

**DIVERSITY OF LEAFHOPPERS (HEMIPTERA:
AUCHENORHYNCHA: CICADELLIDAE) ASSOCIATED WITH
PADDY AND VEGETABLE ECOSYSTEMS IN
MID COUNTRY OF SRI LANKA**

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SUMMARY

This study was conducted to assess the diversity and abundance of leafhopper (Hemiptera: Auchenorhyncha: Cicadellidae) communities in paddy and vegetable ecosystems in Peradeniya, mid country of Sri Lanka. Field survey for sampling of leafhopper fauna in both ecosystems was carried out at monthly intervals, followed by curation and identification of species.

A total of 45 species of leafhoppers belonging to 26 genera under 9 subfamilies was collected in both ecosystems. Of the 45 species, 53, 20 and 9 % of species belong to Subfamilies Deltocephalinae, Typhlocybinae and Cicadellinae respectively.

The occurrence of the six species of Deltocephaline leafhoppers, Hecalus ghaurii (Rao and Ramakrishnan) Cicadulina bipunctata (Melichar), Exitianus indicus (Distant), Exitianus nanus (Distant), Doradulina indra (Distant) and Balclutha incisa (Matsumura) have not been documented previously in Sri Lanka.

The leafhopper community in the vegetable ecosystem was more diverse (Shannon-Wiener index (H') = 3.52) than rice ecosystem (H' = 3.32). Vegetable ecosystem had 44 species representing nine subfamilies while paddy ecosystem had 32 species representing 3 subfamilies. No specific species was dominating the other species in any of the ecosystems; Simpson index (D) was 0.037 and 0.040 in vegetable and paddy ecosystems respectively.

INTRODUCTION

Leafhoppers (Hemiptera: Auchenorrhyncha: Cicadellidae) are generally 2-11 mm long, wedge shape, highly abundant, widely distributed, phytophagous insects. Leafhoppers could be easily distinguished since they possess one or more rows of short spines along hind tibia (DeLong, 1971). Leafhoppers injure the plants by feeding on sap and subsequently transmitting plant viruses. Injury caused during oviposition on plant could be significant in some occasions. Nearly about 1 % of known species (20,000) is considered as pests of cultivated crops (Nielson, 1979). In Sri Lanka several species of leafhoppers are considered as serious pest species. Leafhopper complex also functions as an important component of the food web. Leafhoppers are an important prey for predators, particularly for spiders, ants, and birds. They are also essential host organisms for parasitoids of the families Dryinidae, Mymaridae, Pipunculidae and Strepsiptera.

Very rich insect diversity exists in Sri Lanka (Wijesekara and Wijesinghe, 2003), perhaps common with leafhoppers. The species composition of leafhopper community could vary with ecosystems. There were 213 leafhopper species recorded in Sri Lanka of which 103 species were reported from Peradeniya (Melichar, 1903; Distant, 1908; Dworakowska, 1994; Viraktamath and Parvathi, 2002 and Viraktamath, 2007). However, no study was carried out on assessment of diversity of leafhoppers on ecosystem basis over the last couple of decades. Therefore, this study was carried out with the objective of assessing the leafhopper diversity in paddy and vegetable ecosystems in the mid country areas of the country.

MATERIALS AND METHODS

This study was carried out during January - December 2007 at the Department of Agricultural Biology, Faculty of Agriculture, University of Peradeniya. The study consisted of two major components: (1) field collection of leafhoppers in paddy and vegetable ecosystems and (2) microscopic examination, curation and identification of the collected species.

Two sites at Peradeniya, (7° 15' 13.15" N; 80° 35' 50.32" E, 494 m in Mid Country Wet Zone) were selected for sampling based on the history of pesticide application, cropping system and access to fields. One sampling site was a paddy field and adjoining grasses and the other a vegetable field and its adjoining grasses. Paddy field (1 ha) was under conventional rice cultivation and the vegetable field (0.25 ha) was under pesticide free cultivation over several years, maintained by the Department of Agricultural Biology.

Two quadrates (10 m X 10 m) were used to collect leafhoppers from paddy and adjoining grasses and in vegetables, trees and adjoining grasses. Quantitative sampling of leafhoppers was carried out at monthly intervals for 12 months from January-December 2007, using standard sweep nets within randomly chosen two quadrates from 8.00 and 10.00.am. Ten sweeps in each quadrate of each habitat were taken as one sample. Sampled leafhoppers were aspirated from the net and dried at 30° C for 24 hours. Leafhoppers were processed (Knight, 1965) and the morphological characters were examined under stereo binocular microscope (Meiji EMZ). Specimens were keyed out into species using published keys Distant (1908, 1918), Dietrich (2005), Viraktamath (2005a, 2005b). Identities of the specimens were confirmed by Dr. C.A, Viraktamath, Emeritus Professor, Insect Systematic Unit, University of Agricultural Sciences, Bangalore, India..

The identified leafhoppers were deposited as voucher specimens in the insect museum in Department of Agricultural Biology, Faculty of Agriculture, University of Peradeniya together with the collection data.

The data was analyzed using diversity indices (Magurran, 1987). Species richness (S) (number of species in a particular area); Shannon –Weiner diversity index -H' (Information index) $H' = -\sum p_i \ln p_i$, where p_i , the proportional abundance (n_i/N) of the i^{th} species, Simpson's index- D (Dominance Index) = $D = 1 / \sum_i p_i^2$ and the evenness (E): $E = H' / \ln S$ were calculated to each habitat.

RESULTS AND DISCUSSION

During the survey in both agro ecosystems at Peradeniya, Mid Country, 2335 specimens of leafhoppers were collected and they belonged to 45 species under nine sub families (Table 1). Of these 25 species belonged to the Subfamily Deltocephalinae and they contributed 61.9 and 46.3 % of the total abundance in the paddy ecosystem and the vegetable ecosystem respectively. All the species except *Deltocephalus distinctus* were found in the vegetable ecosystem. *Deltocephalus* species (II) and *Aconeurella* species (II) were not found in the paddy ecosystem.

Table 1. Structure of Leafhopper Communities in Paddy and Vegetable Ecosystems Together with Adjoining Grass Lands at Peradeniya, Mid Country Wet Zone of Sri Lanka

Leafhopper species	Paddy ecosystem	Vegetable ecosystem	Recorded Occurrence in Sri Lanka
Subfamily: Cicadellinae			
<i>Cofana lineata</i> (Distant)	+ grass, Paddy	+ grass	1
<i>Cofana spectra</i> (Distant)	+ grass, Paddy	+ grass	1, 6
<i>Cofana unimaculata</i> (Signoret)	+ grass, Paddy	+ grass	
<i>Kolla ceylonica</i> (Melichar)	+ grass, Paddy	+ grass	4
Subfamily: Coelidiinae			
<i>Calodia ostenta</i> (Distant)	-	+ curcubita	1
Subfamily: Deltocephalinae			
<i>Aconeurella</i> sp.I	+ grass	+ grass	
<i>Aconeurella</i> sp. II	-	+ grass	
<i>Balclutha incise</i>	+ grass	+ grass	NR
<i>Balclutha</i> sp. I	+ grass	+ grass	6
<i>Balclutha</i> sp. II	+ grass	+ grass	
<i>Changwhania ceylonensis</i> (Baker)	+ grass	+ grass	4
<i>Cicadulina bipunctata</i> (Melichar)	+ grass	+ grass	NR
<i>Deltocephalus</i> (R) <i>distinctus</i> Motschulsky	+ grass	-	6
<i>Deltocephalus</i> (R) <i>porticus</i> Melichar	+ grass	+ grass	4
<i>Deltocephalus</i> sp I	+ grass	+ grass	
<i>Deltocephalus</i> sp II	-	+ grass	
<i>Doratulina indra</i> (Distant)	+ grass	+ grass	NR
<i>Doratulina jacosia</i> Melichar	+ grass	+ grass	4
<i>Exitianus indicus</i> (Distant)	+ grass	+ grass	NR
<i>Exitianus nanus</i> (Distant)	+ grass	+ grass	NR
<i>Hecalus arcuatus</i> (Motschulsky)	+ grass	+ grass	4,1
<i>Hecalus porectus</i> (Walker)	+ grass	+ grass	1
<i>Hecalus</i> sp.	+ grass	+ grass	
<i>Hecalus</i> sp. nr. <i>ghaurii</i> Rao & Ramakrishnan	+ grass	+ grass	NR
<i>Hishimonus phycitis</i> (Distant)	+ grass	+ brinjal	1
<i>Nephotettix nigropictus</i> (Stal)	+ grass, paddy	+ grass	6
<i>Nephotettix parvas</i> Ishihara & Kiwase	+ grass, paddy	+ grass	6
<i>Nephotettix virescens</i> (Distant)			6
Pruthi	+ grass, paddy	+ grass	
<i>Racilia dorsalis</i> (Motschulsky)	+ grass,	+ grass	6

Leafhopper species	Paddy ecosystem	Vegetable ecosystem	Recorded Occurrence in Sri Lanka
Subfamily: Iassinae			
<i>Batrocomorphus</i> sp.	-	+ grass	
Subfamily: Idiocerinae			
<i>Idioscopus clypealis</i> (Lethierry)	-	+ avacado	4,6,8,3
<i>Idioscopus nitidulus</i> (Walker)	-	+ avacado	4,6,8,3
Subfamily: Nirvaninae			
<i>Nirvana pallida</i> Melichar	-	+ grass, brinjal	6
<i>Sophana longitudinalis</i> (Distant)	-	+ grass	1
Subfamily: Penthiminae			
<i>Neodartus acocephaloides</i> Melichar	-	+ grass	4
Subfamily: Signoretinae			
<i>Preta gratiosa</i> Melichar	-	+ grass	4
Subfamily: Typhlocybinae			
<i>Amrasca biguttula biguttula</i> (Ishida)	-	+ brinjal, okra, bean	6, 2,5
<i>Bagoidea rubra</i> (Melichar)	-	+ grass	4
<i>Empoasca</i> sp.	-	+ grass	
<i>Empoasca triangularis</i> Dworakowska	-	+ bean, carrot, brinjal	4,2
<i>Empoasca cilla</i> Dworakowska	+ grass	+ grass	7
<i>Empoasca maculifrons</i> (Motshulsky)	+ grass	+ grass	6,2,7
<i>Seriana</i> sp. II	+ grass	+ grass	
<i>Seriana</i> sp I	+ grass	+ grass	
<i>Thaia subrufa</i> (Motschulsky)	+ grass, paddy	+ grass	6,2,7

+ Presence - Absence of species NR: New record for Sri Lanka

Recorded occurrence in Sri Lanka:

1. Distant (1908)
2. Dworakowska, (1994)
3. Gnanaswaran *et al* (2007)
4. Melichar (1903)
5. Visuvalingam and Gnanaswaran (2003)
6. Wilson and Claridge (1991)
7. Wijeratne (1999)
8. Wijesekara and Menike (1997).

The leafhoppers of the genus *Hecalus* Stål were associated with grasses in both ecosystem. Of the 23 species of *Hecalus*, recorded in Oriental Region (Morrison, 1973; Rao and Ramakrishnan, 1990), only three species, *H. Portectus*, *H. arcuatus*, and *H. ghaurii* were found in studied ecosystems.

Six species of Deltocephalinae leafhoppers, *Hecalus ghaurii* (Rao & Ramakrishnan) *Cicadulina bipunctata* (Melichar), *Exitianus indicus* (Distant), *Exitianus nanus* (Distant), *Doradulina indra* (Distant) and *Balclutha incisa* (Matsumura) were recorded in this study which had not previously recorded in Sri Lanka (Oman *et al.*, 1990).

The species *Cicadulina bipunctata* was described as *Gnathodus bipunctatus* by Melichar (1904) and also has been known as *Cicadula bipunctata* Matsumura (Webb, 1987). This species is common in rice in Asia and has been found as a vector of Ragi streak virus (Nielson, 1979). However, this species is not considered as a serious pest (Wilson and Claridge, 1991).

The second largest species assemblage in this collection belongs to Subfamily Typhlocybinae represented by nine species (Table 1). All nine species were present in the vegetable ecosystem contributing 33 % of the species composition collected in this habitat. *Amrasca biguttula biguttula* (Ishida) formally *Empoasca devastant* Distant, a well known vector of little leaf of brinjal in India (Nielson, 1979), was found in the vegetable ecosystem only. It contributed 10 % of the total leafhopper abundance in vegetable ecosystem. Okra, brinjal, bitter gourd and beans are the breeding host of this species. Another green leafhopper, *Empoasca triangularis* (Dworakowska, 1980a) was collected from beans, carrot, and brinjal. *Empoasca maculifrons*, and *Empoasca cilla* (Dworakowska, 1980b) were found in both ecosystems mainly on adjoining grasses. *Thaia subrufa* has been reported as pest on seedling rice in India (Gowda *et al.*, 1983).

Overall relative species abundance (Table 2) varied from 0.14 to 6.62 % with 32 species, and 0.33 to 9.66 % with 45 species in the paddy and vegetable ecosystem respectively. The evenness (E) was relatively high in both communities indicating that no specific species dominated in the species assemblage. This is further confirmed by low dominance index and high evenness ($D = 0.040$; $E = 0.95$ and $D = 0.037$; $E = 0.93$ in paddy and vegetable ecosystems respectively). As illustrated in the rank order-log abundance plot (Fig. 1), the leafhopper community in the vegetable ecosystem was more equitable than that of it in the paddy ecosystem. These two communities could not be discriminated according to their diversity as indices rank them in opposite ways; this is shown by the intersecting two curves (Magurran, 1987).

Table 2. Structure of Leafhopper Community and Relative Abundance in Paddy and Vegetable Ecosystems in Peradeniya, Mid Country Wet Zone of Sri Lanka

Subfamily	Paddy ecosystem		Vegetable ecosystem	
	Species richness	Abundance (%)	Species richness	Abundance (%)
Cicadellinae	4	19.7	4	14.4
Coelidiinae	-		1	0.33
Deltocephalinae	23	61.9	24	46.3
Iassinae	-		1	0.44
Idiocerinae	-		2	2.44
Nirvaninae	-		2	2.21
Penthiminae	-		1	0.44
Signoretinae	-		1	0.44
Typhlocybinae	5	18.4	9	33
Total	32	100	45	100

Table 3. Diversity Parameters of Leafhopper Fauna in Paddy and Vegetable Ecosystems in Peradeniya, Mid Country Wet Zone of Sri Lanka

Diversity	Habitat	
	Paddy ecosystem	Vegetable ecosystem
Abundance - N	1434	901
Species richness – S	32	44
Simpson index - D	0.0408	0.037
Simpson's index 1-D	0.9591	0.963
Simpson's Reciprocal index- 1/D	24.5	26.9
Shannon- Wiener Index H'	3.3	3.52
Evenness -E	0.95	0.93

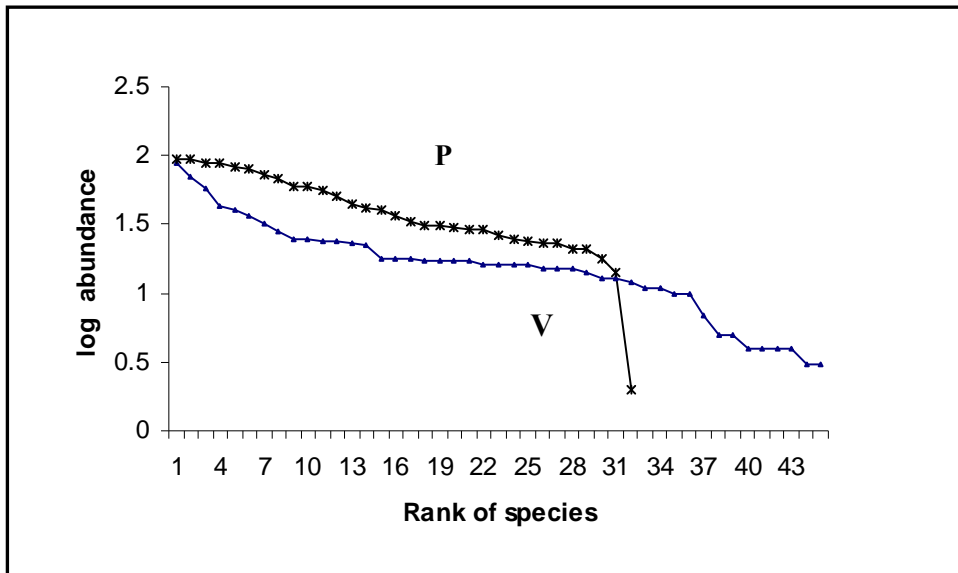


Fig.1. Relationship Between Species Sequence and Log Abundance for Leafhopper Communities in Paddy and Vegetable Ecosystems in Peradeniya, Mid Country Wet Zone of Sri Lanka

Note : P = Paddy ecosystem V = Vegetable ecosystem

CONCLUSIONS

A total of 45 species belonging to nine subfamilies was found in Vegetable and paddy ecosystems in Mid Country Wet Zone area in Sri Lanka. Species diversity was higher in vegetable ecosystem than rice ecosystem. Deltocephalinae was the most abundant and diverse subfamily in both ecosystems.

ACKNOWLEDGEMENTS

The Sri Lanka Council for Agricultural Research Policy is acknowledged for financial support for this study (12/668/504). The authors thank Prof. C.A. Viraktamath, University of Agricultural Sciences, Bangalore, India for the confirmation of identities of leafhoppers and Mr. U.G.L.T. Gunawardana, for assistance in field collection of leafhoppers.

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