

Community Structure of Leaf-and Planthoppers (Auchenorrhyncha: Hemiptera) on Rice Ecosystem in Samosir Island-Sumatera-Indonesia

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Abstract: *The research with the aim to know taxonomic composition, abundance, diversity, evenness of leaf- and planthoppers on rice ecosystem at Samosir Island in Sumatera-Indonesia has been done. Leaf-and planthoppers were collected by using insect net in stubble field and vegetation periods of rice crops. Hoppers sampling has been carried out for six months (May to October 2014 and 2015) at four sites sampling. Research result showed that there was elevenhoppers species on rice ecosystem of Samosir island, four species (*Nilaparvata lugens*, *Sogatella furcifera*, *Nisia nervosa*, *Siphanta sp.*) belonged to planthopper (Fulgoroidea) and seven species (*Nephotettix virescens*, *Nephotettix nigropictus*, *Cofana spectra*, *Recelia dorsalis*, *Thaia ghauri*, *Empoasca sp.* and *Cicadellid sp.*) to leafhopper (Cicadelloidea). Dominant hoppers and very frequent their occurrence were *N. nigropictus*, *Thaia ghauri*, *Cofana spectra* and *Recelia dorsalis*. Species richness and hopper abundance in stubble field period was higher than in vegetation period. Abundance, diversity and evenness of hoppers in the year 2014 were higher than in 2015.*

Keywords: Leaf and plant hoppers (auchenorrhyncha), samosir island, abundance, diversity, evenness

1. Introduction

Leaf- and planthoppers (Auchenorrhyncha: Hemiptera) are phytophagous insects and have body length about 1 mm until more than 1 cm [1]. They are important pests of cultivated crops and injure the plants by feeding on sap and subsequently cause yield loss. According to Nault & Ammar [2] and Matthews [3] from 15,000 leaf and planthoppers that be known, 49 species belongs to vector. There is 12 viruses and mycoplasma like organisms (MLO) diseases that could be transmitted by leaf and planthopper on rice [4].

Indonesia has many nature and artificial ecosystem that can act as good host for diverse leaf-and plant hoppers. Samosir island that be located in North Sumatera Province for example, it belongs into highland Tapanuli area with the altitude more than 900 m. Samosir island is rounded by Toba lake and formed by volcanos eruption that occurred seventy thousand years ago. Therefore, Samosir island has specific ecosystem compare it to another Indonesia ecosystem.

Studies about leaf-and planthoppers community on Indonesia diverse ecosystem, especially in North Sumatera are very limited. The most of leaf-and planthoppers studies were conducted in Java [5,6,7,8,9]. There is no study that has been done to assess their occurring atrice crop ecosystem in Samosir island.

Considering the importance of leaf-and planthopper in the rice crop ecosystem and also because the information about its community structure in Samosir island still is empty, this study has been conducted with the objective of assessing its taxonomic composition, diversity, abundance, evenness and occurrence or frequency. The knowledge of this hopper community structure is essential for integrated pest management.

2. Research Methods

Four sampling sites at non irrigated rice field (each site 0.50 ha) have been set (Fig.1) by this study in Samosir island. The sites lies at altitude 903m-928m. The sampling sites were Tomok (N:2°39'19.34"; E:98°52'42.18"), Ambarita (N:2°39'40.28"; E:98°50'42.65"), Lumban Suhi-suhi (N:2°39'8.77"; E:98°41'23.54") and Pangururan (N:2°36'41.73"; E:98°41'37.34"). Leaf-and planthoppers sampling were done at monthly in conventional rice cultivation field at vegetation- and stubble field periods. The hoppers were caught by using standard sweeps net and done in the western, eastern and windward sides of the field [10,11]. One hundred sweeps in each sampling site were taken as one sample. Hoppers collection were carried out for six months from May-October 2014 and 2015. Sampled hoppers were dry preserved, labeled and transported to the lab for curation and identification. Species identification was done under stereo binocular microscope in taxonomy laboratory of Biology Department of Medan State University and based on Wilson and Claridge [4,12]. The identified leaf-and planthoppers were deposited in 70% alcohol in the Entomological Collection at Taxonomy Laboratory of Biology Department of Medan State University.

The leaf-and planthoppers community data between two vegetation and stubble field periods in two years of investigation were analyzed on species richness (S), abundance (N), Simpson's index (Ds and 1-Ds), Simpson's reciprocal index (1/Ds), Shannon-Wiener index (H'), Evenness index (E) [13,14,15]. The Relative Importance Index (RII) of the species was determined for an estimation the abundance and occurrence or frequency [16,17].

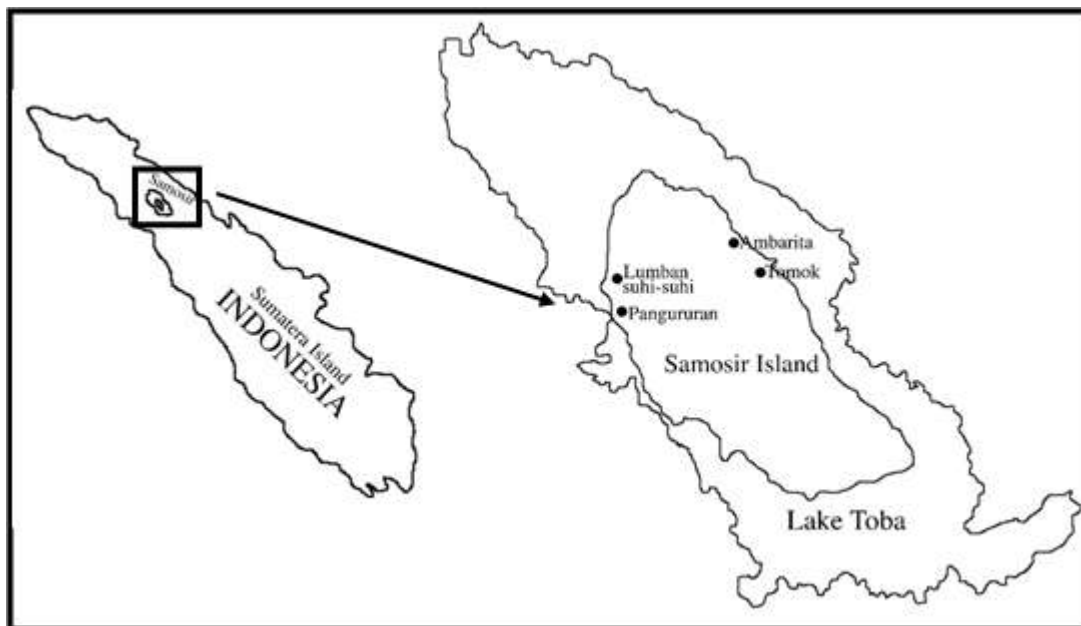


Figure 1: Sketch map of four sampling sites of leaf-and planthopper in Samosir island

3. Results and Discussion

3.1 Taxonomic Composition and Relative Importance Index

3.1.1. Stubble field period in the year 2014 and 2015

During the studies in the year 2014 and 2015 on the stubble field in Samosir island, 11 species of hoppers were collected (Table 1 and 2). Of these 11 species, seven species (63.63%) belonging to leafhopper (Cicadelloidea) and four species (36.36%) belonging to planthopper (Fulgoroidea). The species richness of hoppers in 2014 was higher (11 species) than in 2015 (10 species). The hopper species that occurred in the both years of the study were most similar, except for *Siphanta sp.* It was present in the year 2014 but absent in the year 2015. The occurrence of *Siphanta* in Samosir island (Sumatera) by this investigation is new record because the distribution area of this hopper has been reported primarily in Australia and Indomalayan [18]. The presence of *Siphanta sp.* in Indonesia has been reported in Lombok, Flores, Sumbawa, Timor, Java, Bali and West Papua. According to Fletcher, *Siphanta sp.* is a pest of banana and citrus [18]. Therefore, the occurring of *Siphanta sp.* in rice ecosystem of Samosir was probably accidental.

In comparing to the plant and leafhoppers on rice ecosystem in Philippines, the composition of leaf-and planthoppers that could be found in this research mostly were

similar [19]. Furthermore, the presence of species *Cofana spectra*, *Nephotettix nigropictus*, *N. virescens*, *Recelia dorsalis* and *Thaia ghaurion* rice ecosystem as in this present study also have been reported on paddy ecosystem in Mid Country of Srilanka [20] and in Tripura India [21]. Green leafhopper *Nephotettix spp.* in this research just consisted of two species, whereas, in Bangladesh it has been reported five species [22]. Besides *Nephotettix nigropictus* and *N. virescens*, there was also present *N. malayanus*, *N. cinticeps* and *N. parvus*.

Hoppers that be found in this study belonging to economically important leaf-and planthoppers because mostly of them can act as mayor and minor pests and also act as a virus vector that can cause rice yield loss. *Nephotettix virescens*, *N. nigropictus* and *Recelia dorsalis* are tungro virus vector. *Nilaparvata lugens* is vector of rice grassy stunt and ragged stunt viruses [4]. *Cofana spectra* has been reported as minor pest in West Bengal India and major pest in West Africa [23].

Based on RMII data as in Table 1 and 2, *Nephotettix nigropictus*, *Cofana spectra*, *Thaia ghauri* and *Recelia dorsalis* belonged to species very frequent ($RII \geq 10.00$) in stubble field period, whereas *Siphanta sp.* was species occasional.

Table 1: Leaf-and planthopper composition and RII in stubble period in rice ecosystem in Samosir island in the year 2014

Species	May	June	July	Augt	Sept	Oct	Abd.	RII	Note
FULGOROIDEA									
Fam. Delphacidae									
1. <i>Nilaparvata lugens</i>	+	+	+	+	+	+	13	2.53	frequent
2. <i>Sogatella furcifera</i>	+	+	-	+	+	+	21	3.41	frequent
Fam. Meenoplidae									
3. <i>Nisia nervosa</i>	-	-	+	-	+	+	19	1.85	frequent
Fam. Flatidae									
4. <i>Siphanta sp.</i>	-	-	-	-	+	-	1	0.03	occasional
CICADELLOIDEA									
Fam. Cicadellidae									
5. <i>Nephotettix virescens</i>	+	+	+	+	+	+	28	5.46	frequent
6. <i>Nephotettix nigropictus</i>	+	+	+	+	+	+	159	31.05	very frequent
7. <i>Cofana spectra</i>	+	+	+	+	+	+	102	19.92	very frequent
8. <i>Recelia dorsalis</i>	+	+	+	+	+	+	53	10.35	very frequent
9. <i>Thaia ghauri</i>	+	+	+	+	+	+	73	14.25	very frequent
10. <i>Empoasca sp.</i>	-	-	+	+	+	+	16	2.06	frequent
11. <i>Cicadellid sp.</i>	+	+	+	+	+	+	27	5.27	frequent
Total abundance							512		
Species richness	8	8	9	9	11	10	11		

Abd. Abundance + Presence - Absence of species

Table 2: Leaf-and planthopper composition and RII in stubble period in rice ecosystem in Samosir island in the year 2015

Species	May	June	July	Augt	Sept	Oct	Abd.	RII	Note
FULGOROIDEA									
Fam. Delphacidae									
1. <i>Nilaparvata lugens</i>	+	+	+	-	+	+	9	1.79	frequent
2. <i>Sogatella furcifera</i>	+	+	-	+	+	+	13	2.59	frequent
Fam. Meenoplidae									
3. <i>Nisia nervosa</i>	+	-	+	-	+	+	12	1.91	frequent
CICADELLOIDEA									
Fam. Cicadellidae									
4. <i>Nephotettix virescens</i>	+	+	+	+	+	+	20	4.79	frequent
5. <i>Nephotettix nigropictus</i>	+	+	+	+	+	+	102	24.46	very frequent
6. <i>Cofana spectra</i>	+	+	+	+	+	+	104	24.94	very frequent
7. <i>Recelia dorsalis</i>	+	+	+	+	+	+	35	8.39	frequent
8. <i>Thaia ghauri</i>	+	+	+	+	+	+	97	23.36	very frequent
9. <i>Empoasca sp.</i>	-	-	-	-	+	+	6	1.43	frequent
10. <i>Cicadellid sp.</i>	+	+	+	-	+	+	19	3.79	frequent
Total abundance							417		
Species richness	9	8	8	6	10	10	10		

3.1.2. Vegetation period in the year 2014 and 2015

In the vegetation period of rice crop in the year 2014 and 2015 there was only 10 species hoppers that could be collected (Table 3 and 4), that means a lower species richness than in stubble field periods (11 species). The higher species richness in stubble field compared to vegetation period may be due to the presence of some weeds. Weeds can act as food plants, oviposition alternative host or shelter plant for hoppers [17]. The taxonomic composition of hoppers that could be obtained in this vegetation period was similar with in stubble field period except the absence of *Nisia nervosa*. Of 10 species, seven species (70%) belonging to leafhopper (Cicadelloidea) and three species (30%) to planthopper (Fulgoroidea). The number of species in vegetation period 2015 was less (9

species) than in 2014 (10 species). The presence of *Siphanta sp.* in the vegetation period in the year 2014 confirmed its occurrence in rice ecosystem in Samosir island. As in stubble field period, collected hoppers in vegetation period also belongs to economic importance species. The peak of hopper species richness both in stubble and vegetation periods occurred in September and October 2014 and 2015, whereas, the less species number occurred in May and August.

Based on their occurrence in the field and RII value during vegetation period in the year 2014 and 2015 (Table 3 and 4), *N. nigropictus*, *T. ghauri*, *C. spectra* and *R. dorsalis* belonged also to species very frequent as in stubble field period, whereas *Siphanta sp.* became species less frequent.

Table 3: Leaf-and planthopper composition and RII in vegetation period in rice ecosystem in Samosir island in the year 2014

Species	May	June	July	Augt	Sept	Oct	Abd.	RII	Note
FULGOROIDEA									
Fam. Delphacidae									
1. <i>Nilaparvata lugens</i>	-	+	+	+	+	+	8	2.81	frequent
2. <i>Sogatella furcifera</i>	+	+	-	+	+	+	22	8.08	frequent
Fam. Flatidae									
3. <i>Siphanta sp.</i>	-	-	-	-	+	+	3	0.42	less frequent
CICADELLOIDEA									
Fam. Cidaellidae									
4. <i>Nephotettix virescens</i>	-	+	+	+	+	+	14	4.92	frequent
5. <i>Nephotettix nigropictus</i>	+	+	+	+	+	+	30	12.65	very frequent
6. <i>Cofana spectra</i>	+	+	+	+	+	+	55	23.20	very frequent
7. <i>Recelia dorsalis</i>	+	+	+	+	+	+	28	11.81	very frequent
8. <i>Thaia ghauri</i>	+	+	+	+	+	+	42	17.72	very frequent
9. <i>Empoasca sp.</i>	-	-	+	+	+	+	28	7.87	frequent
10. <i>Cicadellid sp.</i>	-	-	+	+	+	+	7	1.96	frequent
Total abundance							237		
Species richness	6	8	9	9	10	10	10		

+ Presence

- Absence of species

Table 4: Leaf-and planthopper composition and RII in vegetation period in rice ecosystem in Samosir island in the year 2015

Species	May	June	July	Augt	Sept	Oct	Abd.	RII	Note
FULGOROIDEA									
Fam. Delphacidae									
1. <i>Nilaparvata lugens</i>	-	+	+	-	+	+	4	1.25	frequent
2. <i>Sogatella furcifera</i>	+	+	-	+	+	+	14	5.50	frequent
CICADELLOIDEA									
Fam. Cicadellidae									
3. <i>Nephotettix virescens</i>	+	+	+	+	+	+	9	4.24	frequent
4. <i>Nephotettix nigropictus</i>	+	+	+	+	+	+	29	13.67	very frequent
5. <i>Cofana spectra</i>	+	+	+	+	+	+	52	24.52	very frequent
6. <i>Recelia dorsalis</i>	+	+	+	+	+	+	23	10.84	very frequent
7. <i>Thaia ghauri</i>	+	+	+	+	+	+	64	30.18	very frequent
8. <i>Empoasca sp.</i>	-	+	+	+	+	+	12	4.71	frequent
9. <i>Cicadellid sp.</i>	-	-	+	-	+	+	5	1.17	frequent
Total abundance							212		
Species richness	6	8	9	7	9	9	9		

3.2 Abundance

In the two years vegetation period, there was 449 individuals hoppers that could be collected (237 individuals in 2014 and 212 individuals in 2015) (Table 4 and 5). Meanwhile, in the two years stubble periods 929 individuals of hopper could be caught (512 individuals in 2014 and 417 individuals in 2015). It means, the abundance of hopper in stubble periods was more than in vegetation periods and the abundance in the year 2014 (749 individuals) was higher than in 2015 (629 individuals). The higher of hoppers abundance in the stubble field periods than in vegetation periods of rice ecosystem closed probably due to the occurrence of weeds in the field. These weeds can act as a food resource, mating sites for hoppers and therefore contributed on abundance and survival of hoppers [10,11,17]. Some of weeds that could be observed and identified in stubble field during research was *Cyperus spp.*, *Digitaria spp.*, *Echinochloa spp.*, *Fimbristylis sp.*, *Leptochloa sp.* and *Leersia sp.* Meanwhile, the higher abundance of hoppers in the year 2014 than in 2015 was

may be due to the dry season that occurred during in 2015. The effect of dry season on the decreasing of rice hopper abundance has been reported by Begum *et al.*[22].

The relative abundance of hoppers (in percentage) during two years and two growth periods of rice ecosystem in Samosir island be presented in Table 5. Based on these data, *Cofana spectra*, *Nephotettix nigropictus*, *Thaia ghauri* and *Recelia dorsalis* belonged to dominant and common hoppers. The dominance of these four hopper species in rice ecosystem was different compared to Philippines [19]. The abundance of green leafhopper *N. nigropictus* was higher than *N. virescens*. It may be due to the transplanting of local varieties rice in the field and less using N application [22, 24]. The more abundant of *N. nigropictus* compared to *N. virescens* in this present study confirmed the finding of Begum *et al.* that stated *N. virescens* was more dominant in rice fields from low altitude and *N. nigropictus* was predominant in rice fields from high altitude [22].

Table 5: Leaf-and Planthoppers species composition and abundance (as indicated by percentage of total number of leaf-and planthoppers found) at the vegetation and stubble field periods of rice ecosystem in Samosir island in the year 2014 and 2015

	Tg (30.18)	Cs (23.20)	Cs (24.94)	Nn (31.05)
	Cs (24.52)	Tg (17.72)	Nn (24.46)	Cs (19.92)
	Nn (13.67)	Nn (12.65)	Tg (23.26)	Tg (14.23)
	Rd (10.84)	Rd (11.81)	Rd (8.39)	Rd (10.35)
	Sf (6.60)	Em (11.81)	Nv (4.79)	Nv (5.46)
	Em (5.66)	Sf (9.28)	Ci (4.55)	Ci (5.27)
	Nv (4.24)	Nv (5.90)	Sf (3.11)	Sf (4.10)
	Ci (2.35)	Nl (3.41)	Nne (2.87)	Nne (3.71)
	Nl (1.88)	Ci (2.95)	Nl (2.15)	Em (3.12)
		Si (1.26)	Em (1.43)	Nl (2.53)
				Si (0.19)
Sampling time/periods	Vegetation 2015	Vegetation 2014	Stubble 2015	Stubble 2014

Note: Number in parentheses indicate the percentage of individuals to the total number of leaf-and planthoppers found at the site. Nl, *Nilaparvata lugens*; Sf, *Sogatella furcifera*; Nne, *Nisia nervosa*; Si, *Siphanta*; Nv, *Nephotettix virescens*; Nn, *Nephotettix nigropictus*; Cs, *Cofana spectra*; Rd, *Recelia dorsalis*; Tg, *Thaia ghauri*; Em, *Empoasca canara*; Ci, *Cicadellid*.

3.3. Diversity and Evenness Index

The diversity and evenness index of leaf and planthopper in the two years of investigation in rice ecosystem of Samosir island is displayed in Table 6. The Simpson, Shannon-Wiener and Evenness indexes of leaf-and planthoppers were highest in the vegetation period in the year 2014. These values indicated that community structure of hoppers was more stable during vegetation period in the year 2014 compared to other sampling periods. Furthermore, it also means the coexistence or cohabitation life of hoppers was better [25,26].

Table 6: Species richness, abundance, diversity index and evenness of leaf-and planthoppers community during two years investigation in rice ecosystem in Samosir island

Parameters	Rice crop ecosystem habitat			
	Stubble field period		Vegetation period	
	2014	2015	2014	2015
Species richness (s)	11	10	10	9
Abundance (N)	512	417	237	212
Simpson's index (Ds)	0.82	0.81	0.86	0.81
Simpson's index (1-Ds)	0.18	0.19	0.14	0.19
Simpson's reciprocal index (1/Ds)	1.21	1.23	1.16	1.23
Shannon-Wiener index (H')	1.96	1.85	2.06	1.84
Evenness (J')	0.82	0.80	0.89	0.83

4. Conclusions

It can be concluded that there was eleven species hoppers on rice ecosystem in Samosir island of Sumatera. Taxa which their occurrence and abundance was very frequent was *Nephotettix nigropictus*, *Thaia ghauri*, *Cofana spectra* and *Recelia dorsalis*. Diversity and abundance of hopper in

stubble field period was higher than in vegetation period. Diversity, abundance and evenness of hopper in the year 2014 was higher than in 2015.

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