Research article

The Abundance of Hemiptera and Diptera Fauna on Monsoon Rice at Nay Pyi Taw, Myanmar

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Abstract The abundance of Hemiptera and Diptera fauna studied on monsoon rice at Kyee Inn village, Pyinmana Township, Myanmar, 2018. Insect species were collected from 56 grid points (G) using a D-Vac vacuum suction-machine. Using simple correspondence analysis, the peak number of *Sogatella furcifera* occurred in G33, the second-highest number of *Nephotettix virescens* in G35, followed by *Nilaparvata lugens* in G30, they belong to the order Hemiptera. In order Diptera, *Aedes stimulans* in G38 is the highest mean number, followed by *Chironomus* sp. and *Uranotaenia sapphirina* from G32 and *Hydrellia philippina* from G33 was observed. Correspondence analysis showed species population of order Hemiptera is more abundant than the order Diptera. The population of major insect pest species such as *Nilaparvata lugens* and *Sogatella furcifera* occurs at higher density during the study period. It is due to the usage of broad-spectrum chemical insecticides in the early crop growth stage. In order Diptera, *Hydrellia philippina* is a pest on rice, but *Aedes stimulans* and *Uranotaenia sapphirina* are not the rice pests, even though *Aedes stimulans* is a vector of dengue disease. Meanwhile, *Uranotaenia sapphirina* feeds on the invertebrate host. The results indicated that Hemipteran fauna is more abundant than Dipteran. We need to give Hemiptera's serious pests more attention to provide the proper control measure for them.

Keywords Hemiptera, Diptera, monsoon rice

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important crops in the developing world. Insect pests are the significant biotic constraints in rice production throughout the country. Insects have the largest number of species present in the rice field. More than 100 species of insects attack the world rice crop. Almost 20 insects are considered rice pests of economic importance, including stem borers, gall midge, defoliators, and vectors like leafhoppers planthoppers that cause direct damages and transmit various diseases. The actual species complex differs in abundance and distribution from locality to locality and from year to year (Pathak and Khan, 1994). Moreover, knowledge of the species present and their role in the ecosystem can be essential for deciding whether to use insecticides (Wang et al., 2000).

Dooling (1991) stated that Hemiptera is also crucial in agriculture, which causes direct damage to plants by herbivory and indirectly by transporting diseases. Diptera is a disease vector, agricultural pests, pollinators, and biological control agents (Wikipedia, 2020). Many aquatic organisms like hemipterans, coleopterans, dipterans are known to reproduce in paddy fields (Bambaradeniya et al., 2004). Hemipteran and dipteran insects have behavioral, cellular, and chemical strategies to evade or cope with the host plant defenses making these insects incredibly destructive pests worldwide (Kaloshian and Walling, 2016). Most farmers do not realize that the role of insect species composition found in their rice field and cannot differentiate pest or natural enemies. They often apply pesticides when they see species of arthropods in the rice field. There is limited information or knowledge on the Hemiptera and Diptera fauna in the study area. Therefore, it is essential to provide necessary and critical information about the abundance of insect species as a part of a taxonomic framework to bolster rice production in Myanmar.

OBJECTIVE

The study's objective was to investigate the abundance of Hemiptera and Diptera fauna to provide a theoretical basis for pest management's sustainable control in the study area.

METHODOLOGY

Experimental Site

The experiment was conducted in 56 farmers' fields from Kyee Inn village, Pyinmana Township, Nay Pyi Taw, located between 19°70'66"-19°72'62" N and 96°22'43"-96°25'73" E. The study area 's measure 2.4 km wide by 3.9 km long (550 ha) was selected for hemipteran and dipteran fauna in the monsoon rice season of 2018. The rice cultivar was Manawthukha grown as farmers' usual practices in all experimental fields.

Insect Species Sampling

Insects were collected on a 300 m - by 300 - m grid pattern, resulting in 56 grid points (G). The species sampling was done at fortnightly intervals from 20 days after sowing (DAS) to the ripening stage. We took five subsamples at random from each rice field. We collected samples from 56 grid points collected near the center of the field, at least 5m away from the edge, to reduce edge effects by using D-Vac vacuum (Insect Net-Hand Carry Model 122S, made by Rincon-Vitova Insectaries). One sample usually came from 4-5 hills of rice plant at an early stage and 2-3 hills at maximum tillering stage. The duration sampling time is 1 to 2 min, depending on the rice's growth stage. Each sampling was performed three times in each field. All the collected specimens were immediately transferred to sample jars preserved in a labeled and filled with 90% methylated spirit (Zhang et al., 2013).

Identification of Insect Species

All the collected samples were identified to the order, family, genus, and species level using the references and keys; the textbooks of Insects of Australia (CSIRO, 1970), Manual of Nearctic Diptera, Volume 1, 2, 3 (McAlpine et al., 1981), and Pests of rice and their natural enemies in Peninsular Malaysia (Vreden and Ahmadzabidi, 1986). Species identification was done using OLYMPUS SZ 61 camera attached microscope (10 x × 45 x).

Data Analysis

Correspondence analysis of the abundance of Hemiptera and Diptera species composition was done by the software program SAS 9.1 (SAS Institute, 2008).

RESULTS AND DISCUSSION

Correspondence Analysis of Hemiptera and Diptera Fauna in Different Grid Points

Correspondence analysis was carried out to examine the most abundant insect species' mean population in different grid points (Table 1). Average values give the number of insect species. The ordination of other grid points (56 Grid Points) and the mean number per sample of insect species were different. It is necessary to provide critical data in insect species abundance as a partially taxonomic aspect in rice production. The arthropod community is also considered an essential component in rice field ecosystems, showing differences in composition, diversity, and species richness between communities of different habitats and development stages (You, 1997). The collected Hemipteran and Dipteran are used as variables.

Table 1 Contingency table of the observed Hemipteran and Dipteran in different grids points

Order	Hemipteran					Dipteran			
Grid Point	*Nephotettix nigropictus*	*Nephotettix parvus*	*Nephotettix virescens*	*Nilaparvata lugens*	*Sogatella furcifera*	*Chironomus* sp.	*Aedes stimulans*	*Uranotaenia sapphirina*	*Hydrellia philippina*
G1	1.41	0.00	1.73	7.94	16.28	3.61	6.56	7.28	3.00
G2	5.00	4.58	6.32	10.63	13.67	13.08	4.00	8.77	6.40
G3	1.73	1.00	2.65	9.95	13.08	3.87	4.00	2.24	4.24
G4	2.45	1.73	3.46	13.45	18.73	3.16	2.45	3.74	8.89
G5	3.87	0.00	3.61	7.48	10.00	3.87	2.45	1.00	2.65
G6	6.00	5.29	9.54	7.14	18.47	6.00	0.00	7.42	9.06
G7	4.24	4.58	6.78	12.21	26.17	14.90	13.30	15.68	6.56
G8	5.39	3.16	6.08	10.30	14.42	1.41	0.00	4.24	5.48
G9	6.00	4.47	8.37	8.31	11.87	0.00	6.48	7.00	5.10
G10	8.06	5.66	13.60	5.57	16.46	4.24	2.65	2.65	12.69
G11	1.41	6.08	7.48	7.35	14.53	9.00	7.14	8.49	4.12
G12	8.31	5.66	12.85	4.00	24.82	22.52	6.93	24.27	5.83
G13	8.19	4.12	10.54	5.29	11.70	4.90	7.75	2.45	6.00
G14	6.16	4.58	7.75	7.81	11.31	4.90	8.66	3.61	7.42
G15	13.19	6.71	12.69	8.06	15.75	5.20	5.00	4.47	3.74
G16	4.47	3.61	9.00	6.86	24.54	7.94	6.08	11.96	4.00
G17	6.86	3.46	9.75	7.28	16.46	16.67	4.36	11.96	6.86
G18	2.00	2.00	2.65	22.25	48.85	26.04	5.39	24.08	2.24
G19	3.32	2.45	6.63	15.23	10.20	4.36	5.10	10.10	8.37
G20	7.62	4.12	9.70	7.94	13.27	6.78	4.69	5.66	6.63
G21	10.63	4.69	12.88	7.21	10.72	5.00	7.00	4.12	6.93
G22	13.11	8.60	16.00	7.42	8.12	3.46	2.00	2.45	4.00
G23	6.78	3.74	9.06	6.78	11.05	10.91	7.62	9.59	5.66
G24	2.00	4.69	5.57	8.06	14.59	10.77	5.00	11.96	4.90
G25	5.83	3.46	5.48	9.70	13.19	6.08	6.63	2.45	4.24
G26	4.24	2.65	5.00	6.56	14.70	3.00	5.29	6.63	5.00
G27	1.73	5.66	6.48	7.68	11.87	13.75	15.56	12.25	5.29
G28	9.33	6.08	7.87	7.48	10.82	4.47	9.43	8.77	6.71
G29	9.38	14.66	24.04	6.24	11.05	16.28	4.24	9.75	3.87
G30	4.12	1.41	4.69	15.62	7.00	7.94	4.58	4.36	5.48
G31	7.75	3.61	10.54	7.62	8.00	2.83	0.00	5.92	2.83
G32	0.00	1.00	1.41	7.28	9.22	14.39	8.77	14.70	3.87
G33	1.41	0.00	0.00	6.56	10.58	0.00	1.73	3.16	5.20
G34	6.48	3.61	6.16	6.63	10.95	3.16	8.19	6.08	5.83
G35	11.40	10.05	21.31	6.86	7.14	3.87	3.74	2.00	5.10
G36	5.66	2.45	7.81	11.22	12.04	4.90	2.65	0.00	6.32
G37	4.36	1.41	4.24	6.86	17.41	7.14	3.46	5.00	4.24
G38	2.00	0.00	2.83	7.00	6.32	8.00	13.00	5.00	4.36
G39	5.57	2.45	7.21	10.86	8.94	5.66	1.73	1.41	4.69
G40	11.22	6.00	14.25	8.66	8.89	1.41	2.00	4.90	5.83
G41	5.10	2.83	5.48	11.09	14.49	6.71	7.21	10.25	3.16
G42	4.80	4.36	5.92	7.00	17.80	15.36	3.00	12.73	3.74
G43	3.00	2.45	9.43	7.07	19.62	4.90	2.65	0.00	6.93
G44	4.36	1.41	5.20	12.08	10.15	3.32	5.10	4.80	5.83
G45	3.16	5.10	7.55	16.94	20.98	9.64	4.69	7.28	5.48
G46	7.07	7.55	19.05	6.00	11.31	17.20	4.69	9.33	4.69
G47	7.87	4.24	11.83	16.16	18.33	0.00	4.00	5.10	7.21
G48	8.94	5.20	13.96	8.77	9.17	11.70	6.00	11.31	2.45
G49	6.93	5.10	7.48	9.33	15.52	2.00	13.00	8.19	5.00
G50	3.32	1.73	0.00	6.24	8.66	4.80	4.80	4.24	3.46
G51	7.81	4.58	10.77	5.20	10.63	7.48	1.73	0.00	6.32
G52	1.00	0.00	1.41	8.12	9.06	3.16	1.41	5.29	3.87
G53	5.00	3.16	7.21	8.00	14.11	3.16	1.00	9.49	3.00
G54	1.73	0.00	2.24	13.53	16.31	5.57	7.14	8.83	7.68
G55	0.00	0.00	3.16	9.43	12.12	7.81	3.16	9.33	2.24
G56	4.36	3.32	7.21	12.37	10.30	1.41	1.41	0.00	5.57

Correspondence analysis confirmed the peak number (0.37) *Sogatella furcifera* from G33, the second-highest number (0.30) *Nephotettix virescens* from G35, followed by *Nilaparvata lugens* (0.28) from G30, then *Nephotettix nigropictus* (0.20) from G22 and *Nephotettix parvus* (0.15) from G29, respectively. These species belong to the order Hemiptera. However, order Diptera, the peak mean number (0.27) *Aedes stimulans* from G38, the second-highest number (0.24) *Chironomus* sp. and *Uranotaenia sapphirina* (0.24) from G32, followed by the third highest mean number (0.18) *Hydrellia philippina* from G33. Correspondence analysis showed that the species population of order Hemiptera was more abundant than order Diptera. Therefore, Hemiptera was the dominant group in the study area. Indian Hemiptera includes several species of agricultural pests that are important from economic damage and loss to various crops. These insects act as a menace to agriculture because of some hemipteran insects' remarkable ability to transmit viral diseases of many plants in our country documented by (Ghosh, 2008).

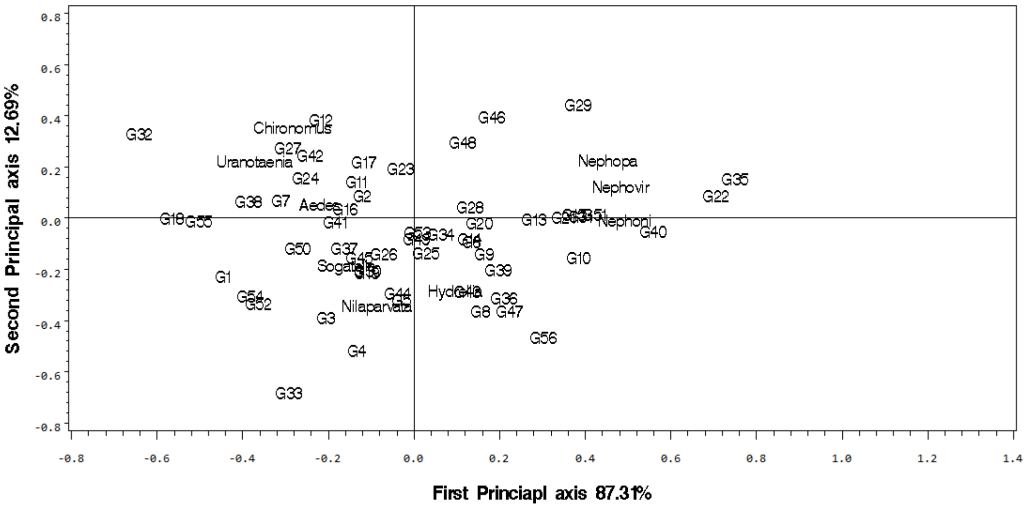

Fig. 1 Correspondence analysis of Hemiptera and Diptera species composition in different grid points

Correspondence analysis showed that the insect pest species *Sogatella furcifera* and *Nilaparvata lugens* had the most remarkable association with G1, G3, G4, G5, G26, G33, G37, G41, G44, G45, G50, G52, G54, and G55, respectively. Catindig et al., (2009) documented that Brown planthoppers transmit viral diseases while white backed plant hopper indirectly damage rice crops immensely. Similarly, *Nephotettix virescens* and *Nephotettix parvus* were closely associated with G22, G28, G29, G35, G46, and G48. *Nephotettix virescens* is a great threat to rice production because it is the most effective vector of rice tungro virus disease (Hibino and Cabunagan, 1986). Moreover, *Chironomus* sp., *Uranotaenia sapphirina* and *Aedes stimulans* were most associated with G2, G7, G11, G12, G16, G17, G23, G24, G27, G32, G38 and G42. However, *Hydrellia philippina* and *Nephotettix nigropictus* were more closely associated with G8, G9, G10, G20, G25, G34, G36, G39, G40, G47, and G56, respectively (Fig 1.). Diptera, given their diversity and abundance, drive ecosystem processes, both on land and in water. All species are of ecological importance, although the degree of their ecosystem influence varies in space and time and across taxa (Adler and Courtney, 2019). The results indicate that the mean population density of species differs widely among the different grid points. The species richness of arthropods in the rice plantation depends on the study's location, cultivation technique, and sampling methods (Zhang et al., 2013).

The first principal axis (Fig 1.) explains 87.31% of the total inertia and indicates the association between insect species and different grid points. However, the second principal axis accounts for 12.69% of the total inertia and shows that insect species also contribute to the relationship. The column categories' positions on the plot (Fig 1.) indicate that the first principal dimension is regarded as showing a contrast among insect species populations. The second principal dimension, on the other hand, is dominated mainly by different grid points. Hence, it may be concluded that about 87%

of the given data's information can be accounted for by a contrast between the insect species population belonging to the orders Hemiptera and Diptera. The different grid points may influence the remaining data (about 13%).

The distance of *Sogatella furcifera* and G45 is quite close. *Nilaparvata lugens* and grid points G5 and G44 are more intimate, and *Nephotettix nigropictus* was very close to G40, with all of these belonging to order Hemiptera. Lee and Park (as cited in May Thet Hlaing, 2018) stated that the pest species were mainly Homoptera and dominated by Delphacidae (*Nilaparvata lugens* Stal and *Sogatella furcifera* Horvath) and Cicadellidae (*Nephotettix virescens*), which involved more than 81 percent of pest abundance. These pests are responsible for substantial economic losses to rice yields. Most of the farmers use broad-spectrum insecticides such as acephate, cypermethrin, carbofuran, chloropyrifos, and imidacloprid in the study area. Multiple reports indicated that white-backed planthopper (*Sogatella furcifera*) and small brown planthopper (*Nilaparvata lugens*) had developed resistance to chlorpyrifos, buprofezin, and imidacloprid (Matsumura et al., 2014). In the agricultural field, the use of insecticides caused planthoppers damage. Similarly, under order Diptera, the distance of *Hydrellia philippina* was quite close to G8 and G36. Ferino (1968) reported that rice whorl maggot (*Hydrellia philippina*) damage led to a significant reduction in productive tillers. *Chironomus* sp. and G12 were even closer, while *Uranotaenia sapphirina* closely associated with G24, G27, and G42, respectively. Chironomids are considered potential pests, and most chironomids are root feeders (Heong et al., 1991). The resurgence of chironomids due to insecticide applications in rice has been noted elsewhere (Takamura, 1993). Flood irrigated rice fields serve as an ideal breeding site for potential vector mosquito species, resulting in a negative impact on human health, causing vector-borne diseases (Amarasinghe and Weerakkodi, 2014).

CONCLUSION

The present study reveals that the insect species population of order Hemiptera is more abundant than order Diptera. The mean population density of insect species composition varies widely for the different grid points. All experimental grid points were on farmers' fields; they sprayed insecticides in the early stages of the rice plant with a lack of knowledge of these chemical insecticides' effect on pest insects' natural enemies in the field. The consequence of this action is a major population increase in insect pests such as *Nilaparvata lugens* and *Sogatella furcifera*. The observed species *Aedes stimulans*, and *Uranotaenia sapphirina* are not pests on rice, but they live primarily in sunlit semi-permanent and water bodies with floating and emergent vegetation. *Aedes stimulans* is a vector of dengue fever disease and negative impact on human health. The obtained results indicated that order Hemiptera composed of severe pests and order Diptera composed of vector-borne mosquito species and one species feed on annelid's blood in the study area. The presences of hemipteran and dipteran species are essential things to be considered when designing pest management methods. Moreover, these findings will provide valuable information to the rice farmers in that area for a theoretical basis to improve rice insect pests' sustainable control. Therefore, further studies should be made on the relationships between these insects and their arthropod natural enemies to understand the rice ecosystem and improve pest management.

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REFERENCES

Adler, P.H. and Courtney, G.W. 2019. Ecological and societal services of aquatic diptera. Insects, 10 (3), 70.

Amarasinghe, L.D. and Weerakkodi, W.G.I.S. 2014. Density and diversity of mosquito larvae associated with rice field and marshland habitats in two climatically different areas in Sri Lanka. International Journal of Entomological Research, 2 (2), 5971.

Bambaradeniya, C.N.B., Edirisinghe, J.P., De Silva, D.N., Gunatilleke, C.V.S., Ranawana, K.B. and Wijekoon, S. 2004. Biodiversity associated with an irrigated rice agroecosystem in Sri Lanka. Biodiversity and Conservation, 13, 1715-1753.

Catindig, J., Arida, G., Baehaki, S., Bentur, J., Cuong, L. and Norowi, M. 2009. Situation of plant hoppers in Asia. Planthoppers: New threats to the sustainability of intensive rice production systems in Asia. International Rice Research Institute, 191-220. Los Banos, Philippines.

CSIRO (Commonwealth Scientific and Industrial Research Organization) and Scientific, C. 1970. The insects of Australia. Melbourne University, Australia.

Dooling, W.R. 1991. The Hemiptera, Oxford University Press, New York.

Ferino, M.P. 1968. The biology and control of the rice leaf-whorl maggot, Hydrellia philippina Ferino (Ephydridae, Diptera). Philippine Agriculturist, 52 (6), 332-383.

Ghosh, L.K. 2008. Handbook on Hemipteran pests in India. Zoological Survey of India.

Heong, K.L., Aquino, G.B. and Barrion, A.T. 1991. Arthropod community structures of rice ecosystems in the Philippines. Bulletin of Entomological Research, 81, 407-416.

Hibino, H. and Cabunagan, R.C. 1986. Rice tungro associated viruses and their relation to host plants and vector leafhopper. Trop. Agr. Res. Ser., 19, 173-182.

Hlaing, M.T. 2018. Species diversity of arthropods in intensive rice-ecosystem of Nay Pyi Taw Council Area. Master thesis of Dept. of Entomology and Zoology, Yezin Agricultural University, Myanmar.

Kaloshian, I. and Walling, L.L. 2016. Hemipteran and dipteran pests: Effectors and plant host immune regulators. Journal of Integrative Plant Biology, 58 (4), 350-361.

Matsumura, M., Sanada-Morimura, S., Otuka, A., Ohtsu, R., Sakumoto, S., Takeuchi, H. and Satoh, M. 2014. Insecticide susceptibilities in populations of two rice planthoppers, Nilaparvata lugens and Sogatella furcifera, immigrating into Japan in the period 2005–2012. Pest Management Science, 70 (4), 615-622.

McAlpine, J.F., Peterson, B.V., Shewell, G.E., Teskey, H.J., Vockeroth, J.R. and Wood, D.M. 1981. Manual of Nearctic Diptera. Volume 1, Manual of Nearctic Diptera, 1 (27).

Pathak, M.D. and Khan, Z.R. 1994. Insect pests of rice. International Rice Research Institute, Los Banos, Philippines.

SAS (Suite of Analytics Software) Institute. 2008. SAS/ STAT user's guide, version 9.1. SAS Institite, Cary, NC. USA.

Takamura, K. 1993. Population changes among chironomid species related to secondary effects of pesticide application in rice fields. Archiv fur Hydrobiologie, 127, 205-225.

Vreden, G.V. and Ahmadzabidi, A.L. 1986. Pest of rice and their natural enemies in Peninsular Malaysia. Pudoc Wageningen Netherlands.

Wang, C., Strazanac, J. and Butler, L. 2000. Abundance, diversity, and activity of ants (Hymenoptera: Formicidae) in oak-dominated mixed Appalachian forests treated with microbial pesticides. Environmental Entomology, 29 (3), 579-586.

Wikipedia. 2020. Biology of Diptera. Retrived from https://en.wikipedia.org/wiki/Biology _of_Diptera.

You, M. 1997. The species richness and diversity of the arthropod communities in rice fields. Insect Sci., 4, 238-248.

Zhang, J., Zheng, X., Jian, H., Qin, X., Yuan, F. and Zhang, R. 2013. Arthropod biodiversity and community structures of organic rice ecosystems in Guangdong Province, China. Florida Entomologist, 1-9.