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A preliminary survey on litter insect's diversity through pitfall trap in different ecosystems of south 24 Parganas district, West Bengal, India

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Abstract
The present paper documents the preliminary study on litter insect abundance and diversity of insect species in diversity through pitfall trap in different ecosystems of South 24 Parganas District conducted during November, 2021- March, 2022. A total of 905 insects from 8 orders, 25 families were recorded. This study shows that Hymenoptera (44%) was the most dominant order according to total number of individuals, followed by Coleoptera (26%), Diptera (17%), Hemiptera (5%), Collembola (4%), Orthoptera (2%), Isoptera (1%) and Dictyoptera (1%). The present study was also conducted to determine the abundance of insect species; species richness, dominance and evenness of insect fauna from different ecosystems. The Simpson's Index diversity is highest in Guava Orchard (0.345) and lowest in Medicinal Plants' Garden (0.281). The species richness, evenness and diversity of insects were calculated by Margalef's Index, Pielou's Index and Shannon-Wiener Index respectively.

Keywords: Litter insects, diversity, distribution, pitfall trap, different ecosystems, South 24 Parganas, West Bengal, India

Introduction
Insects are the most largest and diverse of all animal groups living on Earth. Insects are found in land, in water as well as in air in nearly all habitats and all continents. Insects create the biological foundation for all terrestrial ecosystems. They pollinate plants, disperse seeds, control populations of other organisms, and provide a major food source for other taxa (Majer 1987) [8]. Insects inhabiting the soil play an essential role in decomposing organic matter, cycling nutrients and fertilizing the soil (Dilip *et al.*, 2014) [1]. Soil insects also act as sensitive bio-indicators of environmental change because of their rapid reproductive rates, short generation times, and the fine grain at which they occupy space in the soil (Moldenke & Lattin, 1990) [10]. They have been recognized as efficient indicators of ecosystem function and recommended for use in conservation planning (Rosenberg *et al*., 1986; Finnamore, 1996) [14,2]. Because of their small size, short life spans, and high reproductive rates, the abundances of many species can change by several orders of magnitude on a seasonal or annual time scale, minimizing time lags between environmental changes and population adjustment to new conditions. Such changes are easily detectable and make insects more useful as indicators of environmental changes than are larger or longer-lived organisms that respond more slowly. In turn, insect responses to environmental change can affect ecosystem structure and function dramatically (Hossain, 2010) [3].

The Pitfall trapping is widely used in studies of seasonal occurrence, to examine spatial distribution patterns, to compare relative abundance in different micro-habitats, to study daily activity rhythms, and in community surveys (Dilip *et al*., 2014; Sarkar, Chakrobarty and Moitra, 2016) [1, 13]. They are excellent tools for detecting first activity and monitoring the season-long activity of walking and crawling soil and litter arthropods, especially those that are active at night. Such pitfall trap studies have been undertaken in different parts of India as well (Sabu *et al.*, 2011) [12].

The current knowledge on the role of soil biota, their diversity, and various components has accumulated mainly during the last 30 years, resulting in the modern view of soil fauna as a part of ecosystem (Huhta, 2007) [4]. The study of soil animals has been neglected field for a long time particularly in India (Kumar and Singh, 2016) [7].

Little attention has been given to ecological studies of the soil insects, particularly on their seasonal occurrence, site specific diversity, distribution, species diversity, population dynamics, community structure and effect of population on the population or community of the soil insects. Few publications were made on the diversity of soil insects from different districts of West Bengal (Mandal and Suman, 2014; Imam *et al*., 2016; Sarkar, Chakrobarty and Moitra, 2016) [9, 5, 13]. The present study is a miniscule attempt in this regard. Although the survey period in the present study are inadequate, they are first of the kind efforts reporting the litter insect fauna from four different ecosystems (Medicinal Plants' Garden, Grassland, Pond side, Guava Orchard) of South 24 Parganas District was selected for the present dissertation project work. The study on diversity, distribution and population dynamics of soil insects in West Bengal is very limited and not much work has been done, particularly in case of South 24 Parganas District. In context of the scenario, this comparative study may provide the baseline data of the litter insect fauna from this area which will help future studies.

Materials and Method

Site selection

Four site consisting four different ecosystems were chosen for our work. The sites were Medicinal Plants' Garden, Ramkrishna Mission Vidyalaya, Narendrapur; Grassland in Sonarpur; Pond side of Harinavi; Guava Orchard in Subhasgram. Medicinal Plants' Garden was managed and treated yet with ample shade; Grassland was primarily composed of herbaceous spermatophytes of grass and grass like plants of family Gramineae; Pond side had tall trees so it was shaded; and the Guava Orchard consist of many Guava trees.

Trap setting and sampling

Total 32 traps were placed in these 4 sites over a course of 5 months starting from November, 2021 to March, 2022. At first holes were dug and soil and litter was taken out from the holes. Afterwards the cups (Height-8cm. and Diameter-6cm.) were placed inside those holes in such a way that the top open end is at same level as the ground and not above the ground. It was made sure that the holes were equally distant from one another. ¼ part of each cup were poured with soapy water so that insects fallen inside could not get out. The cups were placed there for two days. All specimens were collected from the traps by pouring the soap water in different containers. After that they were picked up from it with forceps. Collected specimens were then rinsed and then preserved in containers containing 70% alcoholic solution and labeled and in laboratory under stereo binocular following the classificatory scheme of Imm's (1977) [6].

Data analysis

For the statistical analysis of the soil litter insect fauna recorded from the study area were analysed by using various diversity indices, which are as follows:

The following formula is used to calculate the relative abundance of species in an area:

$$RA = TS/TP \times 100$$

Where, RA= The relative abundance of species (%)
TS= the total number of species in an area
TP= The total sum of the populations of all species in the area

The Simpson index of diversity mathematical formula is giving as follows:

$$(D) = 1 - [\Sigma n_i(n_i-1) / N(N-1)]$$

Where, Σ = sum of (Total)
n_i = the number of individuals of each different species
N = the total number of individuals of all the species

The Shannon-Wiener index of diversity mathematical formula is giving as follows:

$$(H) = -[\Sigma(n_i/N) \times \ln(n_i/N)]$$

Where, Σ = sum of (Total)
n_i = the number of individuals of each different species
N = the total number of individuals of all the species

The Evenness of diversity mathematical formula is giving as follows:

$$(E) = H/ \ln(S)$$

Where, H = Shannon's diversity index
ln(S) = Natural logarithm of species richness

The Margalef diversity index expressed as 'd' can be calculated in a spreadsheet by using the formula.

$$(d) = (S - 1)/ \log N$$

Where,
S= The number of species
N= The total number of individuals in the sample

Results and Discussion

There was no rainfall experienced during the study period. During the present study by means of pitfall trapping procedure, a variety of insects were trapped from all the sites. A total of 905 insects consisting 25 families from total 8 orders were collected during the time period (Table 1). With 8 families each Coleoptera and Diptera was the most diverse orders. Hymenoptera had 3 families and Hemiptera had 2 families under them. Orthoptera, Collembola, Isoptera, Dictyoptera had one family each.

The dominating order of insects in pitfall trap collection were Hymenoptera (44%) (Table 3). Their vast food source range made them most active order and thus the higher number of collected individuals.

Coleopterans commonly known as beetles constitutes the largest order of all animals. India is well known for its richness of coleopterans fauna. Out of 3,50,000 described coleopteran species from all over the world, 15,000 species under 2,000 genera are known from India (Biswas, 1995). The present study revealed that according to numbers Coleoptera is the second most dominated order (26%) (Table 3).

Diptera that consist of Mosquito, midges and flies are found to be the third most dominant order in the study (Table 3).

Hemiptera insects that are usually called as 'true bugs' are of great economic importance as most of them are pests of various commercial crops. According to recent estimate about 80,000 Hemipteran species are present worldwide. In India, a total of 77 families containing 6,500 species are found. Out of these, 2,421 species are endemic to India (Alfred, 2003). In the present study Hemiptera is fourth most dominated order (5%) (Table 3).

Collembola (4%), after that Orthoptera (2%) and then Isoptera

and Dictyoptera (both1%) were the least abundant orders respectively.

Out of the 8 families under Coleoptera and Diptera, Staphylinidae (32.05%) and Muscidae (31.41%) were most dominant respectively (Table 2). Staphylinidae was most abundant in Medicinal Plants' Garden and Muscidae was most abundant also in Medicinal Plants' Garden (Table 2). Hymenopteran ants (Formicidae) were most abundant in the pitfall (Fig. 1) and Dictyoptera (Blattidae) was least abundant (Fig. 1).

Table 1: Occurrence of Insects Order/Family wise from 4 different Ecosystems of South 24 Parganas

	Sites	**Medicinal Plants' Garden**								**Grassland**								**Pond Side**								**Guava Orchard**								
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Order	Family	Number of insects found																																Total
Orthoptera	Acrididae	0	0	0	1	0	2	0	0	0	0	0	0	0	0	1	0	2	0	2	0	1	0	4	0	0	0	0	2	0	0	0	0	15
Total		0	0	0	1	0	2	0	0	0	0	0	0	0	0	1	0	2	0	2	0	1	0	4	0	0	0	0	2	0	0	0	0	
Collembola	Entomobryidae	3	0	0	1	2	0	1	2	4	2	0	0	0	1	0	3	1	1	5	3	0	2	1	0	1	0	2	1	3	0	2	0	41
Total		3	0	0	1	2	0	1	2	4	2	0	0	0	1	0	3	1	1	5	3	0	2	1	0	1	0	2	1	3	0	2	0	
Coleoptera	Carabidae	4	3	1	0	2	0	1	1	1	0	0	2	3	0	2	0	8	0	5	8	2	1	4	3	0	0	4	0	0	1	1	0	57
	Staphylinidae	2	7	0	1	6	8	12	4	5	6	0	2	1	0	3	1	4	0	1	0	0	0	0	0	5	2	2	0	0	0	3	0	75
	Scarabaeidae	0	2	0	0	1	0	3	1	0	0	2	0	1	0	0	0	0	0	4	17	0	0	0	0	0	0	0	0	2	0	0	0	33
	Tenebrionidae	0	1	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	5	3	0	0	0	0	0	0	0	0	12
	Anthicidae	5	0	0	1	3	1	1	4	2	4	0	1	1	1	1	0	0	0	0	0	0	0	0	3	1	1	3	0	0	0	0	2	35
	Chrysomelidae	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	6
	Curculionidae	0	0	0	0	0	1	0	0	2	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
	Coccinellidae	0	0	1	0	0	3	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	11
Total		11	13	2	2	12	14	18	11	11	14	3	6	6	2	6	1	13	0	10	25	2	1	9	11	8	3	9	1	2	15	2	0	234
Isoptera	Termitidae	1	0	1	1	0	0	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	10
Total		1	0	1	1	0	0	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	
Hymenoptera	Formicidae	8	12	7	9	7	12	29	15	10	9	13	24	10	12	12	18	6	9	8	6	11	9	10	11	15	10	2	20	18	9	5	11	367
	Pompilidae	1	2	0	1	1	0	0	0	4	0	0	0	0	0	1	0	0	0	0	1	2	0	0	0	1	0	0	2	0	0	0	0	16
	Platygastridae	2	0	0	0	0	1	0	0	1	0	0	0	0	0	2	0	3	0	1	0	0	0	4	0	0	0	2	0	1	0	0	0	17
Total		11	14	7	10	8	13	29	15	15	9	13	24	10	12	15	18	9	9	9	7	13	9	14	11	16	10	4	22	19	9	5	11	400
Dictyoptera	Blattidae	0	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	6
Total		0	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	
Diptera	Phoridae	1	2	0	0	1	0	0	4	0	2	1	0	2	0	3	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	19
	Ceratopogonidae	0	0	0	2	1	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	3	0	0	1	1	0	0	0	2	0	0	13
	Tipulidae	0	0	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	7
	Chironomidae	1	0	0	0	0	0	1	0	0	0	0	0	0	0	4	1	3	0	1	1	0	0	0	0	0	0	1	0	1	0	0	0	14
	Muscidae	0	2	1	0	0	12	4	5	0	0	2	1	0	0	7	3	1	0	0	0	0	1	0	0	2	1	0	0	3	0	3	1	49
	Sciaridae	1	0	1	1	1	0	0	1	0	1	1	1	2	3	0	0	2	0	0	0	4	0	0	0	2	0	0	0	0	0	0	0	21
	Ephydridae	0	0	3	0	0	0	0	2	0	5	1	2	0	0	4	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	21
	Drosophilidae	1	0	1	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	3	0	0	12
Total		4	4	7	4	5	13	5	12	0	8	8	4	4	4	20	4	9	0	4	1	5	4	0	1	7	3	1	0	5	5	3	2	156
Hemiptera	Cicadellidae	2	0	0	3	1	2	0	3	0	1	3	0	0	2	1	1	0	0	0	1	3	0	0	0	1	0	0	4	0	2	0	0	30
	Lygaeidae	1	0	0	0	0	3	0	0	0	0	1	0	1	0	0	1	0	0	0	3	0	0	0	0	0	0	3	0	0	0	0	0	13
Total		3	0	0	3	1	5	0	3	0	1	4	0	1	2	1	2	0	0	0	4	3	0	0	0	1	0	3	4	0	2	0	0	43
Total insects found																																		905

Table 2: Relative Abundance of Orders of all Insects Found

Relative abundance of orders of all insects found			
Sl. No.	**Order Name**	**Total Number Of Insects**	**Relative Abundance (%)**
1	Orthoptera	15	1.65745856
2	Collembola	41	4.53038674
3	Coleoptera	234	25.8563536
4	Isoptera	10	1.10497238
5	Hymenoptera	400	44.198895
6	Dictyoptera	6	0.66298343
7	Diptera	156	17.2375691
8	Hemiptera	43	4.75138122
Total		905	100

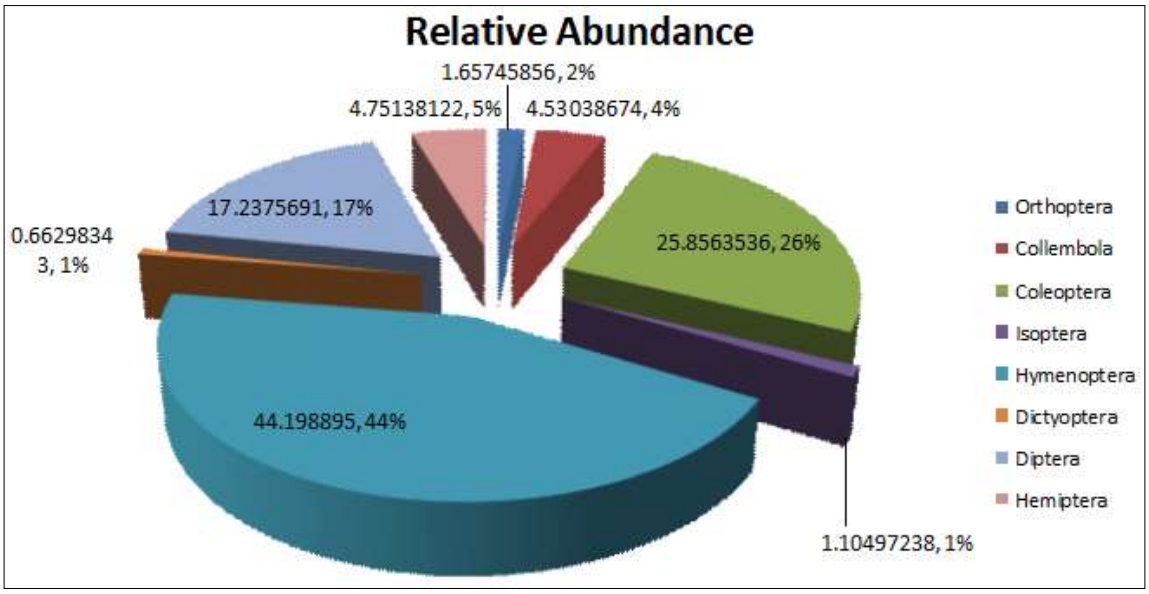

Fig 1: Pie chart showing the Relative Abundance of Orders of all Insects Found (based on Table 3)

Table 3 shows the analysis of pitfall trap collection of insects. The mentioned table reveals that many types of insects were trapped during my project work and subsequently observed different insect orders, families as far as possible within this short time period.

Pitfall trap collection at four different sites of South 24 Parganas consisting four different ecosystems-Medicinal Plants' Garden, Grassland and Pond side and Guava Orchard were done. On the basis of the collection following observations were made-

The dominating order of insects in pitfall trap collection were Hymenoptera (44%), followed by Coleoptera (26%), then Diptera (17%), then Hemiptera (5%) and Collembola (4%), after that Orthoptera (2%) and then Isoptera and Dictyoptera (both1%).

Table 3: Comparing Relative Abundance of Order of Insects found in 4 different Ecosystems of South 24 Parganas

Comparing relative abundance of order of insects found in 4 different sites of south 24 Parganas								
	Medicinal Plants' Garden		Grassland		Pond side		Guava Orchard	
	Number of Insects	Relative Abundance	Number of Insects	Relative Abundance	Number of Insects	Relative Abundance	Number of Insects	Relative Abundance
Order								
Orthoptera	3	1.08303249	1	0.40983607	9	4.36893204	2	1.12359551
Collembola	9	3.24909747	10	4.09836066	13	6.31067961	9	5.05617978
Coleoptera	83	29.9638989	49	20.0819672	71	34.4660194	31	17.4157303
Isoptera	5	1.80505415	2	0.81967213	1	0.48543689	2	1.12359551
Hymenoptera	107	38.6281588	116	47.5409836	81	39.3203883	96	53.9325843
Dictyoptera	1	0.36101083	3	1.2295082	0	0	2	1.12359551
Diptera	54	19.4945848	52	21.3114754	24	11.6504854	26	14.6067416
Hemiptera	15	5.41516245	11	4.50819672	7	3.39805825	10	5.61797753
Total	277	100	244	100	206	100	178	100

Fig 2: Order-wise Relative Abundance in 4 different Ecosystems

This comparison shows the relative abundance of each order in each of the ecosystems. Hymenoptera dominated all the 4 ecosystems with Coleoptera being the second most abundant order in Medicinal Plants' Garden and Pond side and Guava Orchard and third most abundant order in Grassland and on the other hand Diptera was second most abundant order in Grassland and third most abundant in the rest three.

Table 4: Richness across 4 different Ecosystems of South 24 Parganas

Richness across 4 different ecosystems of south 24 parganas					
Order	**Family**	**Medicinal plants' garden**	**Grassland**	**Pond side**	**Guava orchard**
Orthoptera	Acrididae	√	√	√	√
Collembola	Entomobryidae	√	√	√	√
Coleoptera	Carabaeidae	√	√	√	√
	Staphylinidae	√	√	√	√
	Scarabaeidae	√	√	√	√
	Tenebrionidae	√	√	√	
	Anthicidae	√	√	√	√
	Chrysomelidae	√	√	√	√
	Curculionidae	√	√		
	Coccinellidae	√	√		√
Isoptera	Termitidae	√	√	√	√
Hymenoptera	Formicidae	√	√	√	√
	Pompilidae	√	√	√	√
	Platygasteridae	√	√	√	√
Dictyoptera	Blattidae	√	√		√
Diptera	Phoridae	√	√		√
	Ceratopogonidae	√	√	√	√
	Tipulidae	√	√	√	
	Chironomidae	√	√	√	√
	Muscidae	√	√	√	√
	Sciaridae	√	√	√	√
	Ephydridae	√	√	√	√
	Drosophilidae	√	√	√	√
Hemiptera	Cicadellidae	√	√	√	√
	Lygaeidae	√	√	√	√

Species composition in each of these 4 sites is showing a very little variation with Medicinal Plants' Garden and Grassland containing all the above mentioned order and families (Table 5). Order Dictyoptera and few other families from Diptera and Coleoptera were missing in Pond Side (Table 5). Guava Orchard though had all order present but lacked a couple of family from Coleoptera and a family from Diptera (Table 5).

Table 6: Comparing Biodiversity Indices of 4 different Ecosystems in South 24 Parganas

Comparing biodiversity indices of 4 different ecosystems in south 24 parganas				
	Collecting Sites			
Biodiversity Indices	**Medicinal Plants' Garden**	**Grassland**	**Pond side**	**Guava Orchard**
Simpson's Index (D)	0.281	0.316	0.294	0.345
Shannon Wiener Index (H)	1.458	1.392	1.437	1.382
Margalef Richness Index (R)	1.2447	1.2734	1.3138	1.351
Pielou's Evenness Index (E)	0.701	0.669	0.738	0.665

All the Biodiversity Indices shows a very little variation numerically but impose a greater significance. The value of Simpson's Index ranges from 0 to 1 with values closer to 0 indicates low level of dominance i.e. all orders are equally present and values closer to 1 indicates high level of dominance i.e. one order dominates. The Simpson's Index in Guava Orchard shows a higher value than in Medicinal plants' garden, Grassland and Pond side that means this area shows a more inclination to dominance than other three sampling areas (Table 6). The Shannon Wiener Index is higher in Medicinal plants' garden reflects a higher order diversity or occurrence than Grassland, Pond side and Guava Orchard (Table 6). Margalef's Richness Index on the other hand is slightly higher in Guava Orchard (Table 6). Pielou's Evenness Index also ranges from 0 to 1 with 0 meaning no evenness and 1 meaning complete evenness. In this case the collection area of Pond side shows more evenness than the collection area of Medicinal plants' garden, Grassland and Guava Orchard (Table 6).

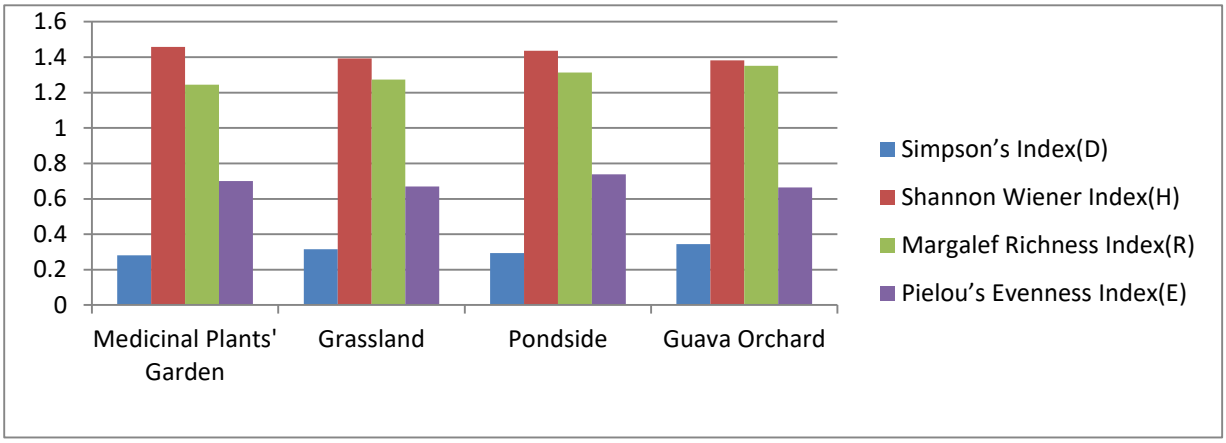

Fig 3: Biodiversity Indices of the different Ecosystems

It has been observed in recent years that there is an increase in the number of research works in the field of litter insect faunal diversity, distribution and the seasonal activities and the role of different edaphic factors on the occurrence of these insects both in India and abroad (Dilip *et al*., 2014; Mouhoubi, Djenidi and Bounechada, 2019) [1, 11]. The present study is a one of such little attempt in this regard but the present study are first of the kind efforts reporting the litter insect fauna in 4 different Ecosystems in South 24 Parganas and this study would help future researchers in understanding the species diversity and distribution patterns of litter insect fauna of this region.

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