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ABUNDANCE OF INSECT DIVERSITY IN PADDY FIELDS OF BODINAYAKKANUR THENI DISTRICT OF TAMIL NADU, INDIA

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ABSTRACT

Insect pests of rice are affected by climate change directly through physiological effects due to changes in temperature and precipitation and indirectly through effects due to changes in the quality of host plants. The environmental changes alter both the timings and rate of interactions with food plants, competitors and natural enemies. In the present study, the insect diversity in paddy fields at Bodinayakkanur area in Theni district, Tamil Nadu, India were surveyed fortnight from December 2017 to June 2019. This study reports on the diversity of the insect in the paddy plots cultivated in Bodinayakkanur area in Theni district, Tamil Nadu, India. There are records of many new pests shifting the host and also some invasive pests due to change in their habitat. There are many good examples of such changing insect pest scenario in rice crops.

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INTRODUCTION

Rice, *Oryza sativa* (Linnaeus) is one of the important cereal crops, being the staple food for more than 65 per cent of the world population [1]. It is cultivated in almost all the tropical, subtropical and temperate countries of the world. Rice (*Oryza sativa* L.) is the most important crop in the world and grown in 117 countries, being a staple food of 2.7 billion people in Asia alone (Kumar et al., 2009). The brown plant hopper (BPH) is economic important pest and they damage plants directly by sucking the plant sap and by ovipositing in plant tissue causing plant wilting or hopper burn (Turner R et al.,1999 Damage to the rice crop is caused directly by feeding on the phloem (Sogawa K, 1992) and indirectly by transmitting plant viral disease like grassy stunt viruses (Powell KS et al., 1995).

The rice Gundhi bug sucks the sap from the peduncle, tender stem and milking grains turning them chaffy. Recently, emphasis is being given on ecological based pest management strategies. The main components of any pest management programme is to study the incidence period of the pest, population distribution on crop and regular monitoring or survey of field. Seasonal incidence studies helps in planning need based application of insecticides as it clearly reveals the insect's peak activity as well as insect free periods during crop growth. Among major insect pest of rice, stem borer has shown geographical variation in its species composition like; yellow stem borer, white stem borer, dark headed borer and pink borer across the country. Though, yellow stem borer is the dominant species, white stem borer and pink stem borer species were found in hill regions, parts of Punjab and Haryana in north India and Kerala in South India (Prakash et al., 2005)

About 300 species of insects have been reported to attack rice crop in India, out of which 20 have been found to be the major pests (Arora R and Dhaliwal GS,1996). Among the insect pests, yellow stem borer (Scirpophaga incertulas Wlk.), brown planthopper (Nilaparvata lugens Stal.), green leafhopper (Nephotettix spp.), ear head bug (Leptocorisa oratorius Fabricius), leaf folder (Cnaphalocrocis medinalis Gn.) and case worm (Nymphula depunctalis Guenee) are predominant in Tamilnadu. These pests infest the crop at all stages of plant growth and cause a variety of damage such as tissue boring, sap sucking, defoliation and leaf scrapping (Sharma MK, et al., 2004).

There are more than 100 insect pests that inflict damage to rice-crop. Among them, stem borers, gall midge, plant hoppers, leaf fodders, rice hispa, gundhi bug, case worm are the most important ones. The biology and ecology of these insect pests of the paddy crop have been dealt in detail by Pathak and Khan (1994), Dale (1994), Chaudhary et al. (2002), Islam et al. (2004), Wopereis et al. (2009) and others. However, unsprayed, irrigated rice fields have relatively few insect pest problems. The rice ecosystem is bestowed with a lot of pests and natural enemies complex, The average yield loss in rice have been accounted for 30% loss in stem borers, while plant hoppers 20%, gall midge 15%, leaf folder 10% and other pests 25% respectively (Krishnaiah and Varma NRG, 2015).

Naturally occurring biological control has a potential role to play in the management of rice fields of tropical south and south East Asia and there is a need to emphasize the impact of indigenous natural enemies as an essential part of IPM programme (Ooi paa and Shephard BM,2004; Way MJ and Heong KL, 2004). Conservation of the natural enemy fauna in situ for suppressing the pest population seems to be a very good alternative. Information available on natural enemies of paddy insect pests from Bodinayakkanur area in Theni district. An attempt has been made to study the pest and natural enemy fauna and its association with rice crop during the year 2017-2019.

MATERIALS AND METHOD

(i) Site Selection

Location of Bodinayakkanur in Theni district: Theni District lies at latitude 9030' of 10030' and longitude 77000' of 78030' with cover area of 3242.30 sqkm, ac- counts for 2.2 % total area in Tamilnadu. Theni district is bound by Madurai on east, Idukki on west, Dindigul on north and Virudhunagar on south sides.

(ii) Collection and Sampling

In present work collection of most of the insects (species) was done twice in the year 2017 in 3-4 visits of at least 2 -3 hours; generally in between 6 am – 9 am hours. The abundance of different species was also recorded. In the present study majority of the insects were collected from all variety of rice fields surface of leafs and under the stems.

(iii) Hand picking and Beating

Small insects, specially the soft bodied insects were collected by hand picking. Bugs, ants, termites, living under stones and dry leaves; were collected by hand carefully so that their body is not damaged. This method was used to catch some crawling insects of those which rest on branches. The method was used occasionally.

(iv) Sweeping

In sweeping technique insects were collected by sweeping net. Net used was simply a light cloth bag hung from loop that is attached to a handle. Insects collected by this method were – butterflies, moths, grasshoppers, dragonflies and the other large winged insects. Most of the collection was done by this method.

(v) Trapping

Though there are 4-5 methods of trapping the insects like light trap, sticky trap, water traps, pit fall trap and baits trap, but pit fall method was used only for crawling and running insects. Specimens caught by any of the methods were immediately transferred into the killing bottles. To prevent any damage proper care was taken while transferring the insects (like – butterflies, moths, grasshoppers, dragonflies) and for their preservation. We have used wide mouthed glass jars containing piece of cotton wool soaked with ethyl acetate. Photographs of some insects were taken to avoid the killing of any species of insects.

(vi) Sorting

After killing the insects were sorted out into different taxonomic groups according to order and family, within 4-5 hours as they become brittle and stiff which would affect the stretching.

(vii) Identification

Rice stem borer, leaf folder moths and leaf hoppers species were collected by using a sweep net from the maximum tillering to flowering stages of the crop and brought to the laboratory and was examined under binocular microscope. Insect Identification Service Division of Entomology, Agricultural Research Institute, Madurai and few of them were identified with the help of Google images.

(vii) Data analysis

The studied indices were abundance, relative abundance of insect species, the Shannon diversity index (H') which was used to compute the ecosystem diversity index, and Jaccard's similarity index. The statistical analysis was carried out with the help of Biodiversity Professional verson. Various biodiversity idices analyzed in the present study were diversity indices, richness index, Hills index and Evenness index.

RESULTS AND DISCUSSION

The present investigation on biodiversity of insects was done in the year 2017-18; 2018-19. The present study was formulated to survey the entomofauna and to evaluate the population dynamics of insects belonging to various insect order, family, genera, and species, and to calculate biodiversity indices to identify their abundance, richness, evenness, and dominance in paddy fields of Bodinayakkanur area in Theni district, Tamil Nadu, India.

A total of 439 insects belonging to 19 species and nine orders viz., Coleoptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera, Mantodea, Odonata, Orthoptera, and Thysanoptera were collected during the period of study (Table-1).

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Table -1 List of insects Collected at the study area

No.	Common Name	Scientific Name	Family
Coleoptera			
1	Rice beetle	*Dyscinetus morator*	Scarabaeidae
2	Rice hispa	*Dicladispa armigera*	Chrysomelidae
3	Rice root weevil	*Echinocnemus oryzae*	Curculionidae
Diptera			
4	Rice gall midge	*Orseolia oryzae*	Cecidomyiidae
5	Rice whorl maggot	*Hydrellia philippina*	Ephydridae
Hemiptera			
6	Brown plant hopper	*Nilaparvata lugens*	Delphacidae
7	Rice ear head bug	*Leptocorisa acuta*	Alydidae
8	Rice leafhopper	*Nephotettix nigropictus*	Cicadellidae
Hymenoptera			
9	Scoliid wasp	*Campsomeriella annulata*	Scoliidae
Lepidoptera			
10	Rice leaf folder	*Cnaphalocrocis medinalis*	Crambidae
11	Rice skipper	*Pelopidas mathias*	Hesperiidae
Mantodea			
12	Asian mantis	*Hierodula patellifera*	Mantidae
Odonata			
13	Globe skimmer	*Pantala flavescens*	Libellulidae
14	Marsh glider	*Trithemis aurora*	
Orthoptera			
15	Short-horned grasshopper	*Acrida exaltata*	Acrididae
16		*Acrotylus humbertianus*	
17		*Hieroglyphus banian*	
18		*Oxya japonica*	
Thysanoptera			
19	Rice thrips	*Stenchaetothrips biformis*	Thripidae

Temperature and rainfall recorded during the period of study ranged from 26.5 to 27.5° C; and 113 to 245mm respectively (Fig.1). The details of species in each order as a whole and month-wise (December 2017, January 2018, and June 2019) are as follows. Coleopterans recorded three species with 96 individuals (42, 28, and 16). Dipterans recorded two species with 74 individuals (24, 31 and 19).

Fig.1 Environmental parameters in the study area

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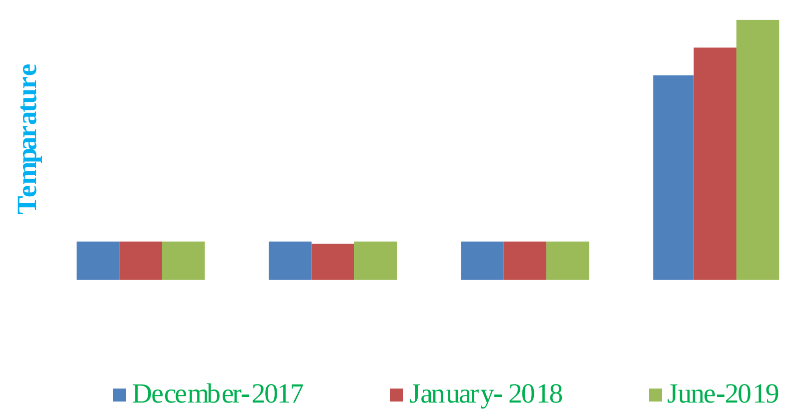

Hemipterans recorded two species with 63 individuals (21, 22, and 20). Hymenopterans recorded one species and 37 individuals (16, 12 and 9). Lepidopterans recorded two species and 54 individuals (15, 21 and 18). Mantodeans recorded one species and 17 individuals (4, 7 and 6). Odonates recorded two species and 38 individuals (13, 15, and 10). Orthopterans were the most dominant order, with 133 individuals (47, 42 and 44) categorized under four species. Thysanopterans collected recorded one species and 13 individuals (3, 6, and 4).

Concerning the comparative month-wise diversity, in December 2017, the most abundant order was Orthoptera, followed by Coleoptera, Diptera, Hemiptera, Lepidoptera, Odonata, Hymenoptera, and Mantodea. The least abundant order was Thysanoptera.

In January 2018, it was again Orthoptera followed by Diptera, Coleoptera, Hemiptera, Lepidoptera, Odonata, Hymenoptera, Thysanoptera, and the least abundant order was Mantodea. For June 2019, the same trend followed in December 2017 (Fig.1). The richness indices represented by Hill's number species richness, Margalef, and Menhinick, are presented (Table -2).

Table-2 Richness indices for the present study

Order	Hill's number species richness	Margalef's index	Menhinick's index
Coleoptera	3	1.96	0.44
Diptera	2	1.54	0.45
Hemiptera	3	1.08	0.37
Hymenoptera	2	0.69	0.39
Lepidoptera	2	0.63	0.31
Mantodea	2	0.78	0.42
Odonata	2	0.64	0.31
Orthoptera	4	2.36	0.53
Thysanoptera	1	0.77	0.47

The diversity indices were represented by Brillouin, Hill, Shannon-Weiner, Simpson's, and species diversity (Table-3). The overall Shannon-Weiner's diversity index was 1.26. Alatalo, Heip, Pielou, Shannon's evenness, and Sheldon's indices represented the present study's evenness indices (Table-4). Other indices show the Berger-Parker dominance (%), community dominance index, Hill's number abundance, relative dominance, and relative frequency (Table-5).

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Table-3 Diversity indices for the present study

Order	Brillouin's index	Hill's index	Shannon's index	Simpson's diversity	Species diversity index
Coleoptera	0.0005	0.07	0.13	0.05	0.009
Diptera	0.0008	0.06	0.12	0.03	0.006
Hemiptera	0.0009	0.03	0.08	0.02	0.004
Hymenoptera	0.002	0.03	0.17	0.003	0.005
Lepidoptera	0.002	0.03	0.13	0.007	0.004
Mantodea	0.002	0.02	0.24	0.002	0.004
Odonata	0.001	0.03	0.15	0.005	0.004
Orthoptera	0.0007	0.09	0.13	0.07	0.03
Thysanoptera	0.002	0.02	0.15	0.0008	0.003

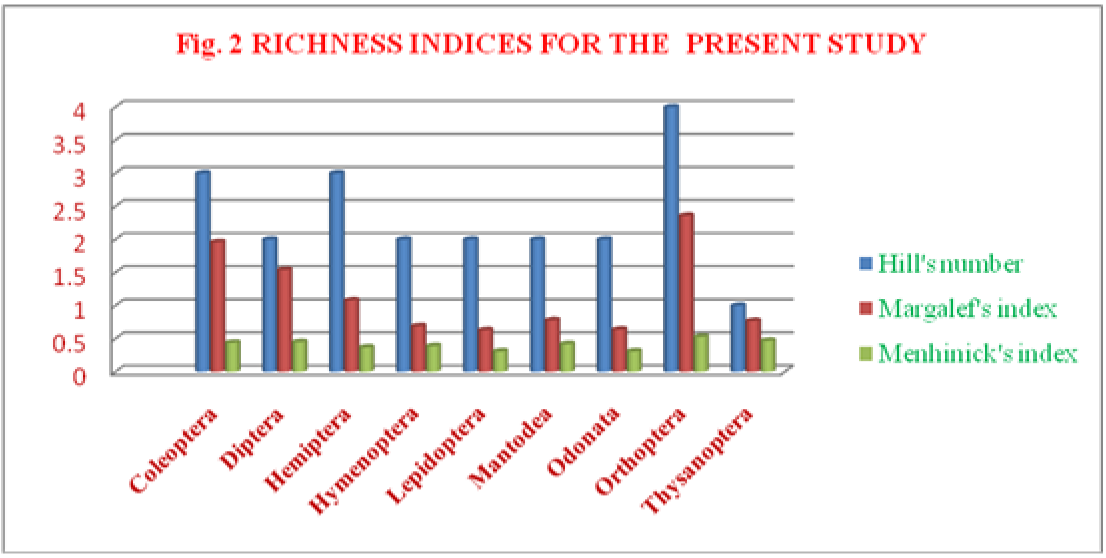
Table -4 Evenness indices for the present study

Order	Alatalo's index	Heip's index	Pielou's index	Shannon's evenness	Sheldon's index
Coleoptera	0.32	0.53	0.24	0.23	0.21
Diptera	0.30	1.16	0.22	0.26	0.32
Hemiptera	0.23	1.16	0.17	0.28	0.33
Hymenoptera	0.33	2.32	0.25	0.32	0.51
Lepidoptera	0.31	2.42	0.22	0.31	0.53
Mantodea	0.37	2.42	0.32	0.41	0.61
Odonata	0.36	2.42	0.23	0.33	0.54
Orthoptera	0.32	0.40	0.21	0.22	0.20
Thysanoptera	0.31	3.42	0.25	0.41	1.13

Table -5 Other indices for the present study

Order	Berger-Parker dominance (%)	Community dominance index	Hill's number abundance	Relative dominance (%)	Relative frequency
Coleoptera	20.34	1.45	1.12	19.13	0.17
Diptera	16.03	1.22	1.10	11.51	0.13
Hemiptera	12.75	1.05	1.09	11.43	0.14
Hymenoptera	5.12	0.32	1.16	7.67	0.04
Lepidoptera	7.85	0.52	1.11	7.67	0.05
Mantodea	3.40	0.23	1.22	7.66	0.03
Odonata	6.45	0.46	1.14	7.63	0.03
Orthoptera	24.72	1.71	1.12	23.03	0.21

Thysanoptera	3.21	0.23	1.12	3.74	0.04



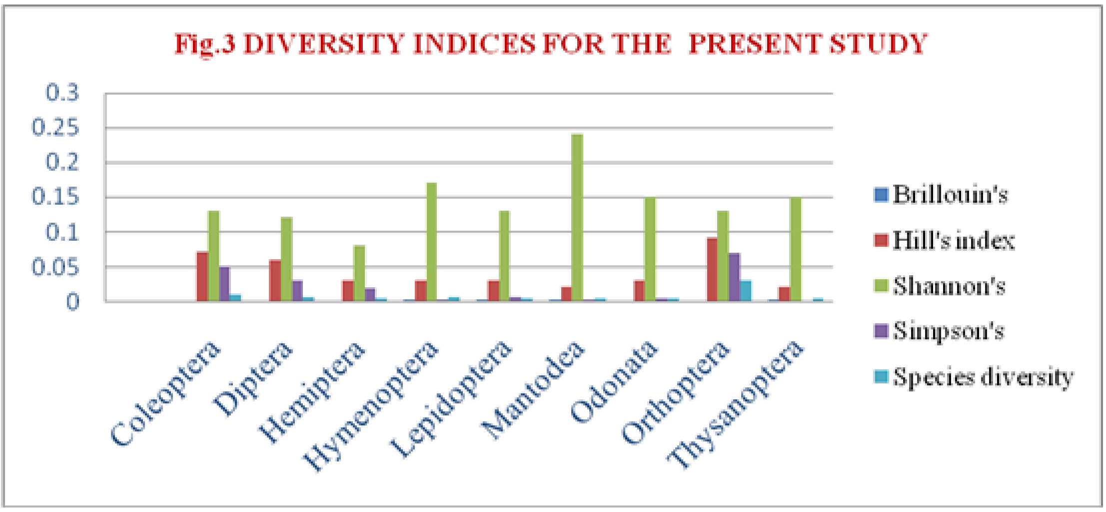


Fig. 4 EVENNESS INDICES FOR THE PRESENT STUDY

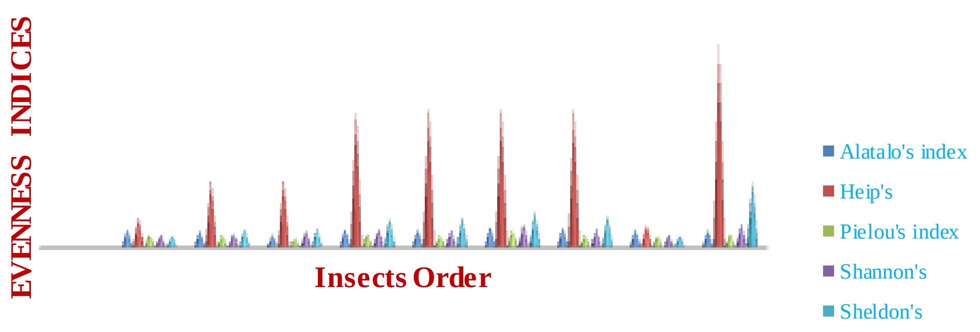
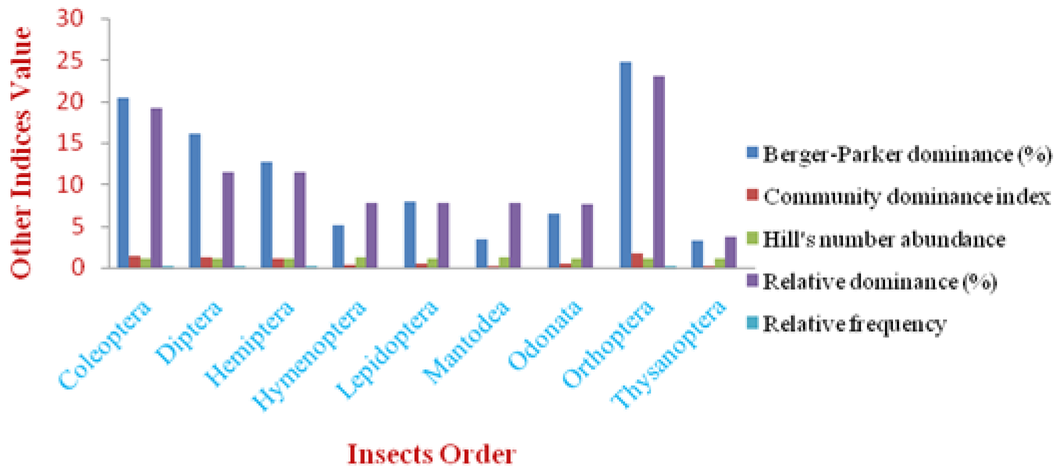


Fig. 5 OTHER INDICES FOR THE PRESENT STUDY



DISCUSSION

Insect's ecology is the scientific study of how insects, individually or as a community, interact with the surrounding environment or ecosystem since they have a wide distribution (Duane, 2006). Insects constitute a remarkably spacious group of organisms attributed mainly to their small size, which allows them to occupy niches not available to larger organisms. Insect abundance is crucial because it regulates insect communities' ecosystems (Savopoulous et al., , , 2012).

Insects are critical natural resources in ecosystems, in addition to their role as efficient pollinators and natural/biological pest control agents (Strong et al., , , 1984; Buchs, 2003, Rosina et al., , , 2014). Insects influence the nutrient and energy flow of ecosystems in many ways, most essentially as decomposers. Barbosa et al., (2005) pointed out that the distribution of the insect orders, viz., Coleoptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera, Odonata, and Orthoptera in all habitations are globally extensive in all habitats.

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Insect diversity accounts for a large proportion of all biodiversity on the planet. Coleopterans make up 40% of described insect species; however, entomologists suggest that dipterans and hymenopterans could be as diverse or more-so. Nevertheless, five insects' orders stand out in their levels of species richness: Coleoptera, Diptera, Hemiptera, Hymenoptera, and Lepidoptera, according to Barbosa et al., (2005), which correlated with the present study. Food resources and climate conditions vary in space and time, directly affecting the diversity and distribution of insect populations (Goldsmith, 2007).

Climate is one of the deciding elements in insect population fluctuations during the year (Wolda, 1978). Other factors that influence the insect diversity, viz., temperature, relative humidity, wind speed, and sunshine, and its abundance depends on seasonal length, rainfall, temperature, surrounding vegetation, and agricultural practices (Pimentel & Wheeler, 1973).

Weather parameters influence the entomofaunistic diversity greatly. Vijayababu et al., (2016) reported that climate change would fundamentally alter the agricultural ecosystem, leading to insect diversity changes and population levels. In the present study, insects' distribution was closely related to the type of vegetation in a particular region or habitat.

Its abundance and distribution were regulated by abiotic and biotic factors and their interactions. Rainfall and temperature influence the development, reproduction, activity, and range of insect expansion. Precipitation is a crucial factor for increasing the insect population followed by temperature (Puttannavar et al., 2005).

Diversity measurements such as the index of dominance, species richness, and species evenness form an integral part of the biodiversity investigation. The relation between the index of dominance and biodiversity lies in the fact that an area with low dominance indicates high diversity while that with high dominance will have less diversity (Joshi et al., 2014).

Berger-Parker and community dominance indices are the measure of dominance by any one species; if any species is found to be exponentially abundant compared to the others in a community, then such species can be called dominant such a community may return high dominance index. This index reciprocal denotes an increase in the index's value accompanied by an increase in diversity and a reduction in dominance. Species richness is the oldest and the most straightforward concept of species diversity, which accounts for the number of species present in an ecosystem, community or region. It is, therefore, the base for most biodiversity assessments (Krebs, 2013).

Shannon-Weiner index of diversity is considered to be the complete measure of diversity because it takes into account both the number of species and the abundance of each species during the present study in the paddy field, as it indicated a healthy environment, and the values ranged from 0.07 to 0.23, and the overall was 1.26. For Shannon-Weiner, the lower the index, the lower the diversity, whereas the higher the index, the higher the diversity, species richness, and evenness.

The quantity of various species inside a geographical region relies upon migration and adaptation to environmental conditions and how they modify the environment (Groombridge & Jenkins, 2002).

Species diversity is a parameter of community structure involving species richness and their abundance for the given taxa (Wang et al., 2000). The biological diversity in one biological community possesses two components: species richness (existing species number) and homogeneity, which depends on the larger or smaller uniformity of the distribution frequency of extant species (Hurlbert, 1971).

The importance of diversity indices is their application in monitoring studies of biological communities' dynamics and structural change detection when the community environment is modified, and the species have to adapt to the modifications to contribute to the conservation of biodiversity in agriculture ecosystems (Southwood, 1995).

CONCLUSION

Insect diversity represents their adaptability to a wide range of environmental conditions, and their dominance influences the structure of their community. Further, this study can be an eye-opener to identify the potential pests of paddy and their seasonal abundance and provide adequate information that would be of incredible assistance to anticipate effective administration procedures that can be embraced by paddy cultivators Bodinayakkanur of Theni district, Tamil Nadu, India.

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