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Diversity and abundance of insect pollinators in urban landscapes of Meera Girls College, Udaipur, Rajasthan, India

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Abstract

Studies on diversity and abundance of insect pollinators are prerequisite of biodiversity conservation. Field study was conducted in flowering gardens of Government Meera Girls College, Udaipur, Rajasthan, India during October 2020 to February 2021 to investigate the diversity and abundance of insect pollinators. A total of 35 species were observed from 5 orders and 13 families. Lepidoptera were found to be the most abundant followed by Hymenoptera, Coleoptera, Diptera and Hemiptera. In order Hymenoptera *Apis dorsata*, *Apis florea*, and *Apis mellifera* and in order Lepidoptera *Catopsila pyranthe*, *Junonia lemonias* and *Phoebis sennae* were found abundant. A research design based on urban landscape areas will enable insect biodiversity conservation through development and management of urban green spaces.

Key words : Abundance, conservation, diversity, insect pollinators, urban green spaces.

Urban environments face different threats and result in decline of insect pollinator species due to stressors like multitude of pesticides, degradation of habitats, climate change, monoculture cultivation in agricultural landscapes, increased urbanization, *etc*. Institutional green spaces not only support sustainability development goals but also favour biodiversity. Urbanization has been found to promote positive effects and increased opportunities for insect pollinators[1] by providing food resources, nesting places and hibernation.

Pollinators are the pollen transfer agents which determine the mating opportunities of plants. Approximately 90 % of flowering plant species are pollinated by insects. Oil seeds (such as sunflower, niger, safflower), vegetables (Cucurbitaceous vegetable crops, legume crops) and many fruit crops are profoundly reliant on pollinators[16]. Numerous crops and the majority of wild plants are dependent on animal pollination, with insects playing the major role for sexual reproduction. In India, many of the food crops require insect

(mostly bee) pollinators for adequate pollination. Solitary and social bees help in crop production both in managed and natural ecosystems. The loss of these pollination services would have unfavourable effect on food production and no doubt for the preservation of biodiversity[12]. The majority of plant species is generalist and depends on various pollinator species for pollination[9]. The order Hymenoptera includes several of the most advanced and very specialized pollinator insects followed by pollinators from order Lepidoptera. The important pollinators are honey bees, bumble bees, solitary bees, stingless bees and many kinds of butterflies, flies, black ants, thrips, beetles and moths.

Intense industrial agriculture, together with the landscape changes and urbanization has been recognized as one of the factors resulting in decline of pollinator species. To understand the impacts of urbanization on plant-pollinator interactions, urban areas in educational campuses may provide a remarkable and productive study system.

Plant diversity and floral abundance in urban environments promote pollinating flower visitors in observations made on plant diversity, floral abundance, flower visitor diversity and plot visits at 89 plant patches within the city of Zürich[8].

Insect pollination is a very significant ecosystem service that provides important support for food security and ecosystem stability[7].

Therefore, it is essential to understand pollinators' diversity and abundance in urban natural ecosystem, so accordingly, strategy can be planned to enhance their number. It will also be helpful for gardeners and farmers to plan appropriate time for pesticide spray. In this study, we aimed to assess the diversity and abundance of insect pollinators in the different gardens of Government Meera Girls College, Udaipur, Rajasthan situated in urban area of the city.

Study area :

The study was conducted at Government Meera Girls College Udaipur, Rajasthan (24058' N Latitude and 70068' E Longitude) in India. Insect pollinators were collected from five different gardens namely Saraswati vatika, Meera vatika, Rashi vatika, Botanical Garden and Herbal Garden near college library.

Selection and survey of Gardens :

College campus gardens supporting the production of flowering plants were surveyed extensively 5 hours daily and 4 days a week for a period of 5 months (from October 2020 to February 2021) covering almost 117569.273 square meters of area.

Collection and Identification :

Active sampling techniques were employed for the collection of insects such as sweep nets and hand-picking method. The species were photographed in field by using camera, insects were recognized on the spot, and the unidentified species were brought to the college laboratory for identification. The collected species were dry pinned and mounted in the laboratory. Identification was done by following standard and available literature.

Data Analysis :
Shannon-Wiener Diversity Index :

The insect pollinator diversity during

the flowering period was measured using the Shannon-Wiener Diversity Index[18].

Relative Abundance Index (RAI) and Simpson's Index of Dominance (D):

By using MS Excel, collected data was analyzed using the Relative Abundance Index[13] and Simpson's Index of Dominance[4].

The plant species in the college gardens include *Tabernaemontana coronaria*, *Magnolia champaca*, *Hibiscus rosa-sinensis, Tecoma stans*, *Duranta erecta*, *Nerium oleander*, *Cosmos sulphureus*, *Lilium candidum*, *Rosa* sps., *Antigonon leptopus*, *Bougainvillea* sps., *Callistemon* sps., *Catharanthus roseus*, *Canna indica*, *Tridax procumbens*, *Combretum indicum*, *Delonix regia*, *Moringa oleifera*, *Abronia ameliae*, *Bauhinia variegata*, *Tamarindus indica*, *Psidium guajava*, *Eucalyptus* sps., A total of 491 individuals of insect pollinators belonging to 35 species, 13 families and 5 orders were captured and identified during the study period, between October 2020 and February 2021 from five different gardens of Government Meera Girls College, Udaipur. Out of these 5 orders, Lepidoptera were most diverse and dominant (62.32%) with 306 individuals, followed by Hymenoptera (22.40%) with 110 individuals and Coleoptera (7.12%) with 35 individuals, Diptera (5.09%) with 25 individuals, and least was Hemiptera (3.05%) with 15 individuals. Among Hymenoptera, the most dominant and common species was *Apis dorsata* (22.72%) followed by *Apis florea* (14.54%). Among Lepidoptera, the most abundant species was *Catopsila pyranthe* (16.99%) followed by *Junonia lemonias* (7.84 %). Out of 13 identified families, Pieridae was most dominant with respect to number of individuals followed by Nymphalidae, Apidae, Coccinellidae, Muscidae, Papilionidae, Lycaenidae, Vespidae, Lygaeidae, Formicidae, Halictidae, Chrysomelidae and Erebidae respectively. The most dominant insect pollinator species in study area was *Catopsilia pyranthe*.

Shannon-Wiener diversity index, Relative Abundance Index (RAI) and Simpson's index of dominance (D) for different orders are as given in the Table-1. Overall, the Shannon-Wiener diversity index H and Simpson's index of dominance D value is as given in Table-2.

Fig. 1 shows pictures of some pollinator insects collected from study sites. Fig. 2 represents Relative abundance Index (RAI) of families of insect pollinators in the study area.

Table-1. Diversity, relative abundance and dominance of orders of insect pollinators at study site

S. No.	Order	Shannon-Wiener Diversity Index (H)	Relative Abundance Index (RAI)	Simpson's index of dominance (D)
1.	Hymenoptera	0.852	22.40%	0.0501906
2.	Lepidoptera	1.984	62.32%	0.388400579
3.	Coleoptera	0.266	7.12 %	0.00508128
4.	Diptera	0.186	5.09 %	0.00259249
5.	Hemiptera	0.106	3.05%	0.000933296

Table-2. Diversity and dominance indices of insect pollinators at study site

S. No.	Index	Value
1.	Shannon-Wiener Diversity Index (H)	3.396
2.	Simpson's index of dominance (D)	1

Apis dorsata *Apis florea* *Apis mellifera* *Xylocopa* sp.

Catopsilia pyranthe *Junonia lemonias* *Pieris brassicae* *Eurema hecabe*

Hypolimnas misippus *Papilio demoleus* *Junonia hierta* *Talicada nyseu*

Junonia orithya *Papilio demodocus* *Hypolimnas bolina* *Amata bicincta*

Fig. 1. Some insect pollinators from research area

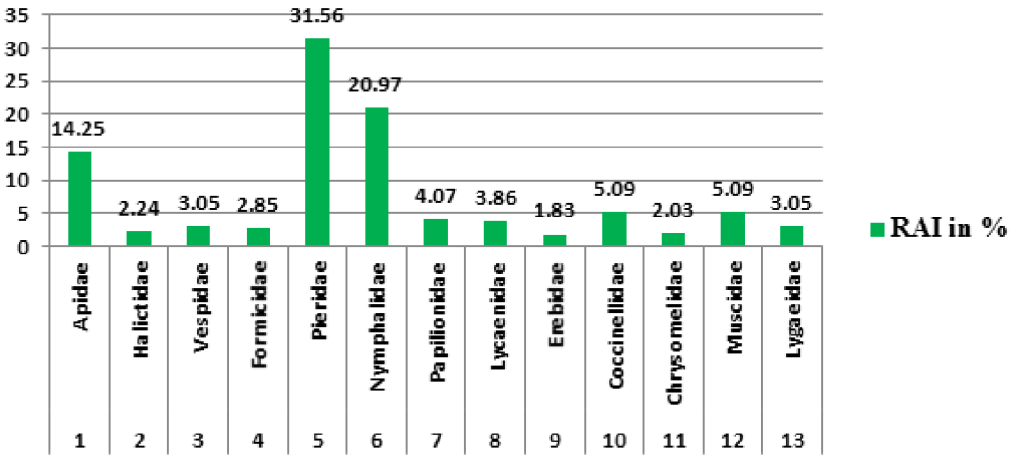

Fig. 2. Relative abundance Index (RAI) of families of insect pollinators

Pollination is one of the most affected ecosystem services in urban areas mainly due to the decline in urban green areas and other factors derived from urbanization itself. The main insect pollinators from our study are from five different orders: Hymenoptera, Lepidoptera, Coleoptera, Diptera and Hemiptera that were observed during the day. Insect pollinators from order Lepidoptera and Hymenoptera showed high species diversity and abundance. In contrast, insect order Coleoptera, Diptera and Hemiptera showed low species diversity and abundance.

Higher abundance of Lepidoptera as indicated by the Shannon-Weiner diversity index[18] in this study have been reported in flowering gardens in previous studies also. Butterflies are considered as good ecological indicators because of their sensitivity towards the environmental changes[11]. Pollinators have colour preferences. Lepidopteran insects are more attracted towards bright colours and this may be the reason of high number of Lepidoptera in flowering gardens. High temperature in the day increases the emission of nectar which attracts more insect pollinators[17].

Hymenoptera are the major pollinator species on both mustard and cauliflower followed by Diptera and Lepidoptera as reported in a study on relative abundance of insect pollinators on mustard and cauliflower, grown on research farms of Lovely Professional University, Jalandhar, India[15]. Difference in pollinator species at different places is probably due to flower preferences of pollinators.

The total abundance of pollinators was suggested to be higher in urban grasslands than in housing estates and urban parks in a comparative study on abundance and species richness of three main groups of pollinators – wild bees, butterflies and hoverflies – in Poznań, western Poland in three different types of urban green areas[6]. It can be inferred that high-quality urban habitats like urban grasslands are apt in sustaining large pollinator

populations. Therefore, protecting prominent urban green areas is indispensable and efforts should be made to plan and manage urban green spaces effectively.

A research carried out in Granada, south-eastern Spain, to evaluate the potential of urban green spaces for the improvement of the Pollination Ecosystem Service suggested that urban green areas may offer enough floral resources for pollinators and have huge potential for pollinator conservation as the major part of its ornamental species has an entomophilic pollination strategy[14] as is observed in our study also. The college gardens and green spaces in this urban environs provide sufficient supply of flowers to the insect pollinators evident from the diversity (3.396) and dominance indices (1) at the study site. Gardens have a high potential to provide a range of various ecosystem services and functions in addition to the habitat potential for flower visitors and resulting ecosystem service of pollination[2].

Pollination is significant in improving food safety and livelihoods through enhancing productivity of horticultural crops such as fruits and vegetables[19]. Bees visit plants for nectar and pollen. This floral fidelity of bees is due to their preference for nectar having sugar content and pollens with higher nutritive values. Three species of Family Apidae, namely *Apis dorsata*, *Apis florea* and *Xylocopa pubescens* were reported from the Government College, Kota Campus, Kota, Rajasthan. The wasp species recorded was *Polistes hebraeus* of family Vespidae and the bee species recorded in maximum was *Apis dorsata* Fabricius[3] while bee species recorded in current study are *Apis dorsata*, *Apis florea*, *Apis mellifera*, *Xylocopa sps.*, *Bombus sps.* and *Ceratina sps.* with *Apis dorsata* the most common and dominant (22.72%) among Hymenopterans and the wasp species observed were *Polistes flavus* and *Polistes stigma*. Hymenopterans are host-specific and several hymenopteran species indicate rich floral resources in the study area.

In a survey conducted on diversity and foraging behaviour of insect pollinators in radish at the experimental fields of the ICAR-Indian Institute of Horticultural Research, Bengaluru, fifteen insect pollinators from insect orders Hymenoptera, Lepidoptera and Diptera were observed to visit *R. sativus* (*Raphanus raphanistrum* subsp. *sativus*) flowers[5].

Anthropological disturbances are bound to influence number of pollinator species in urban green areas. Decline in insect pollinators could be reversed through planting flower strips between crops, reintroducing hedges and planting trees at the farm level, at the same time conserving habitats at landscape levels[10]. To devise solutions suitable to the scale of this global social-ecological crisis, more studies illustrating collective action at all scales of government and industry engaging with insect pollinator biodiversity conservation are needed.

With this research work, we have been able to present baseline insect pollinators diversity data of this urban research area.

It is evident that Lepidopterans are the most diverse pollinating insects found in garden areas of Government Meera Girls College, Udaipur, Rajasthan followed by Hymenopterans.

While Dipterans and Coleopterans showed less diversity, their contribution to pollination cannot be ignored. The findings of the present study underline the importance of institutional campuses as a preferred habitat for insect pollinators in urban areas. This study will also add to our future attempts in understanding the complex nature of mutualistic interaction between pollinators and flowering plants that is essential for continuity of ecosystem services. The present study therefore forms a good basis to take up measures to conserve insect pollinators' diversity in small green urban spaces too.

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