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Efficiency of 2 different trapping methods for monitoring the insect diversity in a selected field at Salt Lake area, Bidhannagar, West Bengal

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Abstract
A Study was conducted to determine the efficacy of 2 different insect trapping methods(Pitfall tarps, Tullgren extraction method) for measuring the insect diversity. The abundance of insects was compared using pitfall trapping and Tullgren extraction methods. Among these two trapping methods the Pitfall trapping method shows a higher efficacy to capturing a large number of insects, whereas the Tullgren extraction method were beneficial for capturing ground dwelling insects belonging to the order Hymenoptera, isoptera, dipluraetc. A high number of Lepidoptera, Diptera, Coleoptera and Thysanoptera occurred in pitfall trapping methods.

Keywords: Tullgren, pitfall trap, diversity, ground dwelling Insects

Introduction

Biodiversity refers to the variety of life forms: the different plants, animals, microorganisms, the genes they contain, and the ecosystems they form. This living wealth is the product of hundreds of millions of years of evolutionary history. Insects comprise more than half of all described species in the animal kingdom and account for a considerable proportion of all biodiversity on the planet (Tihelka *et al.*, 2021; Stork, N.E., 2018) [7, 6]. This great variability is due to the specificity of the genetic, morphological, and functional aspects that different insect species have developed to successfully cope with the complex and dynamic habitats in which they live (Sollai and Solari, 2022) [5]

Insects stand out as the most diverse group of organisms on Earth, with approximately 1.75 million known species, making up a substantial portion of biodiversity. Within the scope of the 14,13,000 total known life forms identified by science, insects alone account for about 54%. When considered among the 10,32,000 known animal species, insects now constitute around 73% of this total, showcasing their dominance in the animal kingdom. In addition to their sheer numbers, insects provide numerous benefits to human society. They contribute to pollination, produce valuable resources, aid in pest control, function as scavengers, and serve as essential components in food webs.

To study the biodiversity of insects various methods are used which also include sweep netting and different traps. By assessing various trapping methods, researchers can ascertain the most suitable and efficient techniques for monitoring insect biodiversity across diverse habitats. This study aims to evaluate the efficacy of different traps in capturing a broad spectrum of insect species while taking into account trap design, specificity, costs, and environmental impact. Commonly utilized traps in insect biodiversity studies encompass pitfall traps, Malaise traps, sweep nets,Tullgren extraction trap and sticky traps, each presenting distinct advantages and limitations. Pitfall traps are adapt at capturing ground-dwelling insects, while Malaise traps excel at trapping flying species. Tullgren trap is widely used for capturing small insects inside the soil. This comparative study will entail setting up these traps in varied habitats, collecting and identifying the captured insects, and analyzing the data to evaluate trap performance.

The present study was designed to compare two traps commonly employed in biodiversity studies to collect soil insects, aiming to evaluate their potential and limitations in assessing insect biodiversity.

Materials and methods

1. Study site

The experiment was conducted in our college campus, (Vidyasagar College, Salt Lake Campus Kolkata). The experiment was done at the same point. The latitude and longitude of the area is 22.5817069, 88.4277032. This site was chosen according to its biological potential, it means their assumed probability to have a high biodiversity. (Fig 1)

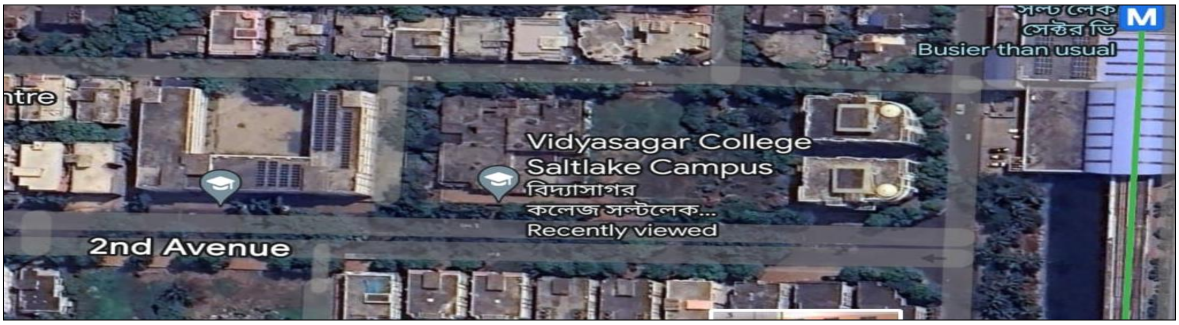

Fig 1: Satellite view of Vidyasagar College Saltlake Campus (Study site)

2. Designing and installation of different traps for insect collection

- **Pitfall trap**

The PVC cups were purchased from the market with an equal diameter of 90 mm. pitfall traps as cup has been used to monitor the insect diversity, but in this study, the cup trap was selected (Lange *et al*., 2011) [4]. While the length of pitfall traps was kept 120mm (Lasmar *et al*., 2017) [2]. The bottom of the trap was filled with 200 ml water including 0.4 % salt and 0.6 % soap to kill the insects for further taxonomic analysis and assessing the numbers involved from different orders (Harris *et al*., 2017) [1]. Particularly, PFT targets soil crawling insects, especially ants that belong to Hymenoptera (Majeed *et al*., 2018; Vieira *et al*., 2017) [3, 8] (Fig 2)

Fig 2: Pitfall trap

- **Tullgren trap**

The Tullgren method is a technique used in entomology to extract and collect small soil-dwelling organisms, such as insects, mites, and nematodes, from soil samples. The method involves gradually drying the soil sample, which causes the organisms to move downward to escape the dry conditions. A light source positioned above the soil sample then encourages the organisms to move further downward into a collection vessel, allowing researchers to separate and study the organisms for research purposes.

Fig 3: Insects collected in Tullgren trap

3. Preservation and identification of the collected samples

After collecting insects from different traps and the insects were preserved in glass vials consisting of 70-90% ethyl alcohol, except Lepidoptera specimens which were stored in triangular bags. All the insects after collection were brought in the laboratory and were examined under a stereo binocular microscope. The collected insects were carefully sorted and identified up to the family level following standard literatures.

Data Analysis

During the present study, For the statistical analysis of the different insect fauna collected using different traps 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:

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

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:

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

Where, Σ= sum of (Total)

ni= the number of individuals of each different species

N= the total number of individuals of all the species.

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

$$(H) = -[\ \Sigma\ (ni/ N) \times In(ni/ N)]$$

Where, Σ = sum of (Total)

ni = 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

In(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

All the statistical analysis was calculated in PAST (Version 4.13) and Microsoft Excel 2019.

Result

1. Diversity study

During the present study by means of different trapping procedure, a total of 456 insects were trapped from the sampling traps a total of 33 families from total 9 orders were collected. Hemiptera, Hymenoptera, Diptera, Coleoptera was the most diverse order according 9 (Aphididae, Cicadellidae, Cicadidae, Coreidae, Delphacidae, Lygaeidae, Nabidae, Pentatomidae,Miridae), 5(Braconidae, Eulophidae, Formicidae, Membracidae, Pompilidae), 5(Calliphoridae,Cecidomyiidae, Psychodidae, Stratiomyidae, Sciaridae), 9(Coccinellidae, Curculionidae, Dermestidae, Latridiidae, Ptiliidae, Phalacridae, Scarabaeidae, Staphylinidae, Tenebrionidae) families respectively. Lepidoptera had one (Tineidae) family and Thysanoptera had one (Thripidae) family, Collembola had one (Entomobryidae) family, Diplura had one (Projapygidae) family, and Isoptera had one (Termitidae) family. (Fig 1, 2, 3, 4, 5).

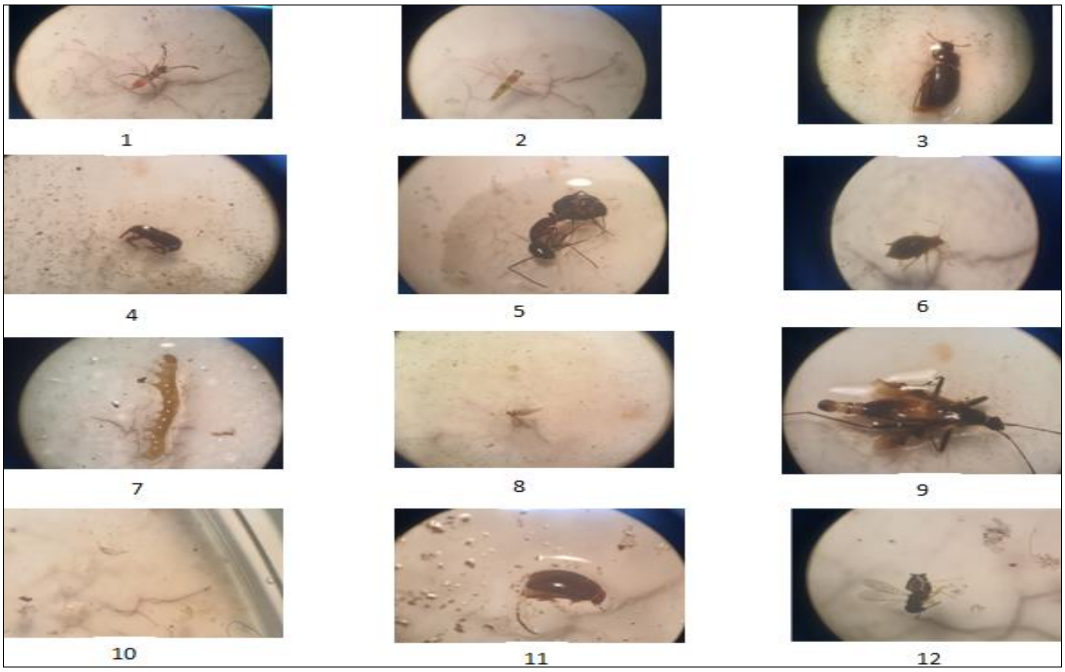

Fig 4: Pictures of some insects collected in Pitfall trap.
1. Hemiptera, 2. Hemiptera, 3. Coleoptera, 4. Coleoptera, 5. Hymenoptera, 6.Hemiptera, 7. Lepidoptera, 8. Diptera, 9. Hemiptera, 10. Collembola, 11. Coleoptera, 12. Hymenoptera.

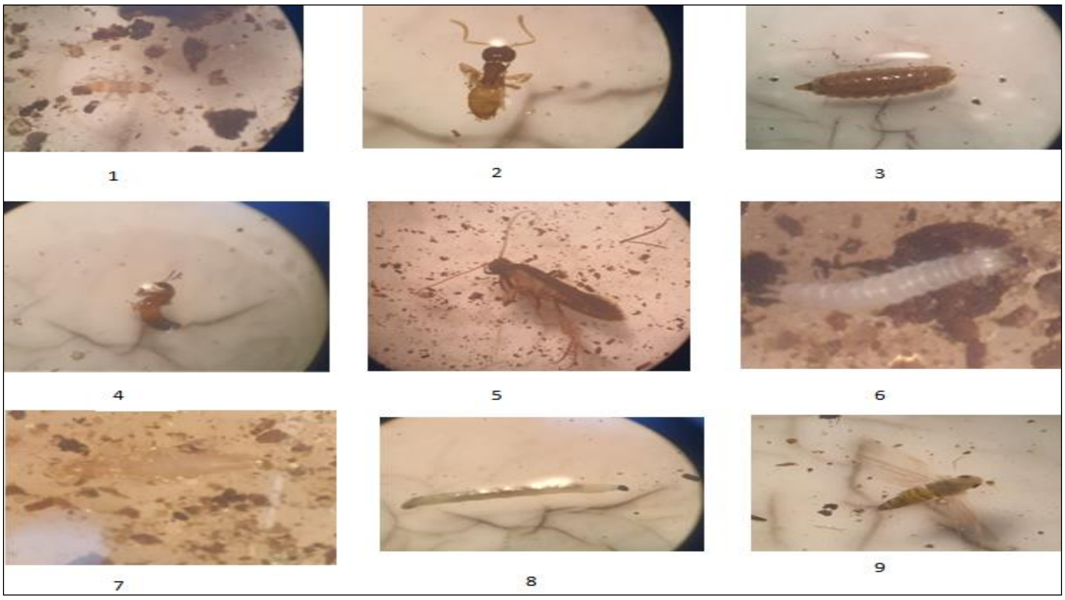

Fig 5: Pictures of some insects collected in Tullgren trap
where1. Hemiptera, 2. Hymenoptera, 3. Diptera, 4. Coleoptera, 5. Lepidoptera, 6.Diplura, 7. Isoptera, 8. Diptera, 9. Hemiptera

2. Ecological data analysis

Table 1: Relative abundance of orders of all insects found

Order	Pitfall Trap		Tullgren Trap	
	No. of Insects	Relative abundance (%)	No. of Insects	Relative abundance (%)
Hemiptera	35	14.583333	15	6.944444
Hymenoptera	108	45	161	74.53703
Diptera	30	12.5	10	4.629629
Coleoptera	28	11.66666	8	3.703703
Lepidoptera	4	1.66666	1	0.46296296
Thysanoptera	19	7.916666	3	1.388888
Colembola	10	4.166666	3	1.388888
Diplura	1	o. 416666	5	2.31481481
Isoptera	5	2.0833333	10	4.62962963
Total	240	100	216	100

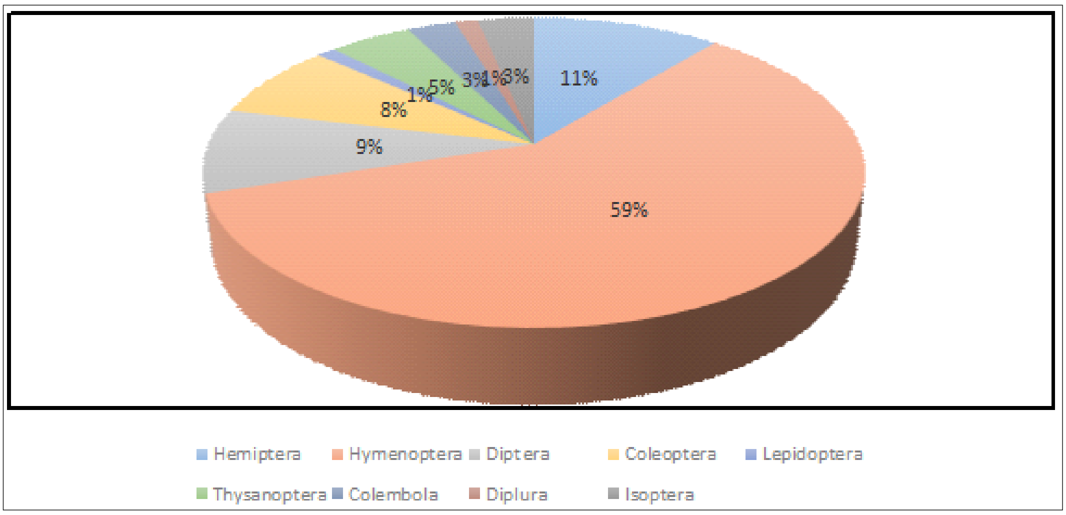

Fig 6: Pie chart showing the Relative Abundance of Orders of all Insects Found (Based on table 2)

Table 2: Comparing relative abundance of insects found in 2 different traps

Order	Pitfall Trap		Tullgren Trap	
	No. of Insects	Relative abundance (%)	No. of Insects	Relative abundance (%)
Hemiptera	35	14.583333	15	6.944444
Hymenoptera	108	45	161	74.53703
Diptera	30	12.5	10	4.629629
Coleoptera	28	11.66666	8	3.703703
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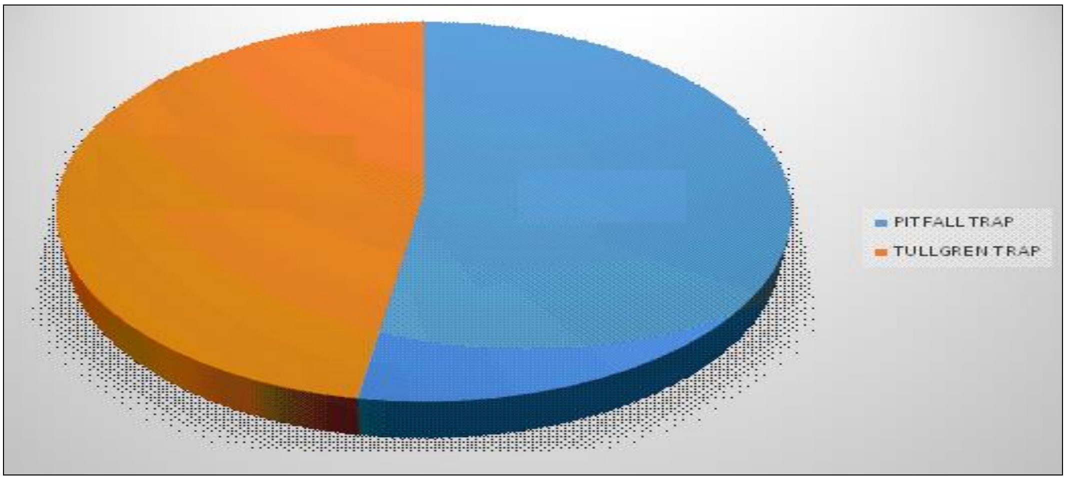

Fig 7: Pie chart showing the comparative relative abundance of insects found in 2 different traps

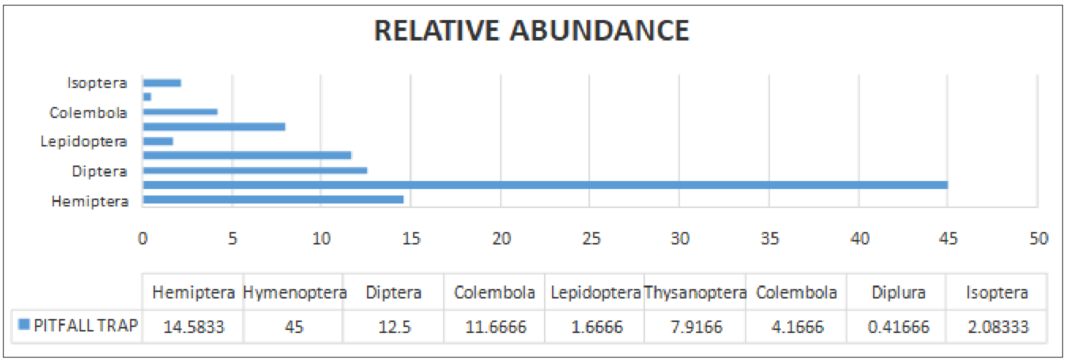

Fig 8: Relative abundance of insects found in pitfall trap

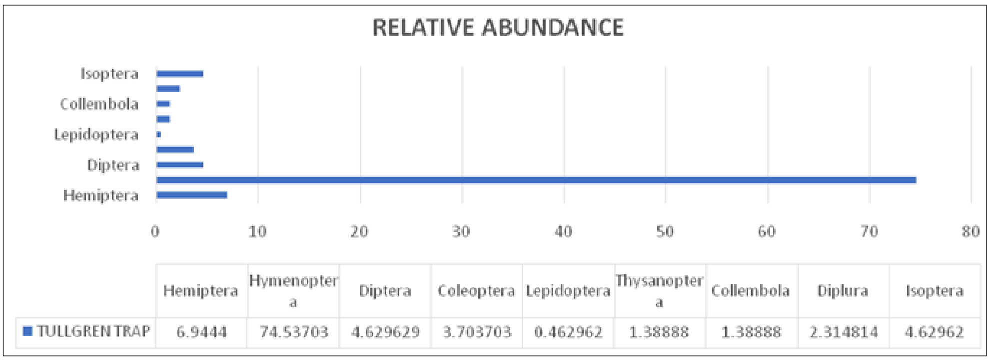

Fig 9: Relative abundance of insects found in tullgren trap

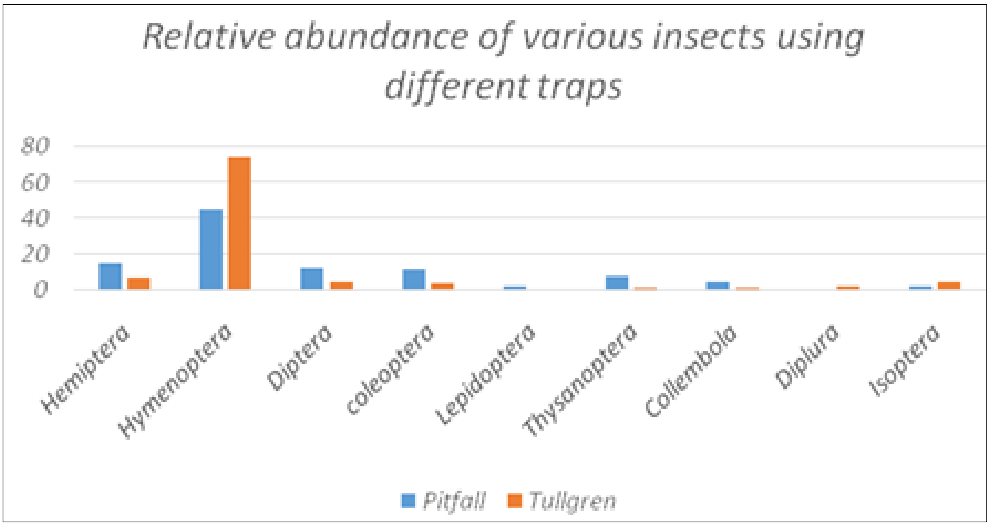

Fig 10: Relative Abundance of various insects collected during the present study using 2 different trapping methods

Variations in the study of relative abundance of the different insect orders collected using two different trapping systems were also recorded during the present research work. The order Hemiptera, Hymenoptera, Diptera and coleoptera were the most common orders collected in 2 different traps (10.96%), (58.99%), (8.77%) and (7.89%) respectively. The order Hymenoptera was dominant order collected in tullgren trap (74.53%) and pitfall trap (45%). The order Hemiptera,Diptera and Coleoptera were dominant order collected in pitfall trap (14.58%),(12.5%), (11.66%) respectively. The order Isoptera and Diplura were dominant orders collected in tullgren trap. The order Lepidoptera,Thysanoptera and Collembola were dominant orders collected in pitfall trap.(Fig : 8,9,10).

Table 3: Biodiversity index of 2 different traps

Biodiversity Indices	Pitfall trap	Tullgren trap
Species richness (S)	9	9
Simpsons index (D)	00.262	00.567
Index of similarity (1-D)	00.738	00.433
Shannon wiener index(H)	1.656	1.042
Evenness (E)	00.754	00.474

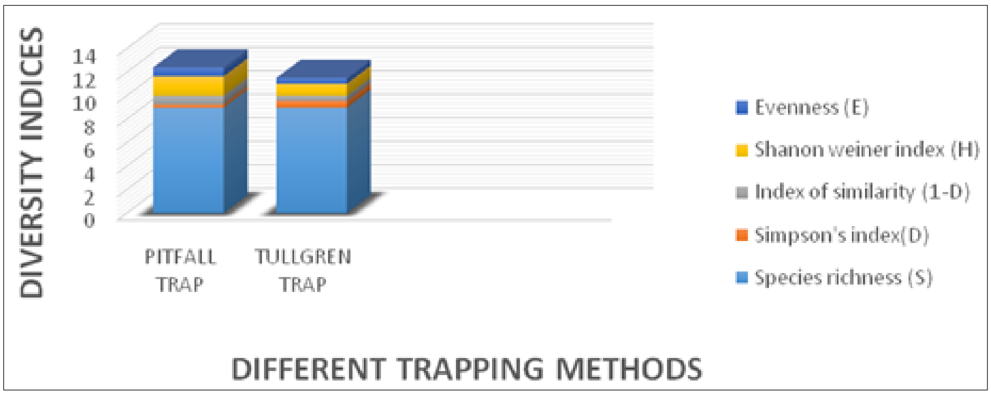

Fig 11: Diversity indices of different trapping methods

Results of various diversity analysis of collected insects with 2 different trapping methods indicated that less diversity found for tullgren trap (H=1.042) and high diversity found for pitfall traps (H= 1.656) sampling methods. More evenness is found for pitfall trap (E= 00.754) and less evenness found for tullgren trap (E=00.474). The Simpson's index in tullgren trap shows a higher value than pitfall trap. Species richness (S) is moreover equal for both traps. As shown in Fig 11.

Table 4: Results of Chi-square test and two sample z- test on the variation in the frequency of collection for ground dwelling insects using pitfall (PIT) and Tullgren funnel method (TFM)

Taxa/Insect orders	Trapping methods	Z-test		Chi-squared test	
		Z	P-Value	C^2	P-Value
Hemiptera	PIT/TFM	1.206	0.227	8	0.004
Hymenoptera	PIT/TFM	-1.209	0.226	10.44	0.001
Diptera	PIT/TFM	1.767	0.077	6.42	0.011
Coleoptera	PIT/TFM	1.965	0.049	5.82	0.015
Lepidoptera	PIT/TFM	1.435	0.151	1.8	0.179
Thysanoptera	PIT/TFM	3.223	0.001	11.62	0.000
Colembola	PIT/TFM	1.765	0.077	3.76	0.052
Diplura	PIT/TFM	-1.506	0.132	2.68	0.101
Isoptera	PIT/TFM	-1.069	0.284	1.68	0.194

From Table 4 we get the values of z test and chi-square test of various orders of insects and we can conclude that the z value of the order thysanoptera is higher than every insect orders and the lowest z value shows for the order Isoptera. For the chi-square the order Thysanoptera, Hymenoptera and Hemiptera gradually shows the higher values than rest of the orders.

Discussion

During the current study, a total of 456 insects were trapped using various trapping procedures. These insects belonged to 33 different families, which were classified into 9 orders. The orders with the highest diversity were Hemiptera, Hymenoptera, Coleoptera, and Diptera. Hemiptera included 9 families: Aphididae, Cicadellidae, Cicadidae, Coreidae, Delphacidae, Lygaeidae, Nabidae, Pentatomidae, Miridae.

Hymenoptera consisted of 5 families: Braconidae, Eulophidae, Formicidae, Membracidae, Pompilidae.Diptera exhibited diversity through 5 families: Calliphoridae,Cecidomyiidae, Psychodidae, Stratiomyidae, Sciarida. Coleoptera had 9 families :Coccinellidae, Curculionidae, Dermestidae, Latridiidae, Ptiliidae, Phalacridae, Scarabaeidae, Staphylinidae, Tenebrionidae. Lepidoptera, Thysanoptera, Collembola, Diplura and Isoptera each had one family: Tineidae, Thripidae, Entomobryidae, Projapygidae, Termitidae respectively.

During this current study a total of 456 insects were trapped using 2 different traps(pitfall trap and tullgren trap).

These insects belonged to 33 different families which were classified into 9 orders. The orders with the highest diversity were Hemiptera, Hymenoptera, Coleoptera, Diptera.

An earlier study in Western Ghats of South India conducted by Sabu and Shiju in the year of 2010, provides data about the abundance of ground dwelling insects, using pitfall and Barlese extraction method.

Conclusion

During the present comparative study, it was found that different traps have varying effectiveness in capturing and representing insect biodiversity.

Off these two traps used, Pitfall traps prove to collect maximum numbers of insect populations. It found to collect maximum variety of insect and pitfall traps were found to be effective in capturing ground-dwelling insects, such as beetles.

Again, Tullgren traps were found to effective in capturing insects of order Hymenoptera,Diplura and isoptera.

It is important to note that the effectiveness of traps can be influenced by environmental factors, such as weather conditions, habitat types, and seasonal variations. Researchers should consider these factors and implement appropriate adjustments to their sampling protocols.

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