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A study of lepidopteran and hymenopteran species diversity in the agroecosystem of Manimuthar, Tirunelveli district

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Abstract
Agricultural systems provide ecosystem services that are essential to human wellbeing. Beneficial insects provide agricultural ecosystem services such as pollination and the natural control of plant pests. A total of 23 species of Lepidopteran belonging to the five families were recorded during the survey. Out of the five families of butterflies, Nymphalidae were the most commonly recorded, accounting for 14 species of the total species recorded, followed by Pieridae (3 species), Lycaenidae (2 species), Hesperidae (2 species), and Papilionidae (2 species) of the total species. The Hymenopteran members such as bees, ants, and wasps are the largest and most diverse orders of insects. The current study documented approximately 13 species of insect visitors, the majority of which are hymenopterans. A total of 13 species of Hymenopterans belonging to the four families were recorded during the survey. Apidae and Formicidae were the most commonly recorded Hymenopteran families, accounting for 5 species of the total species recorded, followed by Vespidae (2 species) and Sphecidae (1 species). Insect abundance is important in biological control, because it provides an important source of food for other organisms in the community, thus providing ecosystem stability. Insect abundance is also crucial to the stability of agricultural landscapes.

Keywords: agricultural systems, beneficial insects, lepidopteran, hymenopteran, abundance

Introduction
Biodiversity is a relative measure among the organisms present in different ecosystems [4, 5, 10, 20]. Most of the world's biodiversity is found in human-managed landscapes, such as forests and agricultural habitats. Agroecosystems also serve as refuges for many species of wildlife that are losing their natural habitats due to habitat fragmentation and human encroachment [11]. The hexapod invertebrates known as insects belong to the class Insecta, phylum Arthropoda, and kingdom Animalia. More than a million insect species have been identified to date, and many more millions are still undiscovered [8]. Due to their importance in many people's diets and medications, as well as their ability to support and create livelihoods, insects have significant intellectual and economic significance. The great majority of plants are pollinated by a variety of insects including bees, wasps, and occasionally ants (Hymenoptera), beetles (Coleoptera), moths, butterflies (Lepidoptera), flies (Diptera), and bugs (Hemiptera).
Biological pest control is yet another significant use of insects. It's interesting to note that many insect taxa can also be used as bioindicators. For instance, butterfly population dynamics have been proposed as bio-indicators of habitat structural and floristic diversity, species richness in overall pollinators, climate change, and landscape distinctiveness [13, 23]. Although numerous studies on the demographic population of insects, their economic significance, and their diversity in various Tamil Nadu locations have been carried out [26, 25, 24, 21]. There has never been any research done on the insect fauna of the Manimuthar agroecosystem. The study focuses on the most common and significant pollinators in the area, which are bees, ants, wasps, and butterflies.

Materials and methods
Lepidopteran and Hymenopteran, two insect groups, have been chosen for this study. As an example, butterflies and moths (Lepidopteron) have huge, frequently colourful wings, whereas ants, bees, and wasps (Hymenoptera) are typically found in large colonies and can occasionally be stringy in appearance.
The Manimuthar agricultural area in the Tirunelveli district served as the site for the study. Paddy, banana trees, coconuts, citrus fruits, cotton, blackgram, and mangoes are some of the most important commercial crops. There were a variety of open grasses and plants on fallow fields. The diversity of hymenopterans and lepidopterans in the agricultural area was the main focus of this investigation. During the study period, a preliminary survey was conducted during the day from 7 a.m. to 12 p.m. To observe butterflies, the pollard walking technique was used [22]. The data was retained along with the photographic documentation. A similar method was used to assess hymenopteran abundance.

Management and analysis of data
Based on the suggestion of Michael and Sharma [17] and Ludwing and Reynolds [14], biodiversity indices can be calculated. The information gathered about the total number of families, genera, species, and individuals in each of the microhabitats under investigation may be combined and analyzed.

a. Species composition: abundance for each species was calculated by summing up the number of individuals recorded in the transect
b. Species diversity using Shannon – Weiner's index (H').

H' = -ΣPiln Pi S i= 1

Where Pi is the proportion of species i and ln is the natural logarithm of the proportion with i = 1, 2.....S. S is the total number of species present.

Results

Table 1 lists the encountered and identified common lepidopteran diversity in the study area. Table 2 shows the common Hymenopteran insect visitors to the study area Tables 3 and 4 shows month-wise variation in lepidopteran and hymenopteran diversity during the study period. Figure 1 shows the comparison of order-wise insect species diversity. Figures 2 and 3 show the family-wise Lepidopteran and Hymenopteran diversity.

Table 1: Identified Common Lepidopteran Diversity in the Study Area

S. No	Common Name	Zoological name	Family name
1	Chest nut bob	*Iambrix salsala*	Hesperidae
2	Plains cupid	*Chilades contracta*	Hesperidae
3	Dark pierrot	*Castalius ananda*	Lycaenidae
4	African Babul Blue	*Azanus jesous*	Lycaenidae
5	Choclate pansy	*Junonia iphita*	Nymphalidae
6	Common Four ring	*Ypthima hiibneri*	Nymphalidae
7	Common Three ring	*Ypthima asterope*	Nymphalidae
8	Common Indian crow	*Euploea core*	Nymphalidae
9	Common Salier	*Neptis hylas*	Nymphalidae
10	Blue tigher	*Tirumala limniace*	Nymphalidae
11	Dark Blue tigher	*Tirumala septentrionis*	Nymphalidae
12	Plains tigher	*Danaus chrysippus*	Nymphalidae
13	Common tiger	*Danaus Genutia*	Nymphalidae
14	Red dish brush brown	*Mycalesis oculus*	Nymphalidae
15	Yellow pansy	*Precis hierta*	Nymphalidae
16	Lemon pansy	*Junonia lemonias*	Nymphalidae
17	Great Egg fly	*Hypolimnas bolina*	Nymphalidae
18	Smooth Eyed Bush brown	*Orsotriaena medus*	Nymphalidae
19	Common blue bottle	*Graphium sarpedon*	Papilionidae
20	Crimson Rose	*Pachliopta hector*	Papilionidae
21	Common grass Yellow	*Eurema hecabe*	Pieridae
22	Common Albatross	*Appias albina*	Pieridae
23	Indian Cabbage White	*Pieris canidia*	Pieridae

Table 2: Identified Common Hymenopteran Diversity in the Study Area

S. No	Common Name	Zoological Name	Family Name
1	Giant honey bee	*Apis dorsata*	Apidae
2	Western honey bee	*Apis mellifera*	Apidae
3	Dwarf honey bee	*Apis florea*	Apidae
4	Indian bee	*Apis indica*	Apidae
5	Black bumble bee	*Bombus melanopygus*	Apidae
6	Formicine ant	*Camponotus compressus*	Formicidae
7	Black ant	*Monomorium minimum*	Formicidae
8	Black garden ant	*Lasius niger*	Formicidae
9	Common red ant	*Myrmica rubra*	Formicidae
10	Red fire ant	*Solenopsis geminata*	Formicidae
11	Burrowing wasp	*Sphecius speciosus*	Sphecidae
12	Potter wasp	*Eumenes petiolata*	Vespidae
13	Oriental hornet	*Vaspa orientalis*	Vespidae

Table 3: Month-Wise Variation of Lepidopteran Diversity during the Study Period

Family name	Total Species	January	February	March	Total Individuals	Abundance
Hesperidae	2	4	3	2	9	11.39
Lycaenidae	2	5	3	3	11	13.92
Nymphalidae	14	11	9	8	28	35.44
Papilionidae	2	5	4	5	14	17.72
Pieridae	3	7	6	4	17	21.51

Table 4: Month-Wise Variation of Hymenopteran Diversity during the Study Period

Family name	Total Species	January	February	March	Total Individuals	Abundance
Apidae	5	9	14	8	31	33.69
Formicidae	5	17	14	18	49	53.26
Sphecidae	1	1	2	1	4	4.34
Vespidae	2	2	3	3	8	8.69

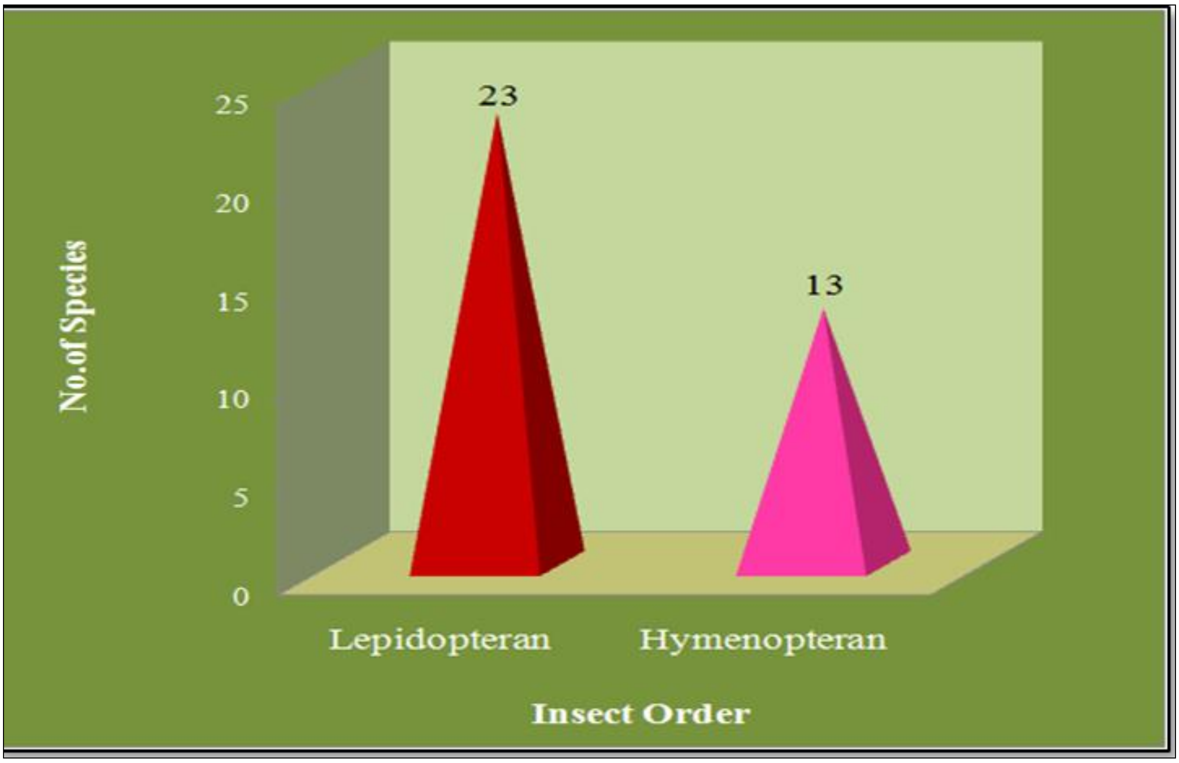

Fig 1: comparison of order-wise insect species diversity

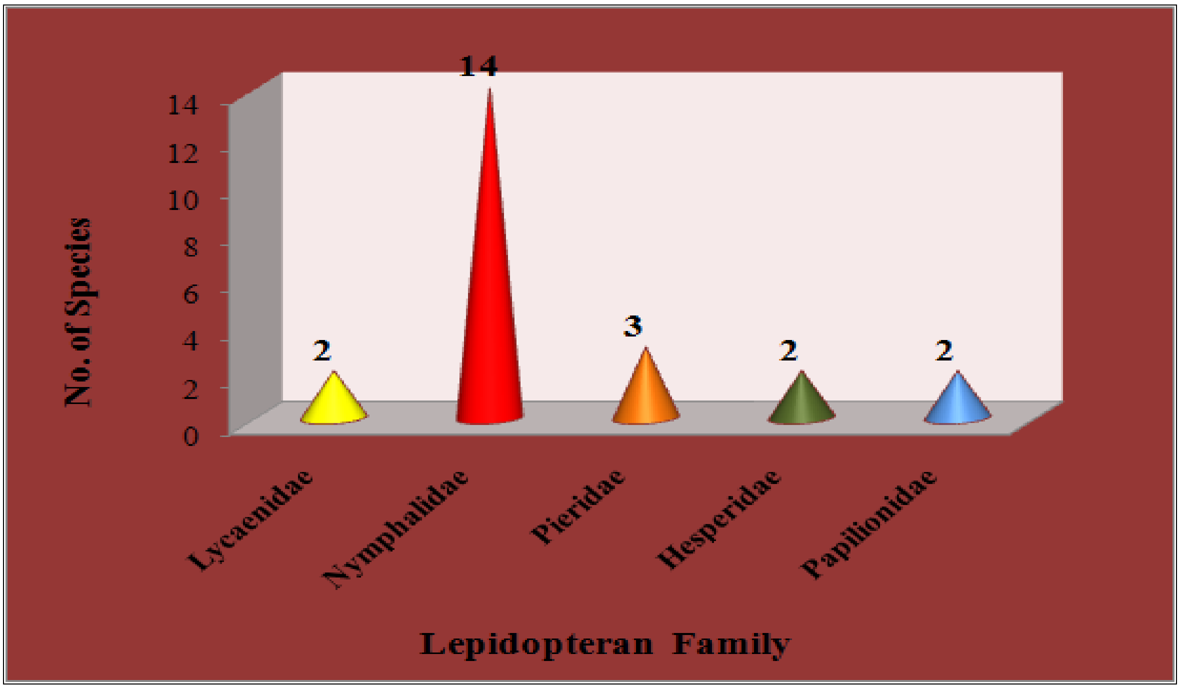

Fig 2: family-wise lepidopteran diversity in the study area

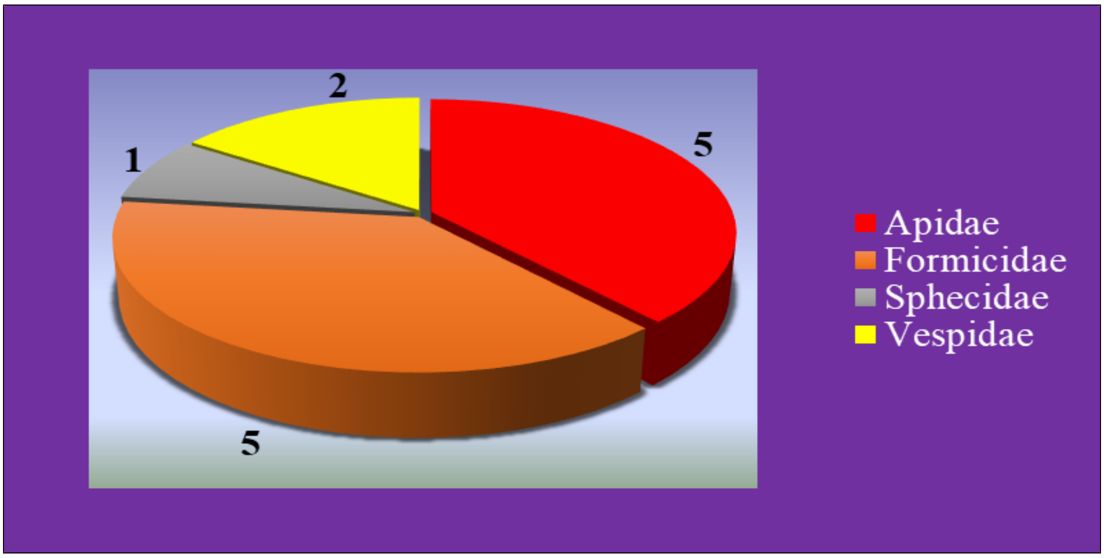

Fig 3: family-wise hymenopteran diversity in the study area

Discussion

Globally, agriculture dominates land management, and agricultural ecosystems make up close to 40% of the planet's land area [6]. Both producers and consumers of ecosystem services are agroecosystems. These highly regulated ecosystems are created to supply food, fodder, fibre, bioenergy, and pharmaceuticals. Humans value these systems primarily for their provisioning functions. In turn, natural, unmanaged ecosystems supply a variety of ecosystem services that are heavily reliant on agricultural ecosystems. Supporting services include the provision of water, soil formation and structure, soil fertility, nitrogen cycling, and genetic variety for use in breeding crops and livestock. Pollinators and natural enemies that migrate into agricultural environments from natural vegetation may offer regulatory benefits to agriculture.

An ecological survival function that is crucial is pollination. Without insect pollinators, the majority of flowering plants are unable to produce seed [15, 1]. A paradigm for calculating the value of pollination by native insect pollinators was offered by Morse and Calderone [18]. Agricultural ecosystem services provided by beneficial insects include pollination and the organic control of plant pests.

Lepidopteran insects are diverse in nature, and both as adults and as larvae, they serve as adult pollinators and crop pests [9]. Diurnal behaviour is common among pollinating butterfly species [19, 2, 1]. Throughout the investigation, 23 different Lepidopteran species from five different families were identified. The Nymphalidae, one of the five families of butterflies, accounted for the majority of species—14—recorded, followed by the Pieridae (3 species), Lycaenidae (2 species), Hesperidae (2 species), and Papilionidae (2 species). Lepidopterans, which comprise both butterflies and moths, account for 1,12,000 species, or nearly 80% of all currently recognized animal species in the world. Butterflies have a strong sense of sight but a poor sense of smell. Large, showy flowers in pink or lavender that are pollinated by butterflies are more common. They can delve deeply into the floral structures that contain food resources because of their lengthy mouthparts. As a result, plants pollinated by lepidopterans frequently develop tubular corollas that produce nectar at the tube's base. Lepidopteran species from various families were found in 32 different species in January, 25 species in February, and 22 species in March, according to data on their monthly occurrence (Table. 3).

According to observations, 50% of all insect visits are made by lepidopteran species. They engage in more interactions than the other insect orders. In terms of population and visitors, the order Hymenoptera outnumbers the other insect orders. The world's pollinating bee species number around 20,000 [3]. Ants are crucial elements of ecosystems since they not only make up a significant portion of the animal biomass but also operate as ecosystem engineers. The family Formicidae, which includes the ant species Camponotus compressus, Monomorium minimum, Lasius niger, Myrmica rubra, and Solenopsis germinata, has been identified in the current study. The figs are a significant family of tropical rainforest plants, and wasps are essential to their survival [7]. According to the study, the orders Lepidoptera and Hymenoptera had high species richness (> 0.5) and the Shannon-Wiener index (h) values were 1.527 and 1.050, respectively. This can be a result of the favourable climate and accessibility to the natural resources required for their survival. The research area is a true haven for Lepidopteran and Hymenopteran pollinators, as seen by the high species variety seen during the survey.

Conclusion

Because it serves as a vital food source for other creatures in the community and promotes environmental stability, insect abundance is crucial for biological control. Insect abundance is also critical to the stability of agricultural landscapes. Insect pollinators are at risk from agriculture due to a variety of factors, including land use changes, habitat loss and fragmentation, the introduction of exotic species, contemporary farming methods, and pesticide use. One of the main causes of the decline in native pollinators in agro ecosystems is the eradication of weeds that serve as food for pollinators. Farmers are not informed enough about these insects or their advantages. They kill both of them and the bug pests using various management techniques. Farmers should receive training and participate in programmes to increase their understanding of the importance of protecting their environment by leaving larger sections of vegetation untouched, using broad-spectrum insecticides sparingly, and avoiding activities that could harm important insects. The effectiveness of conservation and the promotion of more harmonious land use with efficient agricultural production can both be improved with a greater grasp of the advantages.

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