024, October 2024, January 2025, and May 2025. A standardized method was applied across all three habitats: a fixed transect of 3.0 – 4.0 kilometers was established in each, and continuous random sweeping was conducted every 50 – 100 meters for sample collection. The nets used had a diameter of 80 centimeters, with handle lengths adjustable from 1 to 4 meters to facilitate sampling from various positions, such as foliage, branches, inflorescences, and grass cover. The time and location of sample collection were systematically labeled during the survey to facilitate the statistical analysis and monitoring of biological indices. Leafhopper samples were collected from all three habitats.

Natural forest: Primary forest on limestone mountains covers an area of 2,432 hectares. The forest ecosystem is minimally impacted, the species composition and canopy layer remain stable, with many large trees present, and a canopy cover of over 0.8. The main tree species are: *Caryodaphnopsis tonkinensis, Pterospermum heterophyllum, Terminalia myriocarpa, Anogeissus acuminata*, and *Dysoxylum cauliflorum*.

Plantation forest: This type of forest is formed after a long period of exploitation. There are no longer valuable large trees. The vegetation mainly consists of small trees, vines, and shrubs with a canopy height of about 10 m or less. The forest trees are species belonging to the family Moraceae, such as *Streblus laxiflorus, Ficus* sp. *Euodia miliaefolia, Dalbergia balansae, Baccaurea ramiflora, Allospondias lakonensis, Derris tonkinensis, Broussonetia papyrifera.*

Grassland and shrubland: The habitat retains the characteristics of forest land. The vegetation consists largely of lush ground cover and a shrub layer, such as *Centotheca*

lappacea, Randia stenantha, Phyllanthus pseudoreticulatus, Melastoma sanguineum, Cratoxylon cochinchinensis, Ficus hirta, Trema orientalis.

Adult leafhopper specimens were collected during four sampling periods from July 2024 to April 2025, with each period spanning three months. Sampling was conducted using random sweep-netting in three habitat types: natural forest, plantation forest, and grassland–shrubland. The sweep net had a diameter of 80 cm, with a handle adjustable from 1 to 4 m, allowing sampling at various microhabitats such as leaf canopies, tree branches, flower clusters, and grass layers.

Species identification was based on the taxonomic keys provided by Dietrich (2005) [8] and other literature **Error! Reference source not found.-Error! Reference source not found.**. The following indices were calculated: the Shannon-Wiener diversity index (H') [12], the Pielou's evenness index (J') [13] and the Sørensen similarity index (SI) [14].

2.2. Research results

Through four sampling periods across three habitats in Xuan Son National Park, a total of 36 leafhopper species were recorded, belonging to 19 genera, 11 tribes, and 6 subfamilies. These results are presented in Table 1.

Table 1. Species composition of leafhoppers (Cicadellidae) in Xuan Son National Park, Phu Tho province

No	Scientific name	Genus	Tribe	Subfamily
1	*Anatkina devia* Young, 1986	*Anatkina*	Cicadellini	Cicadellinae
2	*Atkinsoniella xanthovena* Yang & Li, 2002	*Atkinsoniella*		
3	*Atkinsoniella albipenna* Yang, Meng & Li, 2017			
4	*Atkinsoniella opponens* (Walker, 1851)			
5	*Bothrogonia ferruginea* (Fabricius, 1787)	*Bothrogonia*		
6	*Bothrogonia hamata* Yang & Li, 1980			
7	*Cofana yasumatsui,* Young, 1979	*Cofana*		
8	*Cofana lata* Young, 1979			
9	*Kolla ceylonica* (Melichar, 1903)	*Kolla*		
10	*Kolla paulula* (Walker, 1858)			
11	*Olidiana bifurcata* (Nielson, 1982)	*Olidiana*	Coelidiini	Coelidiinae

12	*Olidiana filiata* Nielson, 2015			
13	*Olidiana tonkinensis* Nielson, 2015			
14	*Olidiana tuberis* Nielson, 2015			
15	*Tambocerus dentatus* Qu & Dai, 2014	*Tambocerus*	Athysanini	Deltocephalinae
16	*Maiestas dinghuensis* Zhang & Duan, 2011	*Maiestas*	Deltocephalini	
17	*Maiestas remigia* Zhang & Duan, 2011			
18	*Doratulina indra* (Distant, 1908)	*Doratulina*	Eupelicini	
19	*Sophonia lushana* (Kuoh, 1973)	*Sophonia*	Opsiini	
20	*Hishimonoides bougainvilleae* Viraktamath, Anantha Murthy & Viraktamath, 1987	*Hishimonoides*	Scaphoideini	
21	*Hishimonus aberrans* Knight, 1970	*Hishimonus*		
22	*Platyretus gangeticus* Viraktamath & Webb, 2008	*Platyretus*		
23	*Scaphoidella albopunctata* Dietrich, Nguyen & Pham, 2020	*Scaphoidella*		
24	*Scaphoideus harlani* Kitbamroong & Freytag, 1978			
25	*Scaphoideus maai* Kitbamroong & Freytag, 1978			
26	*Scaphoideus shovelaedeagus* Li, Song & Song, 2007			
27	*Carinata bisecta* Hg. Nguyen, Dietrich & Bui, 2025 *	*Carinata*	Evacanthini	Evacanthinae

28	*Multinervis guangxiensis* Li & Li, 2013	*Multinervis*	Agalliini	Megophthalminae
29	*Amrasca excavata* Dietrich, Nguyen & Pham, 2020	*Amrasca*	Empoascini	Typhlocybinae
30	*Amrasca bella* Dworakowska, 1977			
31	*Amrasca biguttula* (Ishida, 1913)			
32	*Amrasca splendens* Ghauri, 1967			
33	*Amrasca uvka* Dworakowska, 1977			
34	*Helionides pocsi* (Dworakowska, 1981)	*Helionides*		
35	*Elbelus tripunctatus* Mahmood, 1967	*Elbelus*	Erythroneurini	
36	*Elbelus wierzbowskae* Dworakowska, 1972			

*Remarks: * new species to science.*

The subfamily Deltocephalinae exhibited the highest diversity, comprising 5 tribes (45.45% of the total tribes), 8 genera (42.11% of the total genera), and 12 species (33.33% of the total species). The subfamilies Evacanthinae and Megophthalminae showed the lowest species diversity, with each subfamily represented by only 1 tribe (9.09% of total tribes), 1 genus (5.26% of total genera), and 1 species (2.78% of total species).

The species *Carinata bisecta* Hg. Nguyen, Dietrich, and Bui (2025) were recently described as a new species to science.

Seasonal distribution characteristics of leafhoppers in Xuan Son National Park, Phu Tho province, are presented in Table 2.

Table 2. Seasonal fluctuations in the species richness and individual number of leafhoppers (Cicadellidae) in Xuan Son National Park, Phu Tho province

No	**Species**	**Number of individuals**			
		Period 1 (VII.2024)	***Period 2 (X.2024)***	***Period 3 (I.2025)***	***Period 4 (IV.2025)***
1	*Anatkina devia*	1	0	0	1
2	*Atkinsoniella xanthovena*	0	1	0	1
3	*Atkinsoniella albipenna*	1	0	0	0
4	*Atkinsoniella opponens*	8	5	6	5
5	*Bothrogonia ferruginea*	8	3	2	4
6	*Bothrogonia hamata*	10	6	5	7

7	*Cofana yasumatsui*	1	1	1	0
8	*Cofana lata*	0	1	0	0
9	*Kolla ceylonica*	1	0	1	1
10	*Kolla paulula*	2	2	2	1
11	*Olidiana bifurcata*	1	3	0	1
12	*Olidiana filiata*	2	3	0	0
13	*Olidiana tonkinensis*	2	5	1	2
14	*Olidiana tuberis*	2	4	1	0
15	*Tambocerus dentatus*	1	0	0	2
16	*Maiestas dinghuensis*	1	1	1	4
17	*Maiestas remigia*	2	0	0	1
18	*Doratulina indra*	3	1	1	0
19	*Sophonia lushana*	11	9	7	6
20	*Hishimonoides bougainvilleae*	1	0	0	0
21	*Hishimonus aberrans*	5	2	1	1
22	*Platyretus gangeticus*	2	0	1	1
23	*Scaphoidella albopunctata*	1	0	0	2
24	*Scaphoideus harlani*	1	2	0	0
25	*Scaphoideus maai*	4	2	1	3
26	*Scaphoideus shovelaedeagus*	1	1	2	2
27	*Carinata bisecta*	5	2	1	1
28	*Multinervis guangxiensis*	1	0	0	0
29	*Amrasca excavata*	8	4	6	6
30	*Amrasca bella*	2	1	1	1
31	*Amrasca biguttula*	2	0	0	2
32	*Amrasca splendens*	1	0	0	0
33	*Amrasca uvka*	0	1	0	0
34	*Helionides pocsi*	0	0	1	0
35	*Elbelus tripunctatus*	1	1	0	0
36	*Elbelus wierzbowskae*	1	0	0	0
Total individuals (N)		*93*	*61*	*42*	*55*
Total species (S)		*32*	*23*	*19*	*22*
Diversity index (H')		*3.08*	*2.89*	*2.61*	*2.83*
Evenness index (J')		*0.89*	*0.92*	*0.89*	*0.92*

Note: VII.2024: July 2024; (X.2024): October 2024; (I.2025): January 2025; (IV.2025): April 2025

Regarding species diversity, the first sampling period (VII.2024) exhibited the highest diversity index (H' = 3.08). This period also recorded the largest number of individuals and species (N = 93; S = 32). The second (X.2024) and fourth (IV.2025)

periods showed moderate diversity levels, with diversity indices of H' = 2.89 (N = 61; S = 23) and H' = 2.83 (N = 55; S = 22), respectively. The third period (I.2025) had the lowest diversity (H' = 2.61, though still at a relatively moderate level), along with the fewest recorded individuals and species (N = 42; S = 19). Consequently, species diversity fluctuated significantly across seasons, decreasing from summer to winter (from period 1 to period 3) and beginning to recover in spring (period 4).

Regarding evenness, the J' indices across all four sampling periods remained high and stable (ranging from 0.89 to 0.92), demonstrating an extremely balanced distribution of leafhopper species within the study area. Specifically, no single species exhibited absolute dominance (i.e., there was no population outbreak of any particular species). Even the most abundant species, such as *Sophonia lushana* and *Bothrogonia hamata*, accounted for only a moderate proportion of the total community.

The distribution pattern of leafhoppers across habitats in Xuan Son National Park, Phu Tho Province, is presented in Table 3.

Table 3. Habitat fluctuations in the species richness and individual number of leafhoppers (Cicadellidae) in Xuan Son National Park, Phu Tho province

No	Species	Number of individuals		
		Natural forest	***Plantation forest***	***Grassland and shrubland***
1	*Anatkina devia*	0	2	0
2	*Atkinsoniella xanthovena*	0	1	1
3	*Atkinsoniella albipenna*	1	0	0
4	*Atkinsoniella opponens*	2	14	8
5	*Bothrogonia ferruginea*	10	5	2
6	*Bothrogonia hamata*	15	8	5
7	*Cofana yasumatsui*	0	3	0
8	*Cofana lata*	0	1	0
9	*Kolla ceylonica*	2	0	1
10	*Kolla paulula*	4	2	1
11	*Olidiana bifurcata*	4	1	0
12	*Olidiana filiata*	3	2	0
13	*Olidiana tonkinensis*	6	3	1
14	*Olidiana tuberis*	5	2	0
15	*Tambocerus dentatus*	1	1	1
16	*Maiestas dinghuensis*	5	0	2
17	*Maiestas remigia*	3	0	0
18	*Doratulina indra*	1	0	4
19	*Sophonia lushana*	2	2	29
20	*Hishimonoides bougainvilleae*	1	0	0
21	*Hishimonus aberrans*	6	1	2
22	*Platyretus gangeticus*	0	0	4

23	*Scaphoidella albopunctata*	3	0	0
24	*Scaphoideus harlani*	0	1	2
25	*Scaphoideus maai*	2	7	1
26	*Scaphoideus shovelaedeagus*	4	2	0
27	*Carinata bisecta*	1	1	7
28	*Multinervis guangxiensis*	1	0	0
29	*Amrasca excavata*	15	4	5
30	*Amrasca bella*	3	0	2
31	*Amrasca biguttula*	3	1	0
32	*Amrasca splendens*	0	0	1
33	*Amrasca uvka*	0	0	1
34	*Helionides pocsi*	0	1	0
35	*Elbelus tripunctatus*	2	0	0
36	*Elbelus wierzbowskae*	1	0	0
Total individuals (N)		*106*	*65*	*80*
Total species (S)		*27*	*22*	*20*
Diversity index (H')		*2.95*	*2.95*	*2.36*
Evenness index (J')		*0.89*	*0.95*	*0.79*

The natural forest habitat showed the highest abundance and species richness, with 106 individuals (accounting for 42.23%) and 27 species (75.0% of the total species). The plantation forest habitat recorded the lowest number of individuals, at 65 (25.90%) and 22 species (61.11%). In the grassland and shrubland habitat, 80 individuals were collected (31.87%), representing 20 species (55.56%).

The natural forest and plantation forest exhibited identical species diversity indices (H' = 2.95). The plantation forest, on the other hand, had a higher evenness index (J' = 0.95) than the natural forest (J' = 0.89). This means that the leafhopper community structure in the plantation forest is more stable than that in the natural forest.

The grassland and shrubland habitats exhibited the lowest diversity (H' = 2.36). Natural forest and plantation forest habitats had a wider variety of green leafhopper species compared to grassland and shrubland habitats. The evenness index for the grassland and shrubland habitat was also the lowest (J' = 0.79), which indicates that individuals of different species were not evenly distributed in this habitat.

The similarity of leafhopper species composition between different habitats is presented in Table 4.

Table 4. Similarity of leafhopper species composition (Cicadellidae) between habitats in Xuan Son National Park, Phu Tho province

Habitat	**Natural forest**	**Plantation forest**	**Grassland - shrubland**
Natural forest	SI = 1.00	SI = 0.65	SI = 0.64
Plantation forest		SI = 1.00	SI = 0.62
Grassland - shrubland			SI = 1.00

The highest similarity of species composition was observed between natural and plantation forest habitats (SI = 0.65), followed by natural forest and grassland-shrubland habitats (SI = 0.64). The plantation forest and grassland-shrubland habitats exhibited the lowest similarity (SI = 0.62).

The similarity indices for the three pairs of habitats were between 0.62 and 0.65. According to the SI classification scale, the leafhopper species composition among the surveyed habitats shows a moderate to high level of resemblance. This demonstrates a significantly high similarity in the leafhopper fauna across the surveyed habitats, suggesting that many species possess strong adaptability, allowing them to occur simultaneously in diverse environments. However, it also indicates that each habitat maintains its own group of endemic leafhopper species. Seven species were found exclusively in natural forests, namely *Atkinsoniella albipenna*, *Maiestas remigia*, *Hishimonoides bougainvilleae*, *Scaphoidella albopunctata*, *Multinervis guangxiensis*, *Elbelus tripunctatus,* and *Elbelus wierzbowskae*; four species were recorded only in plantation forests, including *Anatkina devia*, *Cofana yasumatsui*, *Cofana lata,* and *Helionides pocsi*; and three species were restricted to the grassland-shrub habitat, consisting of *Platyretus gangeticus*, *Amrasca splendens,* and *Amrasca uvka*.

3. Conclusions

A total of 36 leafhopper species belonging to 19 genera, 11 tribes, and 6 subfamilies were recorded in Xuan Son National Park, Phu Tho province. The subfamily Deltocephalidae exhibited the highest diversity, while Evacanthinae and Megophthalminae were the two subfamilies with the lowest diversity. *Carinata bisecta* Hg. Nguyen, Dietrich, and Bui (2025) were described as a new species to science. Leafhopper species richness fluctuated seasonally throughout the year, decreasing from summer to winter and increasing again during the spring, peaking in the summer with 32 species, which accounted for 88.89% of the total recorded species, and reaching its lowest point in the winter with 19 species (52.78%). In terms of habitats, the natural forest harbored the highest number of species, with 27 species, representing 75.00% of the total. This was followed by the plantation forest with 22 species (61.11%), while the grassland-shrubland habitat recorded the lowest richness with 20 species (55.56%). However, the evenness of individual distribution among species remained high and stable (J' > 0.80). This indicates that the ecosystem in the study area has experienced minimal disturbance.

The diversity of leafhopper species composition in Xuan Son National Park, Phu Tho Province, fluctuated across different habitats. The natural forest was a highly diverse habitat, demonstrating a clear dominance in species richness with H' = 2.95 and S = 27 species, which accounted for 75.00% of the total species. The plantation forest had a lower number of species (S = 22, accounting for 61.11% of the total species), yet it also exhibited high diversity (H' = 2.95) and possessed a superior community structure (J' = 0.95). The grassland-shrubland was the habitat with the fewest species (H' = 2.36 and S = 20 species, or 55.56% of the total species) and the least balanced community structure (J' = 0.79). While the leafhopper species composition across the three habitats showed a relatively high level of similarity, distinct species groups characteristic of each habitat were still present.

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