IMPACT: International Journal of Research in Applied, Natural and Social Sciences (IMPACT: IJRANSS)
ISSN (P): 2347-4580; ISSN (E): 2321-8851
Vol. 6, Issue 6, Jun 2018, 19-32

AN INVENTORY ON DIVERSITY AND DISTRIBUTION PATTERN OF HYMENOPTERAN INSECTS IN GUJARAT, INDIA

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Received: 06 Jun 2018 **Accepted:** 11 Jun 2018 **Published:** 23 Jun 2018

ABSTRACT

Insects are one of the most successful groups of living organisms on the earth and have one of the widest distributions around the globe. One of the reasons for their great diversity and abundance is their high reproductive capacity and adaptation in extreme environment. Hymenoptera is the third largest order of class Insecta. Biodiversity of hymenopterans insect shows various patterns in space and time due to the difference in climatic conditions, the interaction between species, geography, local history and many other factors. Hence, this present work provides a baseline data of diversity and distribution pattern of Hymenoptera in Gujarat for further study. The objectives of the study were to prepare an inventory of insects with reference to Hymenoptera. The study revealed a good assemblage of bees, wasps, and ants belonging to order Hymenoptera. A total of 145species belonging to 20 families of Hymenoptera were reported. The study reveals that the area under the survey has hymenopteran insects belonging to 20 families, 83 genera, and 145 species and their ecological roles span from predator to crop pollinator and parasitoids. Out of the total of 145 Species recorded in Gujarat, 96 were common, 39 uncommon and 10 species were rare. During the present inventory, Formicidae family found to be most dominant followed by Apidae and Sphecidae.

KEYWORDS: *Hymenoptera, Diversity, Taxonomy, Abundance, Ecological Role, Gujarat*

INTRODUCTION

In terrestrial ecosystems, insects play a vital function as herbivores, pollinators, predators, and parasites (Weisser and Seimann, 2004). Worldwide, nearly 70% of crop, plants and 98% of trees are being pollinated by the insects (Klein *et al.*, 2006). The loss of this pollinator would have an adverse effect on food production and maintenance of biodiversity (Klein *et al.*, 2006). A great deal of attention has been focused on biodiversity over the past several years. Among the all described living organisms, Insects have a significant role in the ecosystem by affecting the diversity, abundance, and distribution of plant communities (Kannagi *et al.*, 2013). Insects also serve as a tool in monitoring environmental changes. The order Hymenoptera is an extremely diverse group and a major component of insect diversity. The role of bees and wasps as agents of pollination in phanerogamic plants is well recognized (Watson *et al.*, 2011). Each plant species is highly specialized in this regard and requires certain groups of insects for effecting cross-pollination. Further Parasitic and predatory forms of insects have also an important role in suppressing insect pests. Destruction of these insects may affect the forest structure in the long run. Their diversity and composition are largely dependent on vegetation and any change in the habitat is likely to have an impact on their distribution and relative abundance.

According to Aland *et al.,* 2010 the order Hymenoptera includes more than 1,00,000 species which contains some of the most advanced and highly specialized insects which also shows greater adaptation to their environment. Hymenoptera is widely distributed in all the ecosystems of Gujarat, the members of this order show great diversity in their morphological characters and can be acquired according to the habitat. Pollinators have a key part in the survival of terrestrial ecosystem integrity through their major role in plant reproduction; most of the world crop's are dependent upon pollination for their productivity (Potts *et al.*, 2009).

Biodiversity of hymenopteran shows various patterns with respect to the difference in climatic conditions, an interaction between species, geography, local history and many other factors. Currently, there are over 1, 15,000 described species in India, which is about 8.3% of the total species of Hymenoptera in the world (Mathew, 2007). In India total of 65 families of Hymenoptera is reported. Diversity work on Hymenopterans has been very scarce as far as Gujarat is concerned. Hence, the objective of the present work was to have an insight for the distribution pattern and diversity pattern of Hymenoptera in Gujarat.

METHODS AND METHODOLOGY

Site Survey

The entire stretch of Gujarat was thoroughly surveyed so as to select the suitable sampling sites. Based on the agro-climatic zone south Gujarat District (Figure 1) is divided into seven zones. In each zone, the sampling sites were selected on the bases of forest type, proximity of water body and/or road, the relative distance from human settlement. A sampling of the Hymenoptera fauna was conducted from March 2014 to April 2015. All the sites were visited once a month and the collected samples were pulled from each of the zones.

	South Gujarat heavy rain area		North West Zone
	South Gujarat		North Saurastra
	Middle Gujarat		South Saurastra
	North Gujarat		Bhal and Costal Area

Figure 1

METHODS FOR COLLECTION

In addition to the visual sighting and photo documentation following standard method was employed to collect specimens from the study area.

- **Manual Collection:** Sweep net was used for capturing flying insects and also insects found on vegetation. Beating cloth or beating umbrella method was used to collect fauna on the vegetation. Insects thus collected were then processed for further investigation.
- **Litter Sifting:** Large litter and soil Insects were gathered delimiting 1.0 sq.m. Sample area. Soil and litter were sequentially removed to a desired depth of 6cm. The soil was processed through a series of sieves. Large Arthropods were then handpicked from the sieves and the soil residue was extracted for smaller Arthropods and insects using Berlese funnel.
- **Pitfall Trap:** Small Plastic cups were Buried up to the rim in the ground so that passing insects may fall. This method was used to sample surface- active Arthropod fauna.
- **Bark Scraping:** Bark of trees was scraped so as to expose underneath Arthropods. Once sighted, they were collected by soft brush dipped in 70% Alcohol.

Preservation for Taxonomic Study

Killing and preservation of Insects: The collected insects were first killed by the vapor of killing agent to facilitate collection. For that Special killing, jars were prepared with the help of Plaster of Paris, filter paper, and Sodium cyanide. The collected insects were transferred into killing jars and then transported to the laboratory where the insects were stretched and pinned using insect pins. The samples were then oven dried at 60ºC for 72 hr to preserve them, after which they were set in wooden boxes. The identified collections were stored in insect cabinets, containing naphthalene balls wrapped in paper, pinned at one corner of the cabinet. Very small and soft body insects were killed in 70% ethanol.

Identification: Identification of the collected insects was done with the help of the published taxonomic articles (Srivastava, 2004; Hook, 2008; Atwal and Dhaliwal, 2010) and available literature (Bolton, 1994). The identified specimens were confirmed and authenticated by the BNHS, Mumbai.

DATA ANALYSIS

Data Analysis was done on the basis of their Abundance and Habit. Based on the number of times they were encountered they were given abundance grading. Those, which were sighted more than 32 of the visits were rated as COMMON, less than 15 of the visits were UNCOMMON, and less than 5 of the visits were rated as RARE.

RESULTS

Table 1: The Check List of Hymenoptera Insects in Gujarat

Family	Species Name
Apidae	*Abeja carpintera*
	Amegilla cingulata
	Amegilla sp
	Apis dorsata
	Apis florea
	Apis melifera
	Colletes daviesanus
	Xylocopa pubescens
	Xylocopa sp 1
	Xylocopa aestuans
	Xylocopa violaceae
	Xylocopa fenustrata
	Xylocopa virginica
Andrenidae	*Unidentified sp*
Braconidae	*Apanteles Cajani (Wilkinson, 1928)*
	Apanteles sp.
	Cotesia papillionis
	Cendria paradoxa
	Dinocampus Mylloceri
	Doryctes coxalis (Granger, 1949)
	Exobracon maculipennis (Cameron 1910)
	Spathius vulnificus (Wilkinson, 1931)
	Unidentified sp 1
	Unidentified sp 2
Chalcididae	*Sycoryctes Sp.*
	Sycoscaptella affinis (Westwood 1883)
	Brachymeria hapalia (Westwood , 1829)
	Anthrocephalus distructor (Waterson,1922)
	Trigoneura ruficaudis
	Eupristina masoni (Saunders, 1882)
	Unidentified sp 1
	Unidentified sp 2
Chrysididae	*Chrysis fuscipennis (Brulle)*
	Chrysis lusca (Fabricius, 1804)
	Chrysis orientalis (Klein)
	Chrysis angolensis

Table 1 Contd.,

Family	Species Name
	Chrysis ignata
	Chrysis oculata (Fabricius)
	Stilbum Sp. (superbum)
Colletidae	*Colletes sp*
	Colletes devieanus
	Colletes marginatus
	Collete shederae
Crabronidae	*Bembix sp*
Dryinidae	*Dryinus trifasciatus* (Kieffer, 1906)
Eumenidae	*Eumenes coronatus*(Panzer, 1799)
	Odynerus Sp.
Evaniidae	*Unidentified sp*
Formicidae	*Oecophylla smaragdina (Fabricius, 1775)*
	Camponatus sericeus (Fabricius, 1798)
	Camponotus amaurus
	Camponatus compresus (Fabricius, 1787)
	Dorylus labiatus Shuckard, 1840
	Polyrhachis clypeata (Walker, 1859
	Leptogenys assamensis (Forel, 1900)
	Anochetus taylori (Forel, 1900)
	Tetraponera rufonigra (Jerdon, 1851)
	Tetraponera nigra (Jerdon, 1851)
	Myrmicaria brunnea (Saunders, W.W., 1842)
	Cataglyphis setipes (Forel, 1894)
	Meranoplus bicolor (Guérin-Méneville, 1844)
	Lophomyrmexquadrispinosus (Jerdon,1850)
	Cataulacus latus (Wroughton (1892)
	Pheidole Sp (Westwood, 1839)
	Solenopsis geminata (Fabricius, 1804)
	Meranoplus bicolor
	Cardiocondyla sp.
	Componotus pennysilvanicus

Table 1 Contd.,	
Family	**Species Name**
	Componotus sp 1
	Componotus sp 2
	Componotus sp3
	Crematogaster sp 1
	Crematogaster sp 2
	Crematogaster sp 3
	Iridomyrexe sp 1
	Iridomyrexe sp 2
	Iridomyrexe purpurens
	Oecophylla longinoda
	Opisthopsis hoddoni
	Paratrechina sp
	Podomyrma gratiosa
	Polyrachis australis
	Solenopsis invicta
	Solenopsis sp
	Unidentified sp 1
Halictidae	*Nomia sp*
	Agrapostemon virescens
	Shecodes sp
	Halictus scabiose
Ichneumonidae	*Rhyssa sp.*
	Ephialtes sp. (Scheven, 1777)
	Cremastus hapaliae (Cushman, 1934)
	Nemeritis tectonae (Perkins)
	Phobocampe disparis (Viereck, 1911)
	Netelia sp
	Unidentified sp
Mutillidae	*Mutilla dimidiata (Latreille, 1792)*
	Mutilla interrupts (King)
	Mutilla analis
	Mutilla sp 1
	Mutilla sp 2
Megachilidae	*Coelioxys sp*
	Megachile sp
	Meghachile mystaceana
	Unidentified sp
Pompilidae	*Pompilus analis (Fabricius, 1781)*

Table 1 Contd.,

Family	Species Name
	Macromeris violacea (Lepeletier, 1845)
	Pseudogenis blanda
	Salius flavus (Fabricius, 1775)
	Hemipepsis sp
	Unidentified sp 1
	Unidentified sp 2
Specidae	*Astalis agilis*
	Notogonis sp.
	Sceliphron deforme (Smith 1856)
	Scaliphron californicum
	Sphex lobatus (Fabricius, 1775)
	Ampulex compressa (Fabricius, 1781)
	Philantus sp.
	Bembex sp.
	Stigmus Congruus (Walker, 1860)
	Chalybion californicum
	Delta dimidiatipenne
	Larra antathema
	Sceliphron caementarium
	Sphex pensylvanicus
Scolidae	*Scolia sorror*
	Scolia sp.
Tenthredinidae	*Athalia lugens proxima*
Vespidae	*Eumenes sp*
	Odynerus sp
	Polistes exclamans
	Polistes Carolina
	Polistes sp 2
	Vespa sp 1
	Vespa flavopilosa
	Vespa tropica
	Ropalidia fasciata
	Ropalidia marginata
	Ropalidia sp
	Unidentified sp 1
	Unidentified sp 2
	Unidentified sp 3

Table 2: Abundance Grading of Hymenoptera Insects in Gujarat

Family	Species Distribution in the District			Habit
	Common	Uncommon	Rare	
Andrenidae		√		Pollinator
Apidae	√			Pollinator
Braconidae			√	Parasitic
Cephidae		√		Predatory
Chalcididae			√	Parasitic
Chrysididae	√			Parasitic
Colletidae		√		Pollinator
Dryinidae		√		Predatory
Eumenidae		√		Predatory
Evaniidae			√	Predatory
Formicidae	√			Scavenger
Halictidae	√			Parasitic
Ichneumonidae	√			Parasitic
Megachilidae		√		Parasitic
Mutiliidae		√		Scavenger
Pompilidae			√	Predatory
Scoliidae	√			Parasitic
Sphecidae	√			Predatory
Tenthredinidae	√			Predatory
Vespidae	√			Predatory
Total	96 Species	39 Species	10 Species	

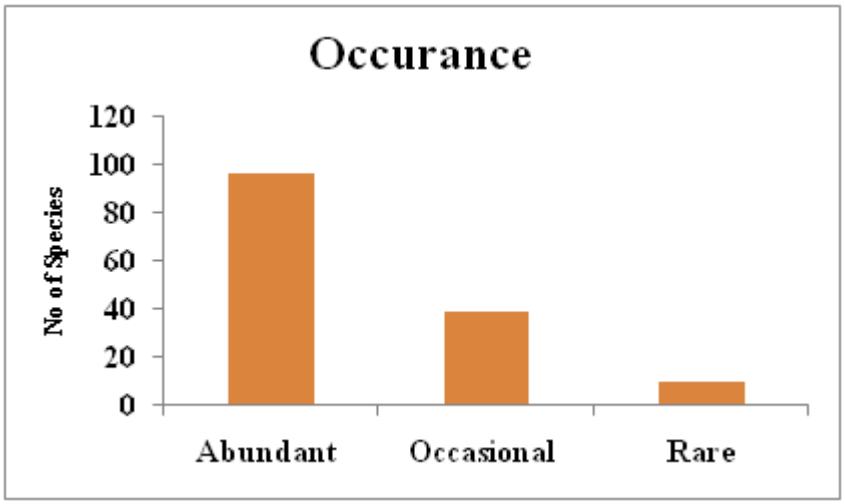

Figure 2: Occurrence of Hymenoptera Insects in Gujarat

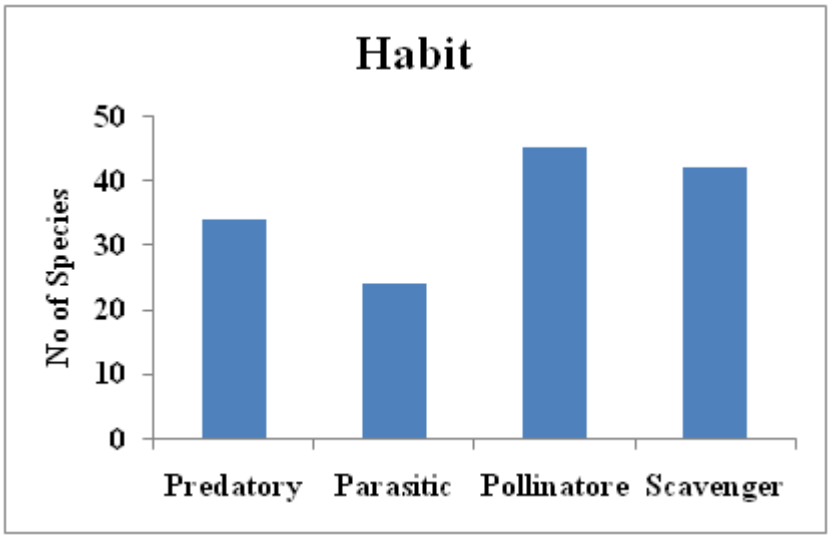

Figure 3: Distribution pattern of Hymenoptera Insects in Gujarat

During the present survey, a total of 145 species belonging to 20 families of order Hymenoptera were collected. Of the collected individuals a total of 131 species were identified and14 individuals were not identified. The checklist of Hymenoptera collected is presented in Table I. On the basis of field observations and specimens collected, insects were divided into three broad categories viz. common, uncommon and rare (Occurrence in more than 15 districts – Common; occurrence in less than 15 districts – Uncommon and occurrence less than 5 districts – rare).Out of the 145 Species recorded in Gujarat, 96 were common, 39 uncommon and 10 species were rare (Table 1). The family Formicidae was dominant with 36 species classified into 24 genera followed by Apidae with 15 species (4 genera). Next in order was Specidae with 13 species (10 genera) followed by Vespidae with 12 species (5 genera). Family Barconidae were recorded with 10 species and 7 genera. Rests of the families were having less than 10 species. When we classified the data on the basis of their habits out of 145 species, 34 were predators, 24 species parasitic, 45 species pollinator and 42 were a scavenger. Similar findings were also reported by Kannagi *et al.*, 2010 with 38 species belonging to 9 families from deciduous forest from South India, Mathew *et al.*, (2007) at Neyyar Wildlife Sanctuary, Kerala and Singh *et al.*, (2010) at Kane Wildlife Sanctuary, Mathew *et al.*, (2005) with 30 species from Peechi Vazhani Wildlife Sanctuary, Kerala.

DISCUSSIONS

Biodiversity of hymenopteran insect shows various patterns in space and time due to the difference in climatic conditions, the interaction between species, geography, local history and many other factors. Order Hymenoptera, being a group of agriculturally important insects including its role in the bio-control agent, demands biodiversity studies, for understanding its biodiversity as well as distribution pattern. In spite of the significance of Hymenoptera insect in biodiversity studies, no effort has been made so far to study and document the prevalent this insect order. However, the present inventory was the first effort to assess the diversity and distribution pattern of important Hymenoptera insects in Gujarat State. A good assemblage might be due to healthy climatic conditions and availability of natural resources necessary for their life processes and existence. Thus detailed biodiversity information is indispensable not only to conservation but also to environmental impact and assessment.

Hymenoptera is one of the few mega diverse insect orders. Approximately 3, 00,000 to 2.5 million hymenopteran species are estimated to be present worldwide and nearly 1, 15,000species of Hymenoptera have been described so far.

Parasitic Hymenoptera constitutes nearly 25% of all arthropods in both temperate and tropical ecosystems (Anbalagan *et al.*, 2015). The majority of species are primary parasitoids of immature stages of Lepidoptera, Coleoptera, and Diptera. The high species diversity and the presence of many rare species indicate that the study area is a real paradise for Hymenoptera. These wasps are of enormous ecological interest because of their role in controlling the natural phytophagous insect populations, causing direct effects in the host species' population size and indirect effects on the diversity and survival of host plants. Additionally, they can indicate the presence or absence of related host and plant populations. Finally, some species can also be relevant from an economic point of view, because of their potential for pest control.

The occurrence of Sphecids/ wasps in a habitat is conditioned by moisture, the soil exposure, soil type and prey abundance (Lázaro *et al.*, 2009; Perfectti *et al.*, 2009). The collection of these wasps is a tedious process, yet the abundance of parasitic and predatory hymenopterans is one of the major forces which can prevent the undue increase of noxious species, thereby helping in biological control of various insect pests. Thus detailed biodiversity information is indispensable not only to conservation but also to environmental impact and assessment.

Hymenopterans perform many ecological roles as predators, pollinators, biocontrol agents and biodiversity indicators. Pollinators are a key component of global biodiversity, providing vital ecosystem services to crops and wild plants. Pollinators play an important functional role in most terrestrial ecosystems and represent a key ecosystem service that is vital to the maintenance of both wild plant communities, agricultural productivity. Insects, particularly bees, are the primary pollinators of most agricultural crops and wild plants In the present survey a total of seven families were recorded which have been known as pollinators. An appreciable number of pollinators are a good indication of the healthy ecosystem.

Overall, during the present survey, it was in general observed that Gujarat harbors an appreciable number of Hymenoptera which can be attributed to the congenial agro-climatic conditions and availability of preferred host plants. A long-term study is needed to observe the species occurrence in all seasons and their interaction with the environmental changes for better results. Hence, the present inventory survey, will provide baseline data for upcoming researchers and furnishes wide scope for further long term studies .

CONCLUSIONS

This work concludes that South Gujarat is dominated by insects. A good assemblage of hymenopterans in Gujarat indicates a healthy climatic condition as well as the availability of natural resources which are necessary for their life processes and existence. However, more intensive and extensive survey will yield better results with their ecological implication and thus will provide detailed insights in utilizing these insects in their economic and ecological role. The results which were being presented in this report are the first comprehensive list of Hymenoptera insects in Gujarat. It is an obvious fact that insects contribute much to the ecological welfare and insect conservation has been recognized as vital for the sustainable world in view of their critical role in the conservation of the ecosystem. However, this study will definitely give an addition to the existing knowledge of the entomologist of Gujarat and India as well. Expectantly, there will be a further research study on the Hymenoptera biodiversity and taxonomy in this area, in order to get better and comprehensive information on those aspects to be documented for future reference.

ACKNOWLEDGMENT

The authors are deeply grateful to Gujarat Biodiversity Board, Gandhi nagar for their financial support to conduct this research study. The authors are also thankful to all forest officials for their help in a field study.

Few representative of Hymenoptera

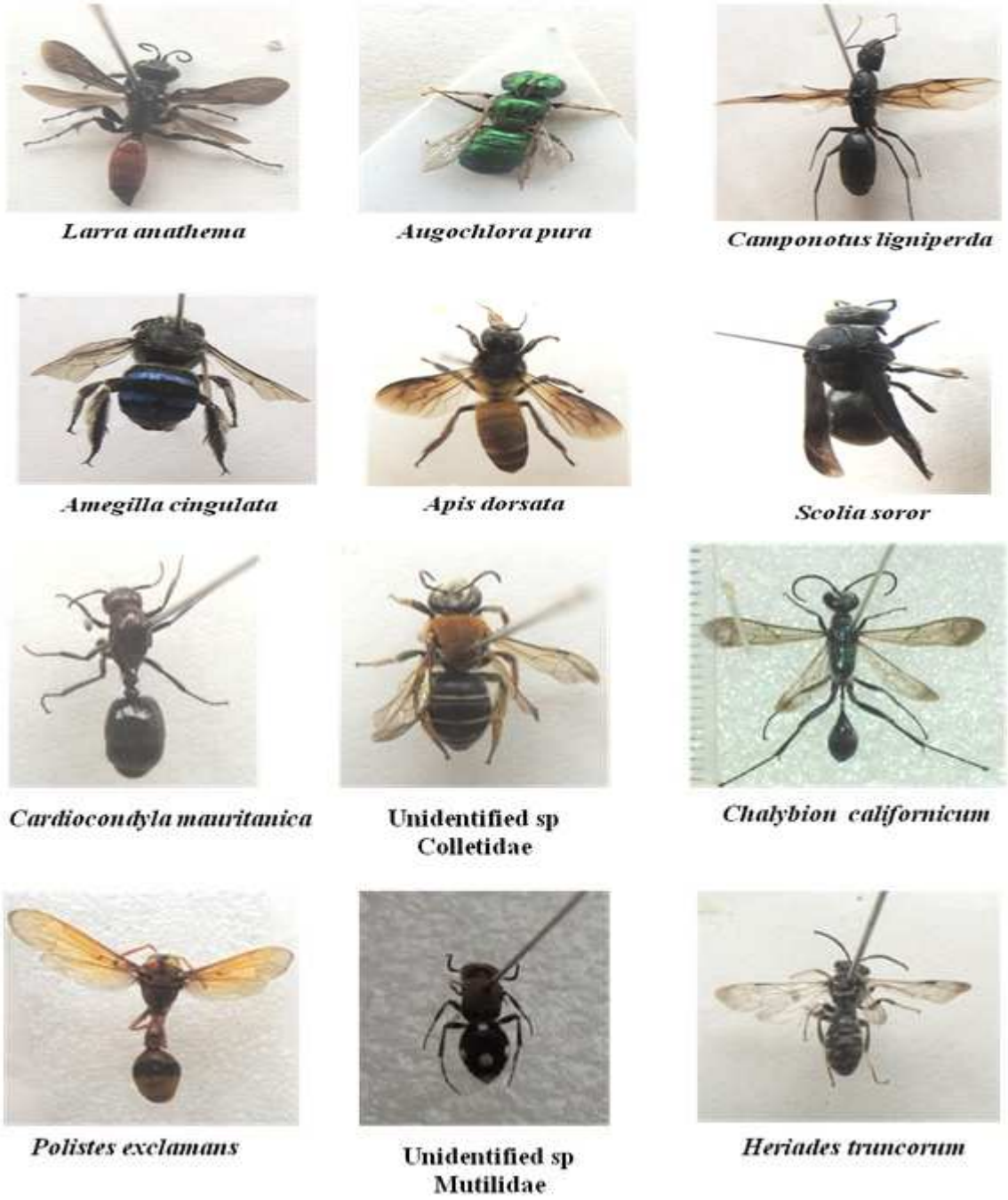

Figure 4

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