Biological study of some butterflies (Order: Lepidoptera) at Atal Harit Upwan, Rahimabad, Lucknow.

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Abstract- Butterflies, with their alluring colours and graceful flight, have been the subject of extensive scientific inquiry. This research paper delves into the captivating biology of butterflies, encompassing their life cycle, interaction with plants, behavior, and ecological significance. Drawing upon a wealth of scientific literature and recent studies, this comprehensive investigation aims to shed light on the intricate mechanisms that govern the lives of these delicate insects.

Keywords- biology, lepidoptera, mimicry, butterfly, habit and habitat.

Introduction
Insects have unrivalled supremacy among all living animals and they are largest faunal components on this planet earth (Tiple et al., 2011). Among all the orders of class Insecta, Order Lepidoptera is most admired and popular. Butterflies are commonly referred to as “insects of the sun” with their remarkable colour and delicate allure. They have been well-liked for centuries for their physical exquisiteness and behavioural flaunt (Sushmita et al.,2021). The behavior of butterflies is a captivating subject of study, driven by their interactions with the environment and other organisms. Butterflies have developed remarkable sensory capabilities, enabling them to perceive and respond to visual, olfactory, and thermal cues. These sensory adaptations play a crucial role in locating food sources, identifying potential mates, and navigating their surroundings. Butterflies' foraging patterns vary significantly between species; some butterflies are territorial, defending specific feeding sites, while others engage in long-distance migrations to exploit seasonal resources (Chittka and Thomson, 2001; Zalucki and Kitching,1982). Throughout history, each stage of their life cycle is governed by intricate hormonal regulation and responsive environmental cues, leading to the astonishing transformation that characterizes the phenomenon of metamorphosis (Gilbert,2003). The physiological adaptations of butterflies are equally enthralling. Their specialized feeding mechanisms, such as the proboscis, enable them to access nectar from a wide range of flowers, while others have adapted to feed on decaying matter or even blood in some species. Additionally, butterflies exhibit unique thermoregulatory behaviors that allow them to maintain their body temperature and optimize their activity levels in various environmental conditions (Boggs,2009). Beyond their physical characteristics, the behavior of butterflies is equally captivating. Butterflies engage in elaborate courtship rituals, intricate communication through visual cues and pheromones, and remarkable migration patterns that span vast distances. These behaviours are influenced by various factors, including mate selection, territory establishment, and adaptation to changing environments (Vane-Wright and de Jong,2003). Moreover, the ecological significance of butterflies cannot be overstated. As crucial pollinators, butterflies contribute to the reproduction and genetic diversity of countless plant species, making them essential components of various ecosystems. Their interactions with plants create intricate mutualistic associations that shape the biodiversity and stability of ecosystems. However, the survival of butterfly populations faces significant threats due to habitat loss, climate change, pollution, and other anthropogenic factors. Understanding the biology of butterflies is vital for implementing effective conservation strategies to safeguard these delicate insects and the ecosystems they inhabit (Thomas et al.,2004; Schultz and Crone,2001).

Material and Methods
Study area
Atal Harit Upwan (N 26° 44' 18";E 80° 53’ 06") comprises 15 acres of land (figure 1) which has various habitats including grassland, wetland and forests. There is also butterfly park (Image 1) in which there are various host plants, nectariferous plants and mud puddling areas for butterflies. The soil of this study area is a new alluvial soil having more sand and silt than clay.
Field Methods
The survey was done on the daily basis from March 2023 to May 2023 in the morning shift (8:00 AM – 11:00 AM). The butterflies were recorded directly in the field by the "Pollard walk" method as used by (Moore,1975; Pollard et al,1975; and Walpole and Sheldon,1999). Their morphology was recorded by direct watching and through the photographic confirmations (Image 2). The collection of specimens was strictly avoided. The butterflies that could be identified in the field were not captured while those that could not be identified were captured by the sweep net method and identified using suitable keys (Gay et al,1992; Haribal,1992; Parasharya and Jani,2007; Kehimkar,2008) and released back in same habitat with least disturbance. The individuals observed were classified into different families as per the classification. Photographs were taken from different angles with (Nikon D5600) DSLR Camera. All the scientific name and identification of Butterflies followed in the present study is referred from (Varshney,1983; Wynter – Blyth, 1957; Peter Smetacek,2017).

Result and Discussion
The survey for the biological study of butterflies was carried on regular basis from March 2023- May 2023 at Atal Harit Upwan, Rahimabad, Lucknow. Here we have observed the biology of some butterflies belonging to different families (Table 1).

Table 1: - Some butterflies at Atal Harit Upwan, Rahimabad, Lucknow whose biology were observed.

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>Common name</th>
<th>Scientific name</th>
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<tbody>
<tr>
<td><strong>Family – Papilionidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Lime Butterfly</td>
<td><em>Papilio demoleus</em></td>
</tr>
<tr>
<td>2</td>
<td>Common Jay</td>
<td><em>Graphium doson</em></td>
</tr>
<tr>
<td><strong>Family – Pieridae</strong></td>
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<tr>
<td>3</td>
<td>Pioneer</td>
<td><em>Belenois aurota</em></td>
</tr>
<tr>
<td>4</td>
<td>Common Emigrant</td>
<td><em>Catopsilia pomona</em></td>
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<td><strong>Family – Nymphalidae</strong></td>
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<tr>
<td>5</td>
<td>Plain Tiger</td>
<td><em>Danaus chrysippus</em></td>
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<tr>
<td>6</td>
<td>Danaid Eggfly</td>
<td><em>Hypolimnas misippus</em></td>
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<tr>
<td><strong>Family – Lycaenidae</strong></td>
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<tr>
<td>7</td>
<td>Pea Blue</td>
<td><em>Lampides boeticus</em></td>
</tr>
<tr>
<td>8</td>
<td>Pale Grass Blue</td>
<td><em>Zizeeria karsandra</em></td>
</tr>
</tbody>
</table>
• Family- Papilionidae (Swallowtails)

1. Papilio demoleus (Lime Butterfly)

_Papilio demoleus_ is one of the most studied species of this family because it is economically important pest.

**-Morphology:** The wingspan can range from 70-90 millimetres, with females are larger than males. The hindwings do not have tail. The upper side of the wings is black with striking yellow bands and spots, making it easily recognizable. The underside of the wings is more cryptic, providing camouflage when the butterfly rests on surfaces.

**-Life Cycle:** Like all butterflies, _Papilio demoleus_ undergoes a complete metamorphosis consisting of four stages: egg, larva (caterpillar), pupa (chrysalis), and adult [Plate 1(1)]. The female butterfly lays eggs on the host plants, which are typically citrus plants like lime, lemon, and orange trees, as well as other members of the Rutaceae family. The caterpillar that hatches from the egg goes through several instars (stages) of growth, shedding its skin each time it outgrows it. The mature caterpillar is green with yellow and black bands, resembling a bird dropping to deter predators. Once the caterpillar is fully grown, it pupates by forming a chrysalis, which can vary in colour from green to brown. Inside the chrysalis, the metamorphosis from pupa to adult butterfly takes place over a period of weeks.

**-Behavior and Ecology:** _Papilio demoleus_ is known for its strong flying abilities, and it often visits flowers to feed on nectar. It is also known to exhibit puddling behavior, where adult butterflies gather on moist surfaces, mud puddles, or wet sand to absorb nutrients and minerals from the damp substrate.

The caterpillars are known to feed on the leaves of their host plants, and they have adaptations to detoxify and tolerate the plant toxins present in these leaves. As a defence mechanism, caterpillars often display a false head, resembling the head of a snake, to deter potential predators.

**-Role in Ecosystem:** It plays a crucial role in pollination, helping to facilitate the reproduction of plants by transferring pollen between flowers. They also serve as a food source for various predators, including birds and insects.

2. Graphium doson (Common Jay)

**-Morphology:** Sexes similar. _Graphium doson_ has a distinctive appearance. It is medium-sized with a wingspan ranging from about 75 to 90 millimeters. Black border having blue spots are present on forewing [Plate 1(2)]. The hindwings have elongated tails and the costal black bar present on the underside of hindwing does not makes the connectivity with basal black band. The undersides of the wings are more cryptically colored, providing camouflage when the butterfly rests on surfaces.

**-Habitat:** It inhabits a range of forested habitats and gardens.

**-Life Cycle:** It undergoes complete metamorphosis, consisting of four stages: egg, larva (caterpillar), pupa (chrysalis), and adult. The female butterfly lays eggs on host plants, which are typically species from the citrus family (Rutaceae).

The caterpillar hatching from the egg goes through several instars (stages) of growth, shedding its skin each time it outgrows it. The mature caterpillar is typically green with white or yellow spots and has small spines along its body. Once the caterpillar reaches its final instar, it pupates by forming a chrysalis, which is often brown or green. Inside the chrysalis, the transformation from pupa to adult butterfly takes place.

**-Behavior and Ecology:** The Common Jay butterfly is known for its strong and swift flight, often fluttering around in the forest understory. It is attracted to flowers for nectar feeding and plays a role in pollination of various plant species. Adults are also known to puddle. The caterpillars feed on the leaves of their host plants, and they have adaptations to cope with the toxins present in these leaves.

• Family-Pieridae (Whites and Sulfurs)

3. Belenois aurota (Pioneer)

**-Morphology:** _Belenois aurota_ is a medium-sized butterfly with a wingspan ranging from about 50 to 70 millimetres. Wings are predominantly white. Female are heavily marked while males are lightly marked with black on upperside. They are distinguished by ‘J’ shaped black mark above forewing. The undersides of the wings are similar in pattern to the upper sides, with a combination of white and black markings [Plate 1(3)].

**-Habitat:** It inhabits in open grasslands, fields and gardens.

**-Life Cycle:** It undergoes complete metamorphosis, consisting of four stages: egg, larva (caterpillar), pupa (chrysalis), and adult. The female butterfly lays eggs on host plants, which are typically species from the capper family (Capparaceae) and other related plant families. The caterpillar that hatches from the egg goes through several instars (stages) of growth, shedding its skin as it grows. The mature caterpillar is typically green with yellow or white markings and has spines along its body. Once the caterpillar reaches its final instar, it pupates by forming a chrysalis, which is often brown or green. Inside the chrysalis, the transformation from pupa to adult butterfly takes place.

**-Behavior and Ecology:** It is known for its rapid flight and its tendency to flutter around open areas and fields. It is attracted to flowers for nectar feeding and plays a role in pollination. The caterpillars feed on the leaves of their host plants and have adaptations to cope with plant toxins.
4. *Catopsilia pomona* (Common Emigrant)

-Morphology: Sexes dissimilar. Common Emigrant butterfly has a wingspan ranging from about 60 to 80 millimetres. Male and Female have red ringed silver spots in centre of wings on underside. Male upper side is chalky white having narrow black border up to forewing while female upper side is lemon yellow having dark spot as well as dark border on forewing.

-Habitat: The Common Emigrant butterfly is found in various habitats, including open fields, gardens, agricultural areas, and even urban environments.

-Life Cycle: It undergoes a complete metamorphosis, consisting of four stages: egg, larva (caterpillar), pupa (chrysalis), and adult [Plate 1(4)]. The female butterfly lays eggs on host plants, which can include species from the legume family (Fabaceae), especially plants like Cassia and Senna. The caterpillar hatching from the egg goes through several instars (stages) of growth, shedding its skin as it grows. The mature caterpillar is typically green with longitudinal stripes and often has spines along its body. Once the caterpillar reaches its final instar, it pupates by forming a chrysalis, which can be green or brown. Inside the chrysalis, the transformation from pupa to adult butterfly occurs.

Behavior and Ecology: These butterflies migrate from the open grassland area towards the high canopy habitats as the temperature rises. It is attracted to flowers for nectar feeding and plays a role in pollination. The caterpillars feed on the leaves of their host plants and possess adaptations to cope with plant toxins.

- Family – Nymphalidae (Brush footed butterflies)

5. *Danaus chrysippus* (Plain Tiger)

-Morphology: Sexes are similar but males can be distinguished by presence of additional black spot over their hindwing. Plain Tiger butterfly has a wingspan ranging from about 70 to 80 millimetres. They are shiny butterflies of orange and brown colours having black and white border over their wings [Plate 1(5)]. The undersides of the wings are paler and have similar markings to the upper sides.

-Habitat: It is found in a wide range of habitats, including grasslands, open fields, gardens, and urban areas.

-Life Cycle: The life cycle of the Plain Tiger butterfly includes the same stages as other butterflies: egg, larva (caterpillar), pupa (chrysalis), and adult. The female butterfly lays eggs on host plants, which are typically species from the milkweed family (Asclepiadaceae). The caterpillar that hatches from the egg goes through several instars (stages) of growth, shedding its skin each time it outgrows it. The mature caterpillar is striped and banded with black, white, and yellowish colours. Once the caterpillar reaches its final instar, it pupates by forming a chrysalis, which can be green, brown, or yellow. Inside the chrysalis, the transformation from pupa to adult butterfly takes place.

- Behavior and Ecology: Flight is slow as it is highly poisonous. The caterpillars of this species are known to be unpalatable to predators due to the toxins they acquire from their host plants. This makes them less likely to be eaten. It is mimicked by several other butterflies like female Danaid Eggfly (Image 2). Both the sexes feed on nectar from a variety of flowers and plays a role in pollination.

 Plain Tiger (unpalatable)  
 Image 2: - Batesian Mimicry (Females Danaid Eggfly mimicking toxic Plain Tiger.  
 Danaid Eggfly (palatable)

6. *Hypolimnas misippus* (Danaid Eggfly)

-Morphology: The Danaid Eggfly has sexual dimorphism i.e., males and females have different appearances. The wingspan is about 70-85 millimetre. Male’s underside is bright brown in colour having broad white bands [Plate 1(6)]. Females have orange brown wings with edges of black and white spots, mimicking the appearance of toxic butterflies
like Plain Tiger (Image 2). It shows the batesian mimicry in which palatable species mimics the warning signals of a harmful or unpalatable species.

-Habitat: It is found in a variety of habitats, including gardens, open fields, forest edges, and urban areas.

-Life Cycle: The life cycle of the Danaid Eggfly includes the standard stages of egg, larva (caterpillar), pupa (chrysalis), and adult. The female lays eggs on host plants, which are often species from the Acanthaceae and Malvaceae families. The caterpillars that hatch from the eggs go through several instars (growth stages) and feed on the leaves of the host plants. The mature caterpillar forms a chrysalis, which is often attached to the underside of leaves or other surfaces. Inside the chrysalis, the transformation from pupa to adult butterfly occurs.

-Behavior and Ecology: Its flight is more powerful than Plain Tiger. Adult males are territorial and may perch on leaves or other surfaces to wait for females. Males are territorial. Both sexes play a role in pollination as it visits various flowering plants.

- Family – Lycaenidae (Including blues, coppers, hairstreaks and gossamer-winged butterflies)

7. Lampides boeticus (Pea Blue)

-Morphology: Pea Blue butterflies are relatively small with a wingspan ranging from about 20 to 30 millimetres. They often have bright blue or iridescent blue wings on the upper side, which may vary in colour intensity and pattern depending on the species. The undersides of the wings are usually pale with intricate patterns that include spots, lines, and markings [Plate 1(7)].

-Habitat: They are found in a variety of habitats, including open grasslands, meadows, gardens, and scrublands.

-Life Cycle: The life cycle of Pea Blue butterflies includes the stages of egg, larva (caterpillar), pupa (chrysalis), and adult. Females lay eggs on host plants, which are typically legume species like clovers and other plants in the family Fabaceae. The caterpillars that hatch from the eggs go through several instars (growth stages) and feed on the leaves of the host plants. The mature caterpillar forms a chrysalis, often attached to leaves, stems, or other surfaces. Inside the chrysalis, the transformation from pupa to adult butterfly takes place.

-Behavior and Ecology: Pea Blue butterflies are known for their active and rapid flight. They often fly close to the ground and are frequently seen in sunny areas. Both sexes play a role in pollination as they visit various flowers. Some Pea Blue butterflies have mutualistic relationships with ants. Caterpillars secrete sugary substances that attract ants, and in return, ants offer protection to caterpillars.

8. Zizeeria karsandra (Pale Grass Blue)

-Morphology: The Dark Grass Blue butterfly is relatively small, with a wingspan of about 20 to 22 millimetres. They show sexual dimorphism. The upper side of the male's wings is bluish-purple with a dark border. The upper side of the female's wings is brown with a similar dark border. The females also tend to have broader wings compared to males. Both sexes have pale grey-brown undersides with white spots and orange submarginal spots [Plate 1(8)].

-Habitat: They are commonly found in a variety of open habitats, including grasslands, gardens, meadows, and agricultural areas.

-Life Cycle: The butterfly's life cycle begins with the egg stage, during which the female butterfly lays eggs on the leaves of host plants, typically leguminous plants like clover and Desmodium species. The caterpillar that hatches from the egg is green and covered in spiky projections. It feeds voraciously on the leaves of its host plants, growing and moulting through several instars. After reaching its final instar, the caterpillar pupates. The pupa, or chrysalis, is usually attached to a substrate, such as a stem or leaf. During this stage, the transformation from caterpillar to adult butterfly takes place.

-Behavior and Ecology: They are often seen fluttering around grassy areas, feeding on the nectar of various flowering plants. Like many butterflies, it engages in basking behavior, where it rests with its wings open in sunny spots to absorb warmth and regulate its body temperature. Males fond of wet sand. Both sexes help in pollination.
Plate 1

1: *Papilio demoleus* (Lime Butterfly) (Family-Papilionidae)

2: *Graphium doson* (Common Jay) (Family-Papilionidae)

3: *Belenois aurota* (Mating shot) (Family-Pieridae)

4: *Catopsilia pomona* (Mating shot) (Family-Pieridae)
Conclusion
In present survey the biology of 8 butterflies belonging to 4 different families has been studied. Studying their biology helps to understand the intricate relationships between butterfly species and their habitats. They are sensitive to environmental changes, so their presence or absence can serve as indicator of environmental shifts and can provide early warnings about potential imbalances.
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