

# Insect diversity in Meerut district of Uttar Pradesh

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## Abstract

In summary, this is the first study ever conducted on the Gandhi Bagh's insect biodiversity. 32 brief surveys, each lasting an average of 10 days, were conducted at various locations as part of the current investigations. Thirteen of these surveys were conducted in the summer (April–mid-June); five in the monsoon (July–September); and fourteen in the winter (October–March). Within four sub-watersheds and several altitudinal zones, including the ecodevelopment region, eighteen distinct intense sites were chosen. For this study, six insect orders were chosen: Diptera, Hemiptera, Odonata, Lepidoptera, Hymenoptera, and Coleoptera. According to the study, the six orders under investigation comprised 125 species from 37 families and 108 genera.

- Of the six (6) orders examined, the order Lepidoptera had the greatest diversity, with 55 genera and 61 species.
- The order Coleoptera, which contained 41 genera and 47 species, came next.
- In decreasing order of diversity, the six orders being studied are Lepidoptera, Coleoptera, Hymenoptera, Odonata, Hemiptera, and Diptera.
- Of the 125 species found in Gandhi Bagh, eight were rare, 21 were sporadic, and 96 were numerous.

**Keywords:** Gandhi Bagh's insect biodiversity, Lepidoptera, Coleoptera, Hymenoptera, Odonata, Hemiptera, Diptera

## 1. Introduction

Gandhi Bagh, also known as Company Garden, is a park in the Meerut cantonment. The Meerut Cantonment Board looks after this well-liked location, which is covered in bamboo, mulberry, and mango trees.

Gandhi Bagh is well-known for its history and flora, but little is known about the park's conservation initiatives for certain butterflies and insects. Numerous butterfly species may be supported by the park's surroundings, adding to the richness of the area.

The current study is a component of the Meerut District of Uttar Pradesh's monitoring and research program. This element was included in the study because it acknowledged the significance of a varied insect population. The study of insect diversity and the identification of monitoring indicators are specifically addressed in this research site.

Recently, there has been an emphasis on biodiversity conservation. To assess the appropriate patterns of biodiversity, a number of research and procedures have been put forth

(Wilson 1988; Noss 1990; Enrich and Wilson 1991) [1-3]. To assess the conservation trends of biodiversity, Vane Wright *et al.* (1991) [4] also categorized groups of taxonomically related species and a hierarchical composition of various organizational levels. According to Harrington and Stork (1995) [5], certain insects can be used to determine the condition or changes in a landscape. Attention has been drawn to the use of indicator taxa in conservation initiatives ranging from biodiversity to pollution management (Landres *et al.* 1988) [6]. Based on their richness patterns, the members of the Coleopteran family *Cicindelidae* (tiger beetle) are considered a suitable indicator for identifying regional biodiversity trends (Pearson and Cassola 1992) [7].

## 2. Materials and Methods

Gandhi Bagh, also known as Company Garden, is a public park in the heart of Meerut, Uttar Pradesh, India, and serves as the study's geographic site. (Fig. 1).



Fig 1: Map of Gandhi Bagh (Company Garden, Meerut)

The Cantonment Board states that Gandhi Bagh is located in Meerut Cantt on Mall Road. It is around  $29.007^{\circ}$  N in latitude. The precise coordinates of this place are  $29^{\circ}0'21.128''$ N,  $77^{\circ}42'10.130''$ E (fig. 2).



Fig 2: Gandhi Bagh (Inside view), a park in Meerut Cantonment

## 2.1. Survey period and sampling method

From August 2024 to May 2025, the field study was conducted at a few chosen locations in the Gandhi Bagh (Company Garden) area of Meerut. Every month, on sunny, bright days between 10 a.m. and 4 p.m., when butterflies are most active, surveys were carried out at each location. The line transect method was used for sampling. Each transect was split up into four 100-meter sections. The counts were performed by walking 100 meters at a steady pace in a straight line. On both sides of the transect, butterflies were seen within 2.5 meters. They were then instantly spotted, caught, identified, and released. The identification of species in relation to abundance was done using magnifying lenses, digital camera (Nikon D 5600) photos, and the naked eye.

### 2.1.1. Collection of insects

Several bug groups were collected during the field investigation, which was conducted at specific locations in the Gandhi Bagh (Company Garden) Meerut region.

Table 1 contains information about the season-by-season surveys that were conducted in Gandhi Bagh. Surveys were therefore limited to Gandhi Bagh during the monsoon season. Since butterflies are often active in the beginning of the day, it was simple to monitor and gather them, therefore the insects were collected early in the day. When the light rose, it was simple to find some phytophagous (plant-feeding) insects on their hosts.

The following general techniques were applied on the collection.



Fig 3: Insects that fly freely were collected using an aerial net

- **Hand picking:** A fine forcep was used to manually collect minute coleopterans, including *Coccnellidae*, *Chrysomelidae*, and *Curculionidae*.
- **Aerial netting:** Insects such as Odonata, Lepidoptera, Diptera, and others that fly freely were collected using an aerial net (Figure 3).

- **Trapping:** In addition, several attempts were made to employ the light trap at specific locations within Gandhi Bagh.

### 2.1.2. Equipment

**Killing bottle, collection vials and paper packets:** To kill and preserve insects without changing their color, killing bottles were utilized. The deadly agent was a glass jar coated with benzoene. A layer of cotton was covered with the liquid, and the cotton was soaked and shielded from direct contact with the specimen using one or two filter or blotting sheets. For future research, small specimens were killed and kept. Tiny glass or plastic vials were used to store these samples. Lepidoptera, Odonata, and numerous other insects were housed in paper packets.

### 2.1.3. Preservation for taxonomic study

- a) **Pinning of insects:** In order to prevent internal harm, insects with hard bodies were pinned directly by piercing pins through their bodies. Care was made to select the appropriate size and quantity of pins (each insect pin has a specific number). The tiniest insect pin is the thinnest and stoutest, while the other numbers are 0, 1, 2, 3, 5, and so forth. They vary in diameter and length. Although longer pins measuring 37–39 mm in length were utilized for large-bodied insects, 0–3 size pins were most frequently used.
- b) **Spreading:** The wings are arranged for taxonomic study using a spreading board, which is made up of two flat, parallel pieces of soft wood with a cork-lined inner groove. The wings were spread and held in place by two thin pieces of paper, and once the wings were adjusted to the desired position, the collected specimen was secured with a small pin.
- c) **Mounting:** On a piece of pith, tiny, delicate specimens were pinned with a tiny, fine pin, through which a longer pin was placed at the other end. This long pin was used exclusively to handle the specimen, and a paper label with the collecting date and other information was affixed to it. Cabinets were equipped with paradichlorobenzene and naphthalene balls for safe preservation against pest attacks. Undistorted mounting, pinning, and labelling with all the necessary collecting details date, time, location, altitude, and host plant are required for this.

### 2.1.4. Taxonomic keys for identification

A taxonomic key's function is to make it easier to identify a specimen. In order to do this, a sequence of alternative choices with dichotomous characteristics was presented, followed by following relevant diagnostic characters (Mayr, 1974) [8]. The reference key and pictures from Mani (1986), Haribal (1992),

and Carter (1992) [9,10,11] were used to identify butterflies. For identifying purposes, two types of keys were typically used:

- a) **Dichotomous key:** For genus and species-level identification, published fauna on several taxonomic subgroups were referenced.
- b) **Pictorial key:** It is anticipated that this graphical key will be useful to park frontline employees and hobbyists for identifying specimens at least up to the order level. During field research, an effort was made to create a basic visual key for specimen identification.

### 2.1.5. Institutions visited for identification

With the aid of pertinent literature and specimen comparison with genuine identifiable collections at various scientific institutions, insects gathered during the previously stated surveys using a variety of techniques were identified and taxonomically examined.

### 2.1.6. Classification of insects

An International Code of Zoological Nomenclature (ICZN) was created in order to govern the process because taxonomic nomenclature has grown more complex over time (Davis, 1988) [31]. Every type of animal has two names: a generic name and a particular name. Binomial is the name given to this system of nomenclature.

## 3. Results

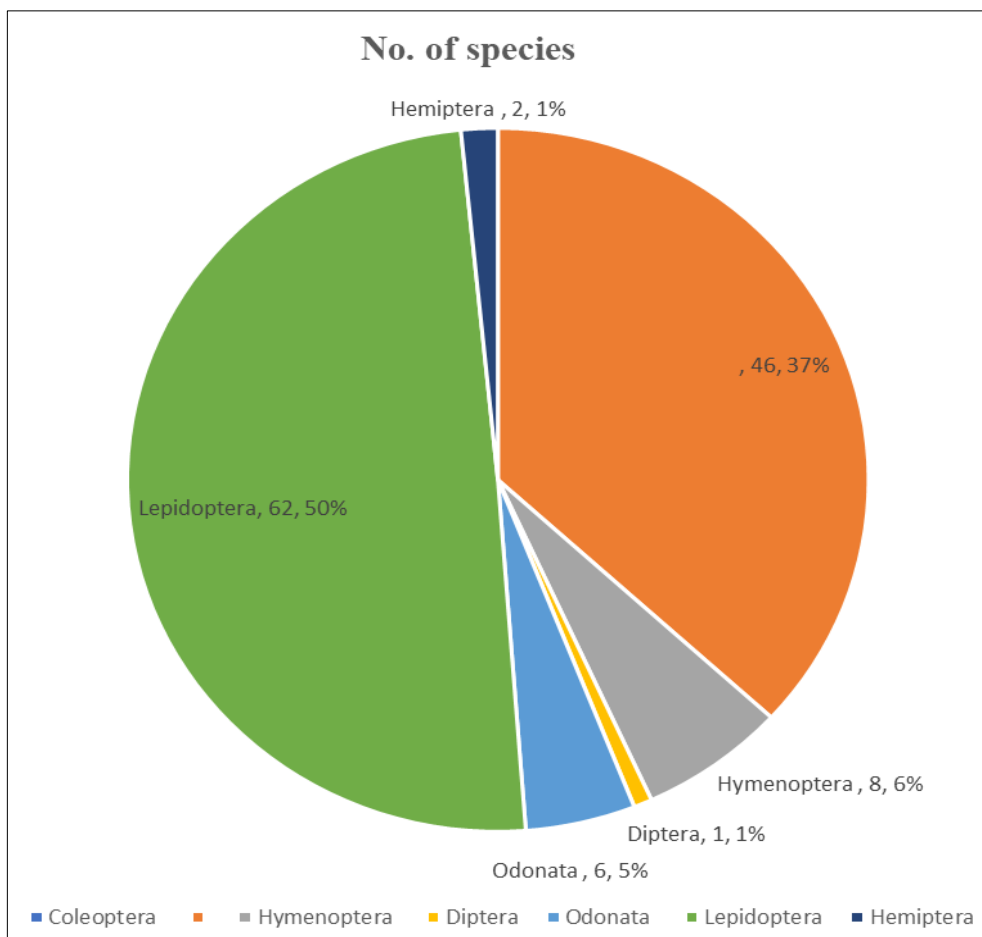
Six orders Coleoptera, Hymenoptera, Diptera, Hemiptera, Odonata, and Lepidoptera represent 37 families, 108 genera, and 125 species among the identified specimens in this study. Table 1 lists the genera and species that each family and the insect orders under investigation represent. Out of the six orders examined, Table 2 showed that the order Lepidoptera has the greatest variety, with 54 genera and 61 species.

The order Coleoptera, with 41 genera and 47 species, came next. The six orders under study Lepidoptera, Coleoptera, Hymenoptera, Odonata, Hemiptera, and Diptera can be grouped in declining order of diversity.

The following orders were discovered in Gandhi Bagh: order Lepidoptera (*Geometridae*, *Arctiidae*, *Noctuidae*, *Sphingidae*, *Hesperidae*, *Lamantridae*, *Saturnidae*, and *Zygaenidae*); order Diptera (*Syrphidae*); order Hymenoptera (*Halictidae*); order Odonata (*Aeshnidae*, *Libellidae*; and order Lepidoptera (*Coccinellidae*, *Curculionidae*, and *Chrysomelidae* *Cicindelidae*, *Lampyridae*, *Carabidae*, *Elateridae*, *Cucujidae* *Buprestidae*, *Meloidae*, and *Scarabaeidae*). Insects were categorized as either plentiful (frequently distributed in the area), occasional (spread in some pockets), or uncommon (few in number) based on field observations and specimens obtained (Graph 1).

**Table 1:** The number of species discovered is shown in a table

S.no.	Order	Family	No. of species
1.	Coleoptera	<i>Cerambycidae, Cassididae, Coccinellidae, Curculionidae, and Chrysomelidae Lampyridae, Cicindelidae, Carabidae, Cucujidae, Buprestidae, Elateridae, Lucanidae, Scarabaeidae, and Meloidae</i>	46
2.	Hymenoptera	<i>Halictidae, Andrenidae, Apidae, Xylocopidae, and Vespidae</i>	8
3.	Diptera	( <i>Syrphidae</i> );	1
4.	Odonata	( <i>Aeshnidae, Libellidae</i> )	6
5.	Lepidoptera	<i>Noctuidae, Sphingidae, Lamantridae, Zygaenidae, Lasiocampidae, Lycaenidae, Nymphalidae, Pieridae, Papilionidae, Hesperidae, Saturnidae, Geometridae, and Arctiidae</i>	62
6.	Hemiptera	( <i>Cicadidae, Aspidiotidae</i> );	2



**Graph 1:** No. of species found in study site.

Additionally, the insect fauna found in Gandhi Bagh has been described based on its eating patterns, with a particular emphasis on the phytophagous group, its role as a pollinator, and biodiversity indices.

**3.1. Coleoptera (Beetles) (Plate 4)**

Almost all of the world's mountains are home to the Coleoptera, one of the most common groups of high-altitude insects (Plate 4). They are hard-bodied, tiny or big insects with modified forewings called elytra that support the body when in flight and shield the membrane hindwing when at rest. Eight of the fourteen families that were identified as having a high level of phytophagy are as follows:

**a) Cerambycidae: (Long-horn beetle):** Four species from four genera *Aeolesthes sarta, Apriona cinerea, Apomectra pertigera, and Lophosterus hugely* were gathered. Using

sharp mandibles to make slits and enter the ovipositor, the eggs are placed inside the plant.

**b) Buprestidae:** In this family, only *Ancylocheira sp.* was gathered and recognized. This family's members have short, serrated antennae and metallic colors.

**c) Elateridae: (Click-beetle):** There are five species: *Pectocera sp., Melanotus sp., and Cardiophorus sp. and Agrypnus sp.*, were identified as members of this family. The hard, elongated, slightly flat, black, grey, brown, and occasionally brilliant metallic click beetles are small to medium in size. Larvae of many species live in dead wood or under the bark of the tree.

**d) Lucanidae: (Stag-beetle):** Three species were identified: *Lucanus sp., Parallelipipedus sp., and Dorcus sp.* Typically, stag beetles are either brown or black in color (Plate 4).

- e) **Scarabaeidae: (Dung-beetle):** This family mostly eats the excrement of different huge herbivores, which they roll into handy balls, bury in subterranean chambers, and consume whenever they want. This family had the highest documented species representation. *Geotrupes sp.*, *Melolontha indica*, *Melolontha furcicauda*, *Anomala rufiventris*, *Anomala lineatopennis*, *Phyllognathus dionysius*, *Hilyotrgus holosericeus*, *Oryctes nasicornis*, *Xylotrupes gideon*, *Anomala dimidiata*, and *Catharsius sagax* were among the eleven species that were found in Gandhi Bagh.
- f) **Coccinellidae: (Ladybird-beetle):** *Coccinella septempunctata L. var. divaricata* was collected in May, and six species from five genera were identified during the current investigations. The ladybird beetles are hemispherical, round or oval, tiny, and frequently speckled (Plate 4).
- g) **Cucujidae:** Many species are significant pests of seeds and related items. *Cucujus sp.* was the only species noted. Tree bark is tiny, flat, and frequently almost as flat as paper.
- h) **Curculionidae: (Weevil-beetle):** *Menectetorus raja*, *Paramecops farinosus*, *Mecyslobus fasciatus*, *Blosyrodus sp.*, and *Aclees cribratus* were among them. Weevils can be little or huge, with the mouthparts at the apex of the head that is extended into a rostrum. In addition to being phytophagous, they consume stored cereals as well as roots, boring stems, fruits, leaves.
- i) **Chrysomelidae:** Within this family, three species were identified: *Merista quadrifasciata*, *Merista sexmaculata*, and *Hoplasoma unicolor*. The larvae of chrysomelids, which are tiny, hard, and frequently have vibrant colors, only consume the leaves of a wide range of plants. Sometimes they burrow inside stems or leaves.
- j) **Meloidae: (Blister-beetle)** *Mylabris macilenta* was documented. Medium-sized, soft-bodied, and frequently having loosely attached elytra, blister beetles are typically black, brown, or occasionally bright metallic-blue or green. The adults eat flowers and are primarily phytophagous.

**3.2. Hemiptera (Bugs) Characteristic features:** In the current investigation, the following two families were documented:

**Cicadidae (Cicada):** Cicadas are the forest's loudest vocalizers; they deposit their eggs in bark cracks and let them incubate for roughly six weeks. After hatching, the nymphs descend to the earth, use their strong fossorial forelegs to dig down to a depth of roughly 50 cm, and live a long life underground, consuming the plant root's sap.

### 3.3. Hymenoptera (Bees) (Plate 2)

**Characteristic features:** Eight species from five families in the order Hymenoptera were examined. The venation is frequently absent or much reduced, and the bees' two sets of membrane wings are always smaller than their forewings. They are free-living, predatory, parasitic,

entomophagous, or gregarious insects that are typically drawn to warmth and sunlight. As a result, they are diurnal insects that either hunt prey or collect pollen and drink the sweet liquids of plants.

Tens of species of Hymenoptera have unique respiratory and other adaptations in accordance with their manner of life, and they are notable for the highly advanced level that parasitism has reached among their larvae. Three species *Bombus sp.*, *B. haemorrhoidalis*, and *B. tunicatus* represented the family *Apidae*. Furthermore, many Vespidae wasps, such as *Vespa auraria* and *Polister maculipennis*, were collected. The flowering plants that these bees and wasps visited included *Aconitum violaceum*, *potentilla atosanguina*, which had flowers that were either pure bright yellow or yellow with orange or dark red; *Aconitum heterophyllum*, which had flowers that were greenish-purple; *Delphinium cashmrianum*, which had bluish-purple flowers; *Adonis chrysocyathus*, which had golden yellow flowers; and *Anemone tetrasepala*, which had white flowers. Numerous *Apidae* and *Vespidae* species were drawn to shrubs with purple blooms, such as *Aquilegia pubiflora*, *Aster diplostephioides*, *Nepeta connata*, *Nepeta govaniane's* huge purple and yellow flowers, and *Pedicularis oederi's* lemon-yellow flowers. *Andrena spp.*, which constitute the *Andrenidae* family, were gathered. The two most significant flowering plant species found at this elevation are *Clematis connata*, which has yellowish white blooms, and *Clematis buchananiana*, which has cream or yellow, sweet-scented flowers on long, leafy branches. *Salvia hians*, *Calamintha umbrosum's* tiny pink or purple flowers, and *Aster thomsonii's* scarlet flowers were all home to *Helictus species* of the *Halictidae* family. *Xylocopa fenestrata*, a member of the and on flowering clusters of *Cyathula capitata*. *Polygonum amplexicaulis* flowers that were pink, deep crimson, or white were found to harbor *Vespa auraria* of the *Vespidae* (Uniyal and Singh, 1996) [12].

### 3.4. Lepidoptera (Butterflies and Moths) (Plate 1).

Moths' antennae show significant structural variation across genera and species, and even between the sexes of the same species, whereas butterflies' antennae are more or less uniform in structure and clubbed at the tip. The eyes of butterflies are also larger and more conspicuous than those of moths.

Again, the insect never twists or folds away the straight, filamentous, roughly clubbed antennae of butterflies, but always holds them upright or stretches them in front of the head. When in repose, butterflies typically display the underside of their wings, whereas moths only display the upper surface. Butterflies can be identified by their wings, which are more or less upright over the back and never folded tightly along the body. During the current investigations, 37 genera and 44 species of butterflies were represented by five families.

#### 3.4.1. Family Pieridae

Various species of Leguminosae, Capparidaceae, and Cruciferae are consumed by the larvae of the *Pieridae* family,

which is mainly composed of white, orange, or yellow diurnal butterflies. There were many species differences between the *Pieridae* members in the region according to the wet and dry seasons. A sulfur-colored or greenish yellow butterfly belonging to the *Pieridae* family, the Common Brimstone (*Gonepteryx rhamni nepalensis*), was discovered. Similar to other places, the *Nymphalidae* family has the most species in this investigation (Table 2). A total of 22 species from various types of plants were found in the region. The Nymphalids are medium to big animals that love the sun, fly quickly and powerfully, have a wide range of flight, and are colorful. They observed the Danaus (Salathura) genutia (Common tiger) and the Parantica sita sita (Chestnut tiger).

The dark brown wings of the Indian Red Admiral (*Vanessa indica indica*) have a red center that is separated on the inside by huge black dots. The back wings, on the other hand, are red around the black center.

### 3.4.2. Family Lycaenidae

Often having metallic-blue, green, copper, and bronze wings with tail lobes on the rear, the Lycaenidae is a stunning family of little butterflies. During the current investigation, just one species the Common Spotted Flat (*Celaenorrhinus leucocera*), which represents the family *Hesperidae* was observed. Eight families *Geometridae*, *Saturniidae*, *Lasiocampidae*, *Sphingidae*, *Lamantriidae* *Arctiidae*, *Noctuidae*, and *Zygaenidae* comprised seventeen moth species.

### 3.4.3. Family Saturniidae

The Saturniidae family comprises over 1,000 species, including some of the largest and most remarkable moths on the planet. Because of their size and beautiful colors, several species have translucent patches or well-developed eyespots on both the fore and hind wings.

The hind wings of the Papilionidae and Nymphalidae families are adorned with long tails. Males and females frequently have differing wing patterns. Only four species of this family have been identified in the current investigations: *Saturnia pyri*, *Nadaurelia* sp., *Samia cynthia*, and *Actias selene*. The ground color of the Ailanthus silk moth, *Samia cynthia*, ranges from brown to olive green or orange brown. All of the wings of the *Saturnia pyri* (Great Peacock Moth) have eyespots that are ringed in red, black, and brown.

### 3.4.4. Family Lasiocampidae

They often have a variety of dark hues and are dreary in color. The only species known to have female moths that are noticeably larger than males and have triangular forewings with broad, pale brown patches near the base is *Trabala viridana*, commonly referred to as the Moss green lappet.

### 3.4.5. Family Geometridae

The second-largest moth family is Geometridae. When disturbed during the day, our pale-yellow swallow-tailed moth, *Apteryx sambucaria*, is frequently confused for a butterfly. As the name implies, there were numerous records of a short tail-like extension on the back wing, along with a characteristic reddish-brown patch at the base of the tail.

### 3.4.6. Family Arctiidae

Tiger moths are a common name derived from the brilliantly striped markings of certain species. *Pericallia galactina* and *Syntomis* sp. were the pair of species found in this area.

### 3.4.7. Family Noctuidae

Noctuid moths can be very small or quite huge, and they are incredibly resilient. There were only four species identified: *Othreis fullonia*, *Trigonodes hyppasia*, *Erebus ephesperis*, and *Catocala ilia*.

### 3.4.8. Family Sphingidae

In the region, two species were identified: *Marumba dyras* and *Acherontia* sp.

### 3.4.9. Family Lamantriidae

Lamantria sp. was the only species identified. The *Zygaenidae* family's *Campylotes* sp. was identified. Although the moths resemble members of the *Noctuidae* family, they tend to have a more hairy appearance. Typically, the wings are drab or pale in color.

### 3.5.1. Coleoptera

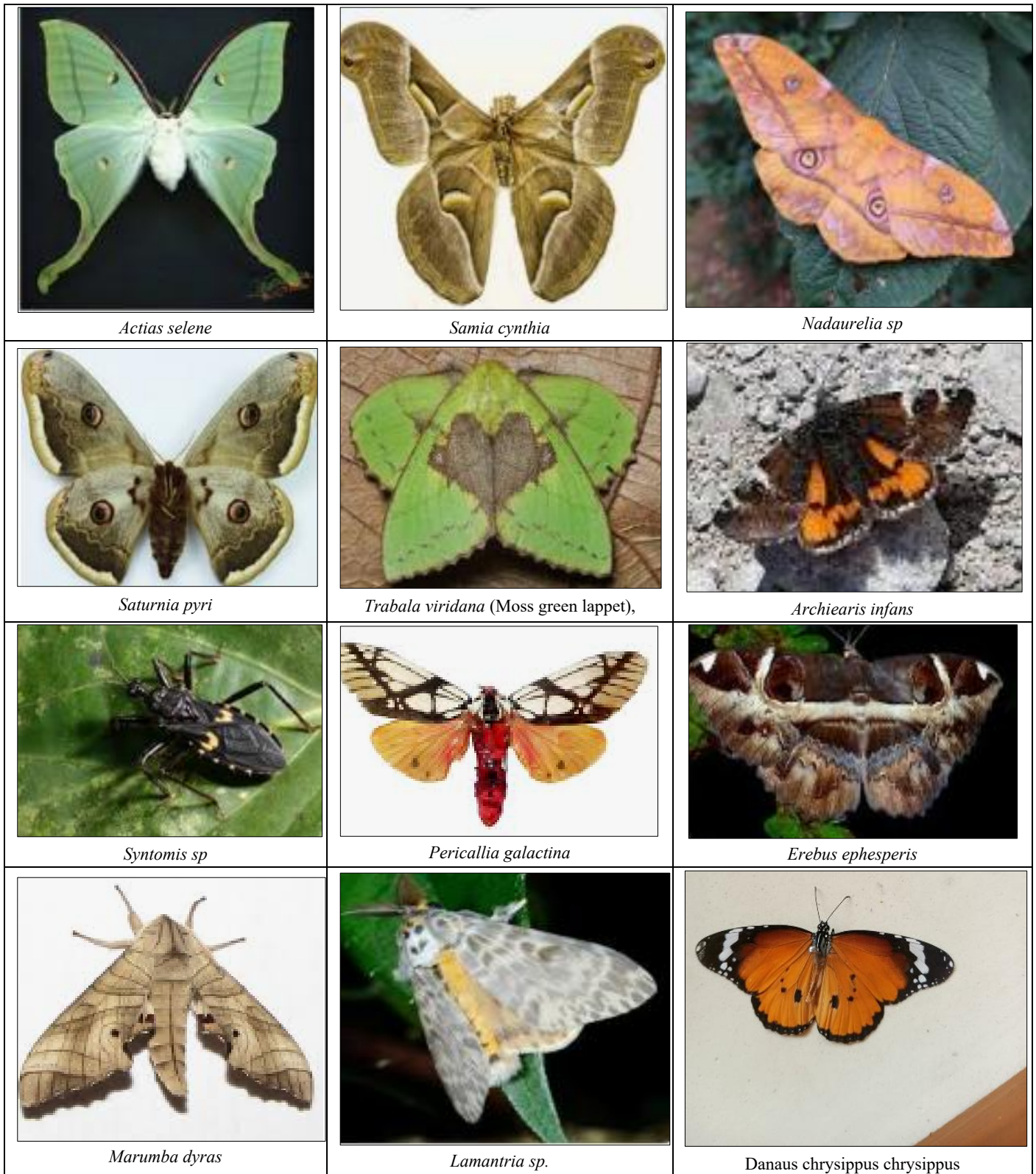
The Cicinididae family (Plate 3) has over 2028 species of the Tiger beetle globally. Some species are still unknown. A total of 406 species names (some of which were duplicated throughout Sumatra, Sulawesi, India, and Australia and New Guinea) were examined in five systematic revisions for species naming and stability (Cassola and Pearson, 1992) [7]. Tiger beetles are found mostly in tropical and subtropical woods and along wide, sandy riverbanks.

### 3.5.2. Odonata

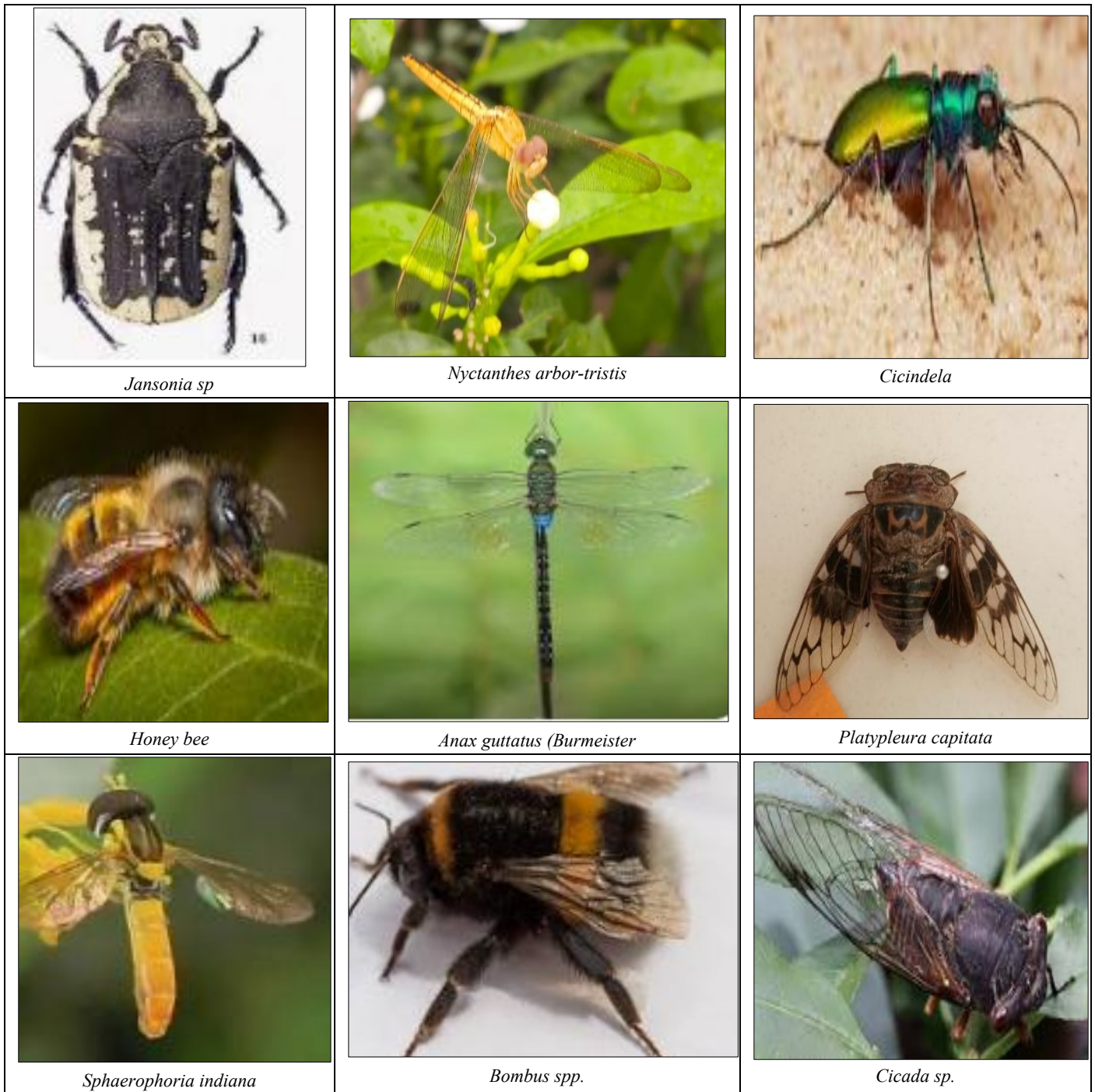
All dragonflies are amphibiotic, predatory, medium-sized or giant insects with big compound eyes, biting mouthparts, and short antennae. They are members of the order Odonata (Plate 2) and have two pairs of wings that are similar in that they are narrow and have net veins. The dragonflies are insects with a rather lengthy lifespan. They are strong aviators that live an active predatory existence, catching a variety of little insects while in the air. They are primarily diurnal. During the winter, the adults hibernate frequently and may move over great distances in massive swarms. Dragonflies are utilized as indicators of bodies of water because their eggs are thrown into the water or attached to submerged things with a long, gelatinous string.

Up to 800 eggs are frequently laid by a single female partner. The larvae are aquatic, voracious predators that mostly eat the larvae of mosquitoes and mayflies, but they also eat other small aquatic species. In Gandhi Bagh, two families of this order the *Aeshnidae* and the *Libellulidae* representing seven species were identified (Graph 1).

Orders Hemiptera (8 genera) and Diptera (4 genera), Coleoptera (3 genera), Odonata (2 genera), Ephemeroptera (2 genera), and Lepidoptera (1 genus) were the most common among the insects gathered at the study site.



**Plate 1:** Diversity of butterflies in study site



**Plate 2:** Diversity of Insects in Gandhi bag.





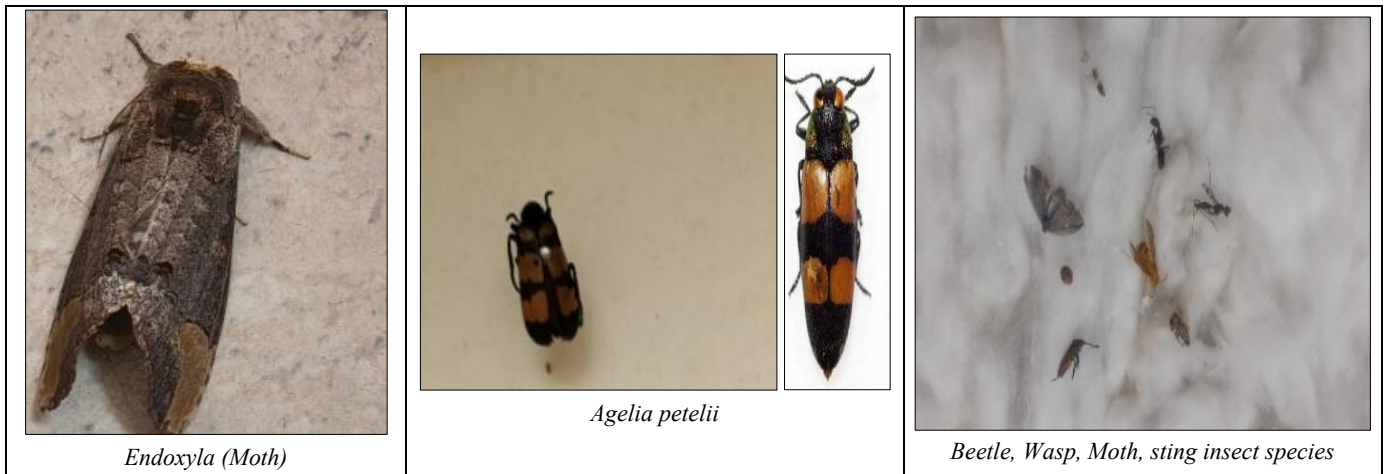


Plate 3: Diversity of Insects in Gandhi bag.



Plate 4: Diversity of Insects beetle in Gandhi bag

#### 4. Discussion

High species richness was found in insects belonging to the orders Hemiptera, Diptera, and Coleoptera (Table 1). Additionally, 20 species of water insects from the Siddharth Nagar district of Uttar Pradesh were reported by Prakash and Verma (2018) <sup>[13]</sup>. Prakash and Yadav (2016) <sup>[14]</sup> found 21 insect species from 6 orders and 21 families in Baghel Taal of Bahraich, U.P. 32 species of water insects from 5 orders and 24 families were identified by Prakash and Verma (2019) <sup>[15]</sup> from Guthia Taal in the district of Bahraich, Uttar Pradesh. Overall species diversity showed that the insects in the Khanwari pond were most prevalent in the order Hemiptera and least prevalent in the order Lepidoptera. The taxa of aquatic insects belonging to the orders Hemiptera, Diptera, and Coleoptera were found to be dominant throughout the study period, with a percentage composition of 40%, 20%, and 15%, respectively. In contrast, the taxa of the orders Trichoptera, Ephemeroptera, and Odonata contributed only 5% and 10% of the total diversity. In Tirunelveli, Tamilnadu, *P. armatissimus* was also observed from August to December by Ambrose and Vennison (1989) <sup>[16]</sup>. Mostly ground-dwelling and nocturnal, these insects were drawn to light (Bellows and Fisher 1999; Claverand Reegan, 2010) <sup>[17, 18]</sup>. Reduviids can be observed waiting for or devouring their prey in areas of light. These predatory insects are mainly beneficial since they consume problem insects. If they start to cause problems, they should ideally be removed rather than destroyed (Plamer 2010) <sup>[19]</sup>. The current study's findings showed that Gandhi Bagh has a higher diversity of insects.

#### 5. Conclusions

Six (6) species of swallowtail butterflies from the Papilionidae family were identified, along with three species of tiger beetles from the Cicindelidae family: *Cicindela (Cosmodela) nirgula*, *Cicindela (Cosmodela) flavomaculata*, and *Jansonia* sp. These species could serve as biodiversity indicators. Therefore, it is suggested that the status and distribution of these indicator species be ascertained in the second part of the current study. This will provide baseline data for subsequent comparisons.

#### 6. Acknowledgement

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