



Diversity and distribution of social apocrites of Vadodara, Gujarat, Western India

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Abstract

Three year survey of bees and wasps carried out in the city of Vadodara and its surroundings at four sites having specific habitat types highlighted the effect of habitat on the presence and abundance of the bees. The study was based on the hourly counts made twice every month in four selected habitats; agricultural fields, community gardens, fragmented habitats and residential sites situated at different locations in and around Vadodara ranging from 25-30 kms. The study recorded a total of 47 species of bees and wasps belonging to 29 genera from 15 families. Out of which 11 species are social belonging to 7 genera under 3 families. Shannon diversity showed highest score of social bee diversity in fragmented habitats, followed by agricultural fields and community gardens. Least diverse were residential sites. The underlying reason for the success of fragmented habitats is that they provide ideal multiple microhabitats for nurturing insect species. Numbers of bees were more in community gardens where exotic and indigenous species of plants were cultivated, followed by fragmented habitats and agricultural fields. Minimum number was obtained from residential sites.

Keywords: Apocrita, food plants, varied habitats, diversity and numbers.

Introduction

Hymenoptera is a large order of insect class with more than 1,20,000 known species on the globe (Gordon, 2009) out of which more than 5000 species are identified in India (Alfred, 1998).

This study involves Vespidae, Halictidae and Apidae families of the suborder Apocrita available in and around Vadodara. Ants, bees and wasps are best known members of this suborder probably the most beneficial of the entire insect class. It contains a great many species that are of value as pollinators e.g. *Apis dorsata*, *A. indica* or predators like *Polistes stigma*, *Icaria ferruginea* of injurious insect pests e.g. *Helicoverpa armigera* and *Spodoptera litura*. Also has parasites like *Evania appendigaster*, *Brachymeria hearseyi*, *Xanthopimpla stemmator*.

Hymenoptera especially the Apoidea group, are the most important plant pollinators of the natural and agricultural ecosystems (Roubik, 1989, Neff and Simpson, 1993) and are strongly related to the evolution and diversification of the angiosperms (Bawa, 1990). Generally, the bees are totally dependent on the floral resources for the maintenance of adults and nests.

Although wasps present less effective participation as pollinators in natural ecosystems, their adults (males and females) are regular flower visitors and nectar consumers, especially social wasps, which also collect nectar for energy supply of their colonies (Gadagkar, 1991).

Asia has a poorer bee fauna compared to other biogeographical regions (Michener, 1979) and lower diversity compared to the Neotropics, but in terms of abundance the social apid bees are the most numerous in the pollinator spectrum (Roubik *et al.*, 2005).

Among the several hundred northwestern species of bees, it is estimated that 10 percent are either social or semisocial, 10 percent parasitic and the remaining 80 percent solitary.

As there is no such study from Vadodara a city of gardens (62 in number) this study was undertaken to know the diversity and abundance of social bees and wasps; the decreasing availability of their food plants; clues which are responsible in reducing their population in agricultural and residential areas to recognize them as biocontrol agents or as components of Integrated Pest management.

Materials and Methods

Study area: Vadodara District is in the eastern part of the state of Gujarat, western India. It is located at 22°11' N latitude and 73°07' E longitude. The diversity of social bees was assessed across 4 habitats of the Vadodara and its surroundings from January 2006 to December 2008. Survey sites were chosen based on accessibility and location within an ecoregion. Four different types of habitats; Agricultural fields in and around Vadodara, fragmented areas within Vadodara, community gardens and the old and new residential areas of the Vadodara city were selected on the basis of ecological factors, flora, type of soil, surrounding environment and anthropogenic activities.

Sampling method: Each study area was visited twice per month from morning 7 a.m. to 9 a.m. and evening 5 p.m. to 7 p.m. of the same day, which included collection for one hour and labeling for the other. At all the sites plots of 10x10 m were laid. The number of individuals in a given species collected during 2 hours, from each site were recorded. Bees on vegetation were collected by sweeping the above ground vegetation. Those on flowers and in flight were individually collected using the sweep net. Of the bees collected in this manner, the easily identifiable common bees were released on site after making a count and recording their identity. Collected bees were identified up to species level.

Identification of bees: Bees collected were identified up to family and generic levels using keys of Imms' general textbook of Entomology (1997) and Borror (1992). Species level identification was based on keys and descriptions of Bingham (1897), Leffroy (1909) and Ananthkrishnan (2004). Reference collections of bees and wasps in the museum of Indian Agricultural Research Institute, PUSA, and New Delhi were also used to confirm the identity of certain species.

Data analysis: Based on the number of bee species and their abundance in each site, bee diversity in each of the study sites was calculated using the Shannon Weiner Diversity Index (Henderson, 2003).

Results and Discussion

Species composition: A total of 1776 bee specimens were collected from the 10 sites during the 3 years. The study recorded a total of 47 bee species belonging to 29 genera in 15 families out of which 11 species, 7 genera and 3 families were social (Table-1). Family Vespidae and Sphecidae included the largest number of

genera. Family Sphecidae included the largest number of species followed by Vespidae and Xylocopidae. Maximum genera and species of social apocrits are also included in Vespidae. 7 species of wasps belonging to Vespidae family and three species of honeybees from Apidae were recorded. Whereas from Halictidae only one species of *Nomia westwoodii* was found.

Percentage composition: 11 species of social apocrits formed 23% of total species of hymenoptera found in Vadodara. (Fig. 1).

Distribution and Diversity of Bees: Social bees and wasp abundance was found maximally in community gardens where different floral plants were grown followed by fragmented habitats, agricultural fields and least number was in residential sites (Fig. 2).

Bee Diversity Indices: Shannon diversity index gave the highest score for the bee diversity in fragmented habitats, followed by agricultural fields, community gardens and lowest score was for residential areas (Table-2). The finding of this study highlights the fact that the highest diversity of bees is in the area where anthropogenic pressure is comparatively less. Furthermore, in these habitats, the vegetation comprises a mixture of flowering herbs and patches of natural vegetation providing a ready source of pollen and nectar for bees throughout the year.

In the city of Vadodara even though the 4 habitats are located at different distances ranging from 25-30 Km, social bees and wasps diversity was nearly same. Some of these social hymenopterans are predators viz., *Polistes* spp. and *Vespa* spp. (Table 3a); as they prey upon the pupae and caterpillars of lepidopteran pests like *Helicoverpa armigera*, *Spodoptera litura* and can be useful components of Integrated pest management. Some are pollinators viz., *Apis indica* and *A. dorsata* (Table 3b), which are important for improving the quality and quantity of agricultural crop plants.

Since hymenopterans are highly beneficial, their nests should not be destroyed, unless and until they become annoyance near house. Establishment of their nests should be encouraged by creating more favorable environmental conditions for them in the gardens as well as in agricultural fields. The vegetation and sites where these bees and wasps make their nests should be preserved (Table 4). Due to building of malls and multiplexes as well as urbanization in the city many green spaces with the type of vegetations where bees and wasps thrive upon are lost leading to decrease in their population.

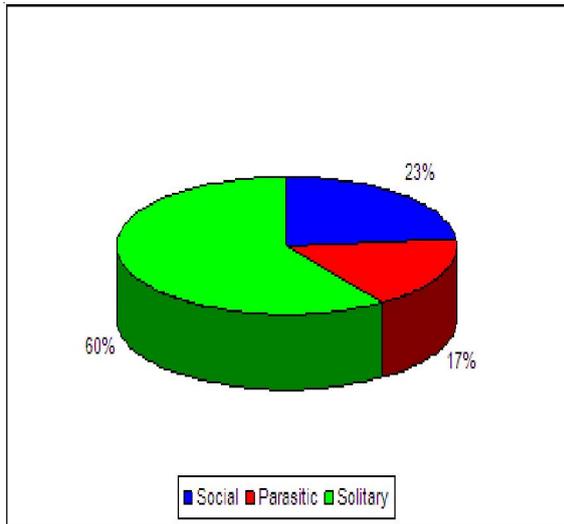


Fig. 1: Percentage of Apocrita in Vadodara

Table 1: Taxonomic composition of bees and wasps in the 4 study sites of Vadodara and its surroundings.

S. No.	Family	Genus No.	Species No.
1.	Ichneumonidae	2	2
2.	Evaniidae	1	1
3.	Chalcididae	1	1
4.	Chrysididae	1	1
5.	Scoliidae	1	2
6.	Pompilidae	1	1
7.	Eumenidae	2	5
8.	Vespidae	5	7
9.	Sphecidae	5	9
10.	Halictidae	1	1
11.	Andrenidae	2	2
12.	Megachilidae	2	3
13.	Anthophoridae	2	2
14.	Xylocopidae	2	7
15.	Apidae	1	3
Total		29	47

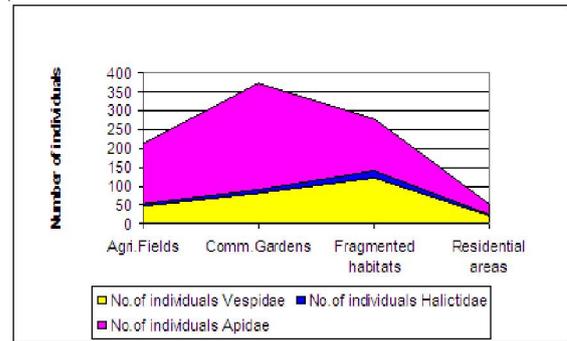


Fig. 2: Social Apocrits in various habitats of Vadodara

Table 2: Shannon Weiner Diversity Index for bees sampled at the 4 study sites of the Vadodara and its surroundings.

Habitat	Shannon-Weiner index H
Agricultural Fields (AF)	2.2591
Community Gardens (CG)	2.2127
Fragmented Habitats (FH)	2.2673
Residential Areas (RA)	2.1984

Table 3a: Food of social Apocrits.

S. No.	Family: Vespidae	
1.	<i>Icaria ferruginea</i> Fabricius	Predators of Noctuid caterpillars and grubs of Chrysomelid beetles.
2.	<i>Polistes fuscatus</i> Fabricius 1793	
3.	<i>P.stigma bernardii</i> Le Guillou	
4.	<i>Parapsamophila erythrocephala</i> Menke	
5.	<i>Rhynehium abdominate</i>	
6.	<i>R. cubzeipenne</i>	
7.	<i>Vespa cincta</i> Fabricius, 1775	Adults of <i>Vespa</i> predate on <i>Apis indica</i> .
Family: Halictidae		
8.	<i>Nomia westwoodii</i>	Parasitic on other Halictids.

Table 3b: Food of social Apocrits.

S. No.	Family: Apidae	Food plants and pollen sources			
		Crop plants	Floral plants	Herbs/Shrubs	Trees
1.	<i>Apis indica</i>	Paddy, Pigeon pea, Maize, Wheat, Cotton, Castor	<i>Hibiscus lobatus</i> , <i>Ixora</i> , <i>Canna indica</i> , <i>Rosa</i> <i>chinensis</i> <i>Gaillardia</i> , <i>Helianthus annuus</i> , <i>Gerbera</i> sp., <i>Phlox paniculata</i> , <i>Calendula</i> <i>officinalis</i> , <i>Dianthus</i> sp., <i>Cosmos</i> sp.	<i>Lawsonia inermis</i> , <i>Zizyphus mauritiana</i> , <i>Caesalpinia crista</i> , <i>Portulaca oleracea</i>	<i>Mangifera indica</i> , <i>Moringa oleifera</i> , <i>Butea monosperma</i>
2.	<i>A. dorsata</i>	Cotton, Castor	<i>Hibiscus lobatus</i> , <i>Helianthus annuus</i>	<i>Zizyphus mauritiana</i> , <i>Calotropis procera</i> <i>Ficus bengalensis</i>	<i>Mangifera indica</i> , <i>Annona squamosa</i> ,
3.	<i>A. florea</i>	Paddy, Pigeon pea	<i>Ixora</i> , <i>Canna indica</i> <i>Lantana camara</i> , <i>Gerbera</i> sp., <i>Phlox drumondi</i> , <i>Calendula officinalis</i> , <i>Dianthus</i> sp., <i>Cosmos</i> sp.	<i>Lawsonia inermis</i> , <i>Zizyphus mauritiana</i> , <i>Ipomea obscura</i> , <i>Portulaca oleracea</i>	<i>Mangifera indica</i> , <i>Moringa oleifera</i> , <i>Annona squamosa</i>

Table 4: Nests and their sites

S.No.	Species	Type of nest	Site of nest	
			Non Vegetative	Vegetative
1.	<i>Polistes</i> sp. and <i>Icaria</i> sp.	Single horizontal series of cells, not enclosed in an envelope and supported by a short stout peduncle. Nest composed of paper like material made from withered fibers of wood collected from dead trees, fences and posts, chewed by mandibles into a paste with the addition of salivary fluid.	Hanging under eaves of buildings	In shades and branches of <i>Zizyphus</i> , <i>Ixora</i> , <i>Mangifera indica</i> .
2.	<i>Vespa</i> sp.	Number of circular combs attached one over the other and each comb contains numerous hexagonal paper cells. The whole nest is enclosed in a paper envelop.	Hanging under eaves of buildings	Branches of <i>Butea monosperma</i> , <i>Annona squamosa</i> , <i>Ficus bengalensis</i> .
3.	<i>Apis dorsata</i>	Very large single comb, arrange their wax cells on layers which may be vertical with nearly horizontal cells	Vertical structures such as eaves and walls of buildings	Inaccessible branches of tall trees like <i>Mangifera indica</i> , <i>Ficus bengalensis</i> .
4.	<i>Apis florea</i>	Tiny single combs, vertical and horizontal cells.	Crevices in buildings	Bushes of dense vegetation
5.	<i>Apis indica</i>	Series of parallel combs	Eaves of rocks, walls and safe places of buildings	Hollowed out tree trunks
6.	<i>Nomia</i> sp.	Main burrow is usually vertical with lateral branches	Burrows in the ground	

Thus there is a strong need of conserving their biodiversity and focussing their importance as pollinators and biocontrol agents.

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