VAN VIHAR
NATIONAL PARK & ZOO

Tinsa

DEVELOPMENT AND ESTABLISHMENT OF BUTTERFLY CONSERVATORY AT VAN VIHAR NATIONAL PARK & ZOO

Further Contact:
Tinsa Ecological Foundation, Bhopal
Email: tinsafoundation@gmail.com
Contact no.: +91-9479889952

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Technical report.

Contents

List of Figures

List of Tables

INTRODUCTION

The butterflies are one of the most visible and functional species in the ecosystem (Larson et al. 2001). Butterflies belong to Lepidoptera or scaly-winged insects (lepidos = scales and pteron = wings in Greek). Butterflies have fine scales on their wings that look like fine powder. These scales are colored and result in giving striking colors and patterns to many butterflies while providing cryptic colors and camouflage patterns to others. When touched by humans, the wings tend to lose some scales. If too many scales are lost, the butterfly's ability to fly will be impaired. The scales on the butterfly wings have many properties, mostly optical, that interest scientist. The patterns they make are also seen as the best animal system for understanding the developmental and genetic processes that produce morphological variation in nature. Butterflies have been used as model organisms for a variety of fields of study, spanning ecology, evolutionary biology, and conservation biology (Boggs et al. 2003).

1.1 Life Cycle of a Butterfly

The life cycle of a butterfly can be discussed in four stages in detail. All the butterflies have complete metamorphosis. To grow into an adult, they go through four stages - egg, larva, pupa, and adult. Every stage has different goals to achieve like caterpillars need to eat a lot and adults need to reproduce. The life cycle of the butterfly may depend on the type of butterfly; it might take from a month to a whole year.

Metamorphosis is the process where butterflies' life cycle depends on. Metamorphosis, which means transformation or change in shape, is a very lengthy process. There are two types of metamorphosis, first complete metamorphosis and second incomplete metamorphosis.

Some common insects like dragonflies and cockroaches go through incomplete metamorphosis. But insects like butterflies and moths go through the complete metamorphosis process. The butterflies' life cycle is divided into four parts: egg, larva, pupa, and adult. (Figure 1)

Figure 1: Life cycle of Blue tiger Butterfly

- First Stage: Egg

The first stage of the butterfly is the egg from where a butterfly starts its life. The different types of eggs are small, round, oval, or cylindrical. The shape of the egg depends on the type of butterfly. The special thing about butterfly eggs is that you can see the tiny caterpillar growing inside of it. If you look closely, especially at monarch caterpillars. The eggs of the butterfly are usually laid on the leaves of plants.

First, the female butterflies laid eggs on plants. By the time these plants are changed into foods for the newborn larva. Spring and summer are the best time or climates to lay eggs for female butterflies. It also varies on the species of that female butterfly. Female butterflies could lay a vast number of eggs at one time. But in the end, some of them can survive. In size and shape, butterfly eggs are tiny.

- Second Stage: Caterpillar, The Larva

The larva is the next stage. It is also named a caterpillar. The main thing that caterpillars do is eat. Larvas stored this food for the future and used it to get an adult. At that time, it grows up, splits its skin, and sheds it four 4 to 5 times. It grows up to 100 times on this stage. Also, the larva size grows up to 2 inches long in several weeks.

The second stage of the butterfly life cycle is the larva. Butterfly larva is one which is called a caterpillar, the butterfly does not remain in this stage for a long time, in this stage all they do is to eat. An egg of the butterfly once hatched, the caterpillar will start to do his work to eat the leaf they were born on. So, it is very important for mother butterflies to lay an egg on the leaf which caterpillars can eat.

The different caterpillars eat different types of leaves, so, it is very important to lay an egg on the kind of leaf the caterpillar prefers to eat because the caterpillar cannot travel to a new plant. The main purpose of the caterpillar is to eat as much as it can and grow quickly. When the caterpillar is born, it is extremely small and when they start eating, they start growing and expanding instantly.

- Third Stage: Pupa, The Transition Stage

The third stage of the butterfly is the pupa. It is one of the coolest stages of butterfly life. Once the caterpillar is grown fully to its full length and weight, they form themselves into a pupa, also known as a chrysalis. Caterpillars change rapidly inside of the pupa, their remarkable transformation called metamorphosis. In this transformation, the caterpillar is transformed into a butterfly by changing tissue, limbs and organs of the caterpillar.

Caterpillars stop eating after being grown. Now it's transformed into a pupa. The pupa of butterflies is known as a chrysalis. A cocoon of silk covers the pupa. This stage can take more than a week or a month. These original larva cells provide lots of energy to the growing adult cells at this stage.

- Fourth Stage: Adult, The Reproductive Stage

The fourth stage is the final stage of the butterfly known as an adult butterfly. Once all the transformation is done inside the pupa. A person has to be very lucky to see an adult butterfly emerging out. The adult stage is the final stage of the butterfly life cycle. In this stage, the larva gets more extensive and has a pair of giant wings for the fly. But after this stage the butterfly can't grow.

The main job of the butterfly is to mate and lay eggs. At this stage, some butterflies can eat nectar from flowers, but some cannot. Most of the adults' butterfly live for one or two weeks. Some of them can hibernate in winter and live more days. When the butterfly first emerges from the pupa, both of the wings are soft and folded against its body. So, all the body parts fit into the pupa.

1.2 Taxonomy of Insects

Butterflies belong to class Insecta which is a part of Phylum Arthropoda. Other classes of Phylum Arthropoda are Crustacea, Myriapoda, Arachnida, and Onycophora. These classes defer from each other in various characteristics ranging from body regions, locomotor organs types, respiration type, feeding habit, sensory organ types etc. (Table 1).

Table 1: Classification of Insects

Character	Crustacea	Arachnida	Chilopoda	Diplopoda	Onychopoda	Insecta
Habitat	Aquatic and terrestrial	Terrestrial	Terrestrial	Terrestrial	Terrestrial	Many terrestrial and few aquatic
Body regions	Two – cephalothorax and abdomen	Three- Pro, meso and meta soma	Two- head and multi segmented trunk	Two- head and multi segmented trunk	Worm like- unsegmented in adults	Three: Head, thorax and abdomen
Antennae	Two pair	No antenna	One pair	One pair	One pair	One pair
Visual organs	One pair of stalked compound eyes	One pair of simple eyes	One pair of simple eyes	One pair of simple eyes	Simple eyes	Both simple (3 no.) and two compound eyes
Locomotor organs	Five pairs of biramous legs	Four pairs	One pair/segment	Two pairs/ segment	Many bilateral lobe like legs	3 pairs of legs on 3 thoracic segments and 2 pair of wings on meso and meta thorax
Respiration	Gill breathing	Book lungs tracheal	Tracheal	Tracheal	Tracheal	Tracheal
Habit	Herbivores, carnivores	Phytophagous and predators	Carnivorous	Herbivorous	Organic matter	Phytophagous, predators and parasitoids
Examples	Crayfish, crabs, wood lice and lobster	Spiders, scorpions, mites and ticks	Centipedes	Millipedes	*Peripatus* sp.	Insects

The classification of insects into various orders is based on the presence or absence of wings and their venation, type of mouth parts, type of metamorphosis and characteristics of antennae and tarsi. The Insecta has two subclasses, Apterygota, the primitive wingless insects, and Pterygota, insects with wings (although some of them may be secondarily apterous).

There were originally 29 insect orders. Because of their superficial similarities to preying mantids and phasmids, the stick insects, a new insect order (with only three members) was added in 2002 and named Mantophasmatodea. These insects don't have an elongated mesothorax like phasmids, and they don't have raptorial forelegs like mantids.

Table 2: Characteristics of various Orders of Insecta

S. No.	Order	Examples	Wings	Type of mouth parts	Metamorphosis
1	Blattodea	Cockroaches, Termites	Two pairs of wings Forewings hardened into leathery tegmina (cockroaches) , Wings, when present equal in size and shape (termites; only reproductive have wings)	Chewing mouthparts	Incomplete metamorphosis
2	Coleoptera	Beetles	Two pairs of wings , Forewings hardened into elytra	Chewing mouthparts	Complete metamorphosis
3	Collembola	Springtails	Wings absent	Chewing mouthparts	No metamorphosis
4	Dermaptera	Earwings	Two pairs of wings	Chewing mouthparts	Incomplete metamorphosis
5	Diplura	Two-Pronged Bristletails	Wings absent	Chewing mouthparts	No metamorphosis
6	Diptera	Flies	One pair of wings , Hind wings developed into halters	Mouthparts highly variable- Piercing/sucking Cutting/lapping Sponging	Complete metamorphosis
7	Embioptera	Webspinners	Two pairs of wings or wingless	Chewing mouthparts	Incomplete metamorphosi
8	Ephemeroptera	Mayflies	Two pairs of wings held vertically at rest	Chewing mouthparts (vestigial as adults)	Incomplete metamorphosis, Immatures are Naiad
9	Hemiptera	True Bugs, Leafhoppers, Aphids	Two pairs of wings Forewings modified into hemelytra	Piercing mouthparts	Incomplete metamorphosis
10	Hymenoptera	Bees, Wasps, Sawflies, Ants	Two pairs of membranous wings	Chewing mouthparts May be modified into chewing/ lapping mouthparts	Complete metamorphosis
11	Lepidoptera	Moths And Butterflies	Two pairs of wings	Siphoning mouthparts	Complete metamorphosis
12	Mantodea	Mantids	Two pairs of wings Forewings modified into leathery tegmina	Chewing mouthparts	Incomplete metamorphosis

13	Mecoptera	Scorpionflies	Two pairs of wings	Chewing mouthparts	Complete metamorphosis
14	Thysaneura	Silverfish	Wingless	Chewing mouthparts	No metamorphosis
15	Trichoptera	Caddish Flies	Two pairs of wings held like a puptent over body Wings covered in hair	Piercing mouthparts	Complete metamorphosis, Immatures are naiad
16	Neuroptera	Lacewings, Antlions	Two pairs of wings. Wings have net-like venation	Chewing mouthparts	Complete metamorphosis
17	Siphunculata	Sucking Lice	Wingless	Piercing mouthparts	Incomplete metamorphosis
18	Odonata	Dragonflies, Damselflies	Two pairs of wings , Wings cannot be folded over the abdomen	Chewing mouthparts	Incomplete metamorphosis, Immatures are Naiad, with extendable labrum
19	Orthoptera	Grasshoppers, Crickets, Katydids	Two pairs of wings , May be wingless	Chewing mouthparts	Incomplete metamorphosis
20	Phasmatodea	Walking Sticks	Winged or wingless, If winged, forewings developed into leathery tegmina	Chewing mouthparts	Incomplete metamorphosis
21	Plecoptera	Stoneflies	Two pairs of wings held flat along back at rest	Chewing mouthparts	Incomplete metamorphosis, Immatures are Naiad
22	Protura	Coneheads	Wings absent	Chewing mouthparts	No metamorphosis
23	Psocoptera	Book Lice	Wingless or two pairs of wings	Chewing mouthparts	Incomplete metamorphosis
24	Mallophaga	Bird Lice	Wingless	Chewing mouthparts	Incomplete metamorphosis
25	Siphonaptera	Fleas	Wingless	Chewing mouthparts	Complete metamorphosis
26	Strepsiptera	Twisted-Wing Parasites	Males have one pair of wings with the other pair reduced to small appendages	Piercing mouthparts	Complete metamorphosis

27	Thysanoptera	Thrips	Two pairs of wings. Wings fringed	Punching/sucking mouthparts	Incomplete metamorphosis with a pupa-like resting stage
28	Grylloblatoidea	Gryloblatta	Wingless	Chewing mouthparts	Incomplete metamorphosis
29	Zoraptera	Zorapterans	Two pairs of wings or wingless	Chewing mouthparts	Incomplete metamorphosis
30	Mantophasmatodea	Mantophasnati-Ds	Wingless	Chewing mouthparts	Incomplete metamorphosis

1.3 Lepidoptera Order

Lepidoptera order contains over 100 families of insects worldwide, some of which are moths and some of which are butterflies. However, there are some differences in physical and behavioral characteristics that are easy to learn and recognize.

The most obvious difference is in the feelers or antennae. Most butterflies have thin slender filamentous antennae which are club-shaped at the end. Moths, on the other hand, often have comb-like or feathery antennae, or filamentous and un-clubbed. This distinction is the basis for the earliest taxonomic divisions in the Lepidoptera, separating them into the following two groups: The Rhopalocera – 'clubbed horn' (Butterflies) & the Heterocera - 'varied horn' (moths).

Most moth caterpillars spin a cocoon made of silk within which they metamorphose into the pupal stage. Most butterfly caterpillars, on the other hand, form an exposed pupa, also termed as chrysalis. There are many exceptions to this rule, however. For example, the Hawkmoths form an exposed chrysalis which is underground. Gypsy moths sometimes form butterfly-style pupae, hanging on twigs or tree bark, although usually, they create flimsy cocoons out of silk strands and a few leaves, partially exposing the chrysalis. A few Skipper butterfly larvae also make crude cocoons in which they pupate, exposing the pupa a bit. The Parnassius butterfly larvae make a flimsy cocoon for pupation and they pupate near the ground surface between debris.

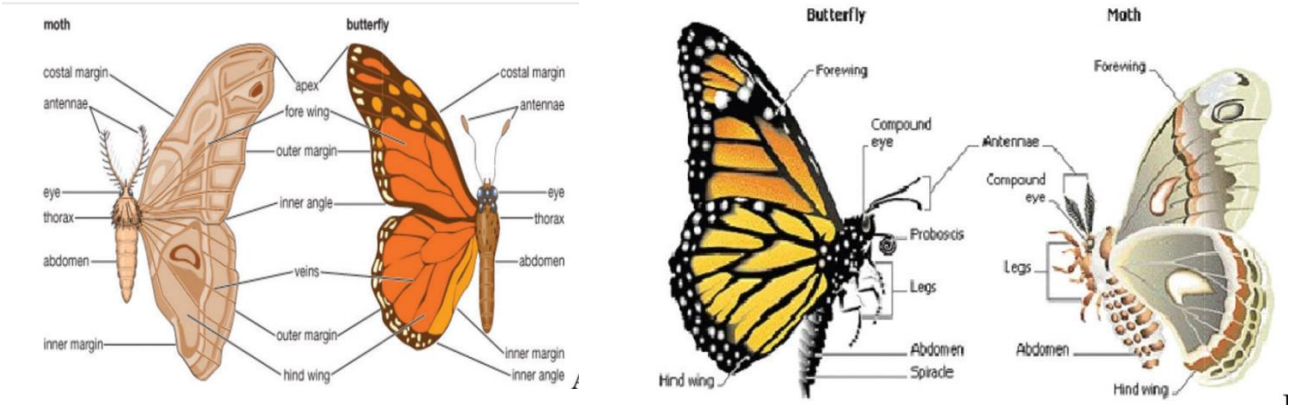

Figure 2: Body differentiation in Butterfly and Moths (Source: Parveen, F.K., 2017)

1.4 Host and Nectar Plants

Host plant: Host plants are plants that adult butterflies depend upon to raise their larval young. Female butterflies lay their eggs directly onto their host plant of choice since caterpillars cannot travel far to feed. This include trees, shrubs, herbs, climbers, and grasses. Trees like *Bauhinia racemosa, Albizia lebbeck, Aegle marmelos, Butea monosperma, and Peltophorum pterocarpum; and* shrubs like *Caesalpinia pulcherrima, Calotropis gigantea,* and *Calotropis procera,* were found frequent during the survey. The important herbs like *Barleria cristata, Mimosa pudica, Hygrophila auriculata,* and *Senna tora* act as host and nectar plants for butterflies.

Nectar Plants: A constant supply of nectar is vital to reduce the waning of native butterfly populations, and so it's important to try and deliver a range of plants that will have at least some viable nectar-producing flowers throughout the year. Wild plants like *Ocimum americanum, Boerhavia diffusa, Desmodium triflorum, Euphorbia hirta, Malvastrum coromandelianum, Melochia corchorifolia, Ludwigia adscendens, Sesamum indicum, Sesamum radiatum, Sida cordifolia, Tridax procumbens, Triumfetta rhomboidea, and Urena lobata, are important sources of nectar.*

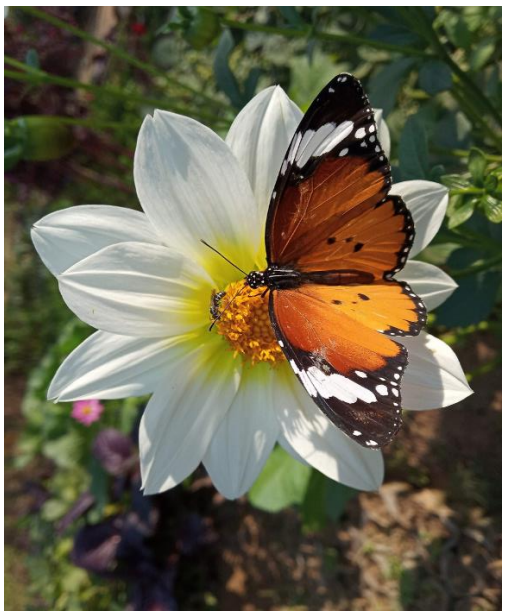

Figure 3: Egg and caterpillar of lime butterfly on Limonia acidissima and a Plain tiger taking nectar

1.5 Classification of Butterflies

Butterflies are classified into two superfamilies, Hesperioidea, consisting of the 'skippers,' and Papilionoidea, or 'true butterflies.' Skippers differ in several important ways from the remaining butterflies. Skippers have the antennae clubs hooked backward, have stocky bodies, and possess stronger wing muscles and better eyes. However, Hesperioidea and Papilionoidea are considered sister taxa. Modern taxonomists place them all in the superfamily Papilionoidea (Fig 1-3), distinguishing the skippers from the other butterflies at the series level only.

There are about 180,000 described species of Lepidoptera, around 10% of all described species of living organisms. In butterflies (Papilionidae), there are about 17,500 described species, or 1% of known organisms (Vane-Wright, 2003). In India, there are about 1646 species of butterflies recorded (Sharma, N et al., 2020). Total of 153 species of butterflies were reported from Madhya Pradesh (Chandra et, al. 2007).

The previous research works on butterflies were carried out in the state of Madhya Pradesh by Forsyth, 1884; Bentham, 1890; Witt, 1909; Singh, 1977; Gupta & Shukla, 1987; Chaudhary, 1995; Siddiqui & Singh, 2004, and Chandra et, al. 2007.

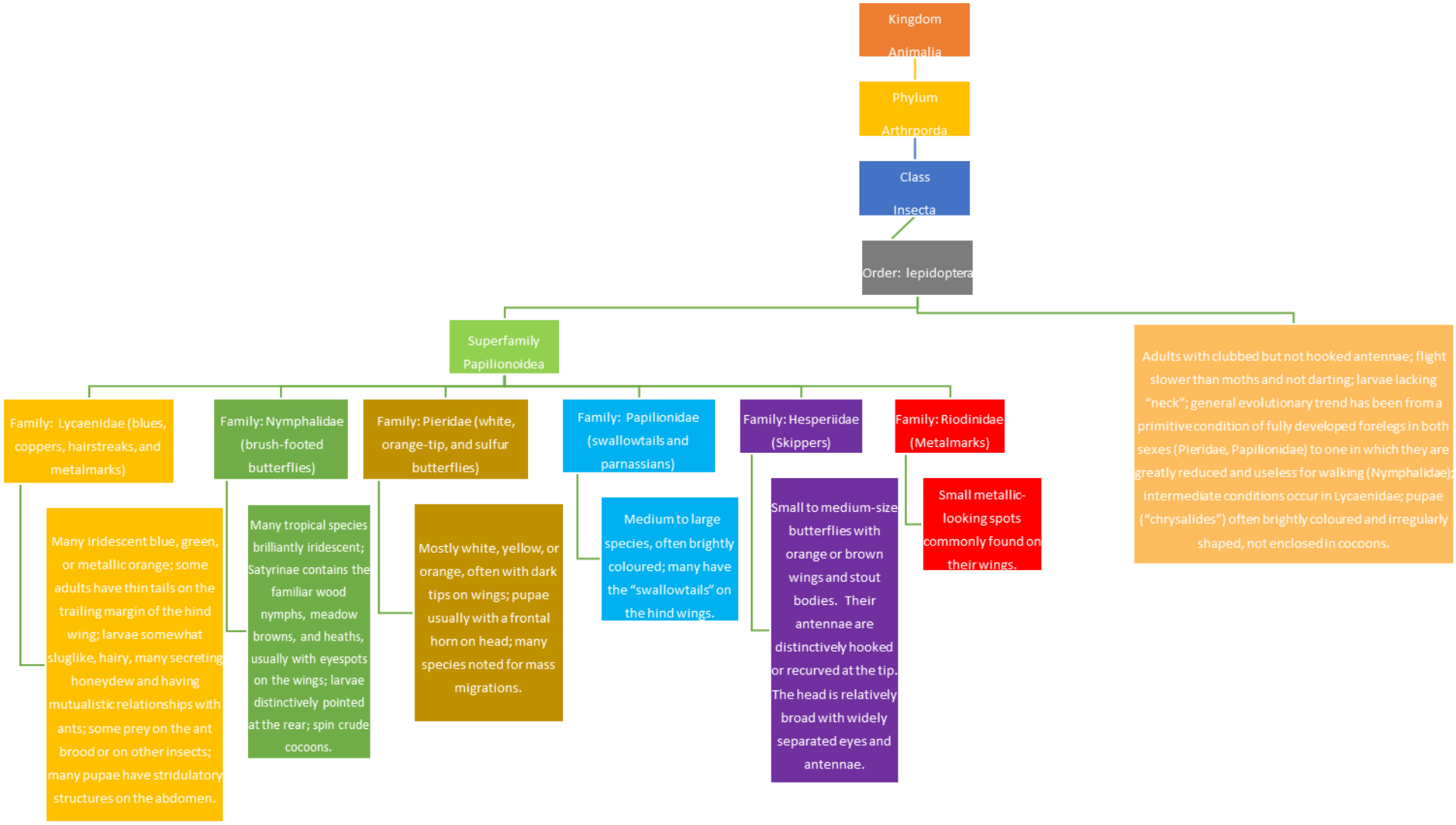

Figure 4: Classification of Butterflies

1.6 Importance of Butterflies

Humans regard a variety of insects to be pests. Insects, on the other hand, are extremely important for a variety of reasons.

Ecological Importance

Insects play a significant role in many ecosystems, performing a variety of services. They help to aerate the soil, pollinate blossoms, and keep insects and plant pests at bay. Scavenger insects, particularly beetles, feast on dead animals and fallen trees, recycling nutrients back into the earth. Insects, as decomposers, aid in the formation of top soil, the nutrient-rich layer of soil that aids plant growth. Burrowing insects such as ants and beetles excavate tunnels that offer water conduits for plants. Flowering plants are pollinated by bees, wasps, butterflies, and ants. Certain insect populations, such as aphids and caterpillars, which feed on new plant growth, are controlled by bugs and praying mantis. Finally, all insects use the nutrients in their droppings to fertilize the earth.

Economic Importance

Insects are extremely valuable economically. Honey, wax, lacquer, and silk are examples of beneficial things produced by insects. Humans have reared honeybees for the purpose of making honey. To make silk, the silkworm is utilized to develop silk. Insect larvae and adult insects, such as crickets, are often used as fishing bait.

Insects as food

Insects, of course, are not just eaten by people. Insects are the sole food source for many amphibians, reptiles, birds, and mammals, making their roles in food chains and food webs extremely important. It is possible that food webs could collapse if insect populations decline.

Ecosystem value

Butterflies and moths are indicators of a healthy environment and healthy ecosystems. They indicate a wide range of other invertebrates, which comprise over two-thirds of all species. Areas rich in butterflies and moths are rich in other invertebrates. These collectively provide a wide range of environmental benefits, including pollination and natural pest control. Moths and butterflies are an important element of the food chain and are prey for birds, bats and other insectivorous animals (for example, in Britain and Ireland, Blue Tits eat an estimated 50 billion moth caterpillars each

year). Butterflies and moths support a range of other predators and parasites, many of which are specific to individual species, or groups of species. Butterflies have been widely used by ecologists as model organisms to study the impact of habitat loss and fragmentation, and climate change.

Educational value

Butterflies and moths have fascinating life-cycles that are used in many countries to teach children about the natural world. The transformation from egg to caterpillar to chrysalis is one of the wonders of nature. Other educational aspects include the intricate wing patterns and iridescence, and as examples of insect migration.

Aesthetic value

Butterflies and moths are part of our natural heritage and have been studied for over 300 years. Butterflies and moths are beautiful. Many are iconic and popular. People like butterflies. There are many references to butterflies and moths in literature, from the Bible through Shakespeare to modern day literature, and from poetry to musical lyrics. Butterflies are used by advertisers and illustrators the world over as way of indicating that something is environmentally friendly. Butterflies are often portrayed as the essence of nature or as representing freedom, beauty or peace.

1.7 Establishment and Development of Conservatory of Butterfly

Nature education and wildlife awareness is effective tool for addressing the utility of biodiversity, and natural ecosystems. Nature Education and Wildlife awareness also provide an opportunity for direct observation and communication of the importance of biodiversity and natural ecosystems. It helps to create awareness among the masses about the fact that the human population can't survive without natural ecosystems such as forests, wetlands, and rivers. With the growth of cities, the distance between nature and people had been increased. People tend to forget the importance of nature and ecosystem goods and services provided by it. The Stockholm Conference on the Human Environment and the Tbilisi Intergovernmental Conference on Environmental Education, which were held in 1972 and 1977 respectively, established the need for environmental education at the global level.

The development and promotion of nature education, nature walks, and environmental awareness will concise the importance of environmental components. Experiencing forest, wetland, river, and

grassland can excel students as well as citizens' vision for conservation of biodiversity that will ultimately lead to healthy humankind.

Development of conservatories are one of the important phase of in-situ conservation. Butterfly conservatory is one of very interesting and informative section in any nature park and zoo. Butterfly conservatory have a nursery, host plant section, nectar plant section, section for mud-pudling, interpretation center etc.

1.8 Butterfly Survey at Van Vihar National Park

Van Vihar comprises of different habitats with various plant communities. The forest is dominated by *Tectona grandis* with common associate tree species like *Aegle marmelos, Diasporus melanoxylon, Lagerstroemia parviflora, Albizia lebbeck, Albizia procera, Terminalia elliptica, Butea monosperma,* and *Cassia fistula*. These tree species are contributing for host and nectar for butterflies. There are various herbs such as *Heliotropium indicum, Aegle marmelos*, *Mimosa, Abutilon indicum, Sida acuta, Sida cordifolia, Senna tora, crotalaria retusa, Sesamum indicum, Verbesina encelioides* and *Tridex procumbens* which assist butterflies' population.

Butterflies are the important biotic component of the ecosystem, as they are important pollinators and visibly attractive. The ecological role of butterflies in an ecosystem is not only as herbivores, but they can also be used to monitor environmental conditions (Beccaloni & Gaston, 1995). Change in butterfly abundance may indicate change in habitat conditions. The diversity of butterfly can be the indicator of rich plant diversity as butterflies are host specific and the high diversity of plants supports organism at different trophic levels. Significant diversity and population of butterflies can be savior of habitats for mega herbivores to top predators.

1.9 Objectives

The aim of the project is to develop and enrich butterfly park of Van Vihar National Park for Education and Awareness. The objectives are as follows

- To establish baseline data of butterflies in Van Vihar National Park.
- To document host and nectar plants species and create a nursery for Butterfly Conservatory.
- To establish a conservatory for Butterflies.
- To develop butterfly life cycle model on the ground in form of a park.
- To monitor the diversity of butterflies after establishing Conservatory for butterflies.
- To develop modules for butterflies' conservation awareness and develop a Public Participation Model for conservation.

STUDY AREA: VAN VIHAR NATIONAL PARK & ZOO

Van Vihar National Park and Zoo are one of Central India's most revered National Parks and Zoos. It has become a shining beacon of conservation and an ideal example of eco-restoration. It is a national park located within the city limits of Bhopal that exemplifies the grandeur and peaceable of a forest area. Van Vihar National Park (IUCN category II) is an urban protected area in the heart of capital city of Madhya Pradesh, Bhopal. Established in 1979, on the fringe of upper lake of Bhopal city, the park covers an area of about 445 hectares and serves as green lung for the city, is beloved by the residents of the capital (Kanoje, 2006). Van Vihar National Park came into being after the importance of natural space conservation was recognized in the area. Consequently, both naturally occurring and brought in species of endangered animals are kept here. What started as a protected area, now not only serves the purpose of conservation but also provides socio-cultural services to the city. Van Vihar NP and Zoo is unique in the sense that it got dual status and is situated in the heart of Bhopal city. The park has a free-roaming population of small carnivores and herbivores, while large carnivores are in big-sized enclosures designed in the natural habitats. The carnivores in the park are those abandoned, injured, or those who came into serious conflict with humans.

It is parks like these, which make awareness about biodiversity. It truly is a treasure trove of nature and wildlife to be explored by both wildlife enthusiasts and casual visitors.

Van Vihar's rich floral and faunal diversity is supported by the typical combination of rich wetland areas, meadows, pools of water at various locations, rugged slopes, mixed bamboo vegetation, grass-covered plateau, and areas of mixed plantations. This green oasis amid the city of lakes also serves as an important carbon sink, contributing to Bhopal's environmental health.

It is right next to the well-known Upper Lake of Bhopal, also known as the "Bada Talab," which is a Ramsar Site and one of the two lakes of Bhoj Wetland. Van Vihar is part of the Upper Lake catchment area, which helps to prevent siltation and contributes to clean water in the lake, which is one of the city's main sources of water.

Figure 5: Aerial view of Van Vihar National Park (Pic credit: Tushar Bhojwani)

The present survey was carried out in Van Vihar National Park, Bhopal, Madhya Pradesh with the GPS coordinates N 23°14'42.72" E 77°20'42"; N 23°12'59.04" E 77°23'6". It is surrounded by the Wetland which provides a good habitat for the diverse species of fauna. The altitude varies from 450 meters to 650 meters above mean sea level in the Plateau of Vindhaychal Hill Ranges. The climate is subtropical type in the area which is characterized by monsoon (July to August), post-monsoon (September-October) winter (November to February) and summer (March to June). In winter the average temperature is around 18-20^{o}C and it drops to as low as 7^{o}C in the month of January. The summer months are hot and humid with an average temperature of about 35-40^{o}C and it reaches as high as 47^{o}C especially in the month of May. The average annual rainfall is around 1266 mm. (Kanoje, 2006 and Wani et al., 2012).

From the management aspect, the park has been divided into three zones, tourism, management, and Safari. The key features are following for each zone:

Tourism Zone:

☐ 5Km length of trail from Ramu Gate to Cheeku Gate

☐ Vihar Vithika Interpretation centre, Bird Interpretation Centre, Butterfly park, and Reptile park

☐ Carnivore Enclosure, and Aviary

Figure 6: Tourism Zone (Pic Credit: Tushar Bhojwani)

Management Zone:

☐ Open area of 375 ha

☐ Free roaming population of herbivores

☐ Species: Cheetal, Sambhar, Blackbuck, Nilgai, Swamp Deer, Wild Pigs, Jungle cat, Jackal, Pangolin, Monitor Lizard, Porcupine, Hare, etc.

Safari Zone:

☐ Includes Rescue Centre and Breeding Centre

☐ Open for vehicular safari for general people

Figure 7: Management Zone (Pic Credit: Tushar Bhojwani)

Figure 8: Safari Zone (Tushar Bhojwani)

Being nestled in heart of the city, the park received hundreds of footfall daily starting from the morning walkers, to families, school and college students, and nature enthusiasts. Various educators, wildlife experts, and NGOs working for environmental education have been involved in

different nature education and sensitization activities conducted by the park management throughout the year.

However, there is a need to improve the management of the park enclosures and outreach activities conducted in the VVNP for the better dissemination of knowledge about biodiversity, nature and ecosystem goods and services provided by it to the visitors. Therefore, this proposal identifies the areas/enclosures/programs which need immediate prompt actions.

This project aims to the improvement and enrichment of existing facilities, development of new facilities, and streamlining nature education programs.

The survey was carried out in morning hours from 8.00 am to 2.00 pm during 14th -20th February 2022 and 24th -28th February 2022, where the activity of insects was observed. To record the daily observations observation sheet, GPS, Camera (Model) were used. In daily observations, Temperature, Weather, Terrain, GPS coordinates were maintained.

Figure 9: Google Earth Image of Van Vihar National Park

METHODOLOGY

For development and establishment of Butterfly conservatory in Van Vihar National Park and Zoo, we need a baseline assessment of butterflies and the host plant diversity.

3.1 Baseline Assessment of Butterfly diversity

To effectively use butterfly as indicators applying appropriate survey method for butterfly monitoring program by citizen scientist/people participatory program is really important. Survey design must include a reliable method of data collection and statistical analysis so that results are scientifically sound and robust (Nowicki et al. 2008).

Major four methods that are frequently used in butterfly research and monitoring are (1) trapping and netting, (2) mark-recapture, (3) transects (Pollard walks), and (4) distance sampling.

Trapping and netting are primarily used to ascertain the presence–absence of a species or to produce species counts (Droege et al. 1998).

Researchers use **mark –recapture method** to gain in-depth and accurate population data (Gall 1985), this method is performed by capturing individuals, marking them with fine-tipped markers, identification tags, or unique appendage clippings, releasing them, and recapturing marked and unmarked individuals.

Transects or Pollard walks, are a specific type of line transect done in butterfly research (Pollard 1977), this method uses visual identification while searching along desirable transects of a specific width to count butterflies.

Distance sampling uses randomly placed transects or points to collect unbiased butterfly data (Moranz et al. 2012; Henry et al. 2015).

Usually, checklist survey is employed in public participation program for butterfly surveys. Checklist survey primarily confirm presence of species and sometimes number of individuals for the survey site. However, such ''open-ended'' survey approaches frequently are inadequate to meet the rigors of statistics (Hellawell 1991). Relative abundance is difficult to estimate accurately across a series of checklist data sets (Royer et al. 1998). For continuous monitoring or indexing of actual or relative abundance a more carefully designed sampling model is essential. Keeping our objectives in mind we adopted the transect method developed by Pollard *et al.* (1975), and later adapted by Pollard (1977, 1982), as it is a quick way to assess relative abundance and species presence while reducing the need for handling individuals (Pollard 1977).

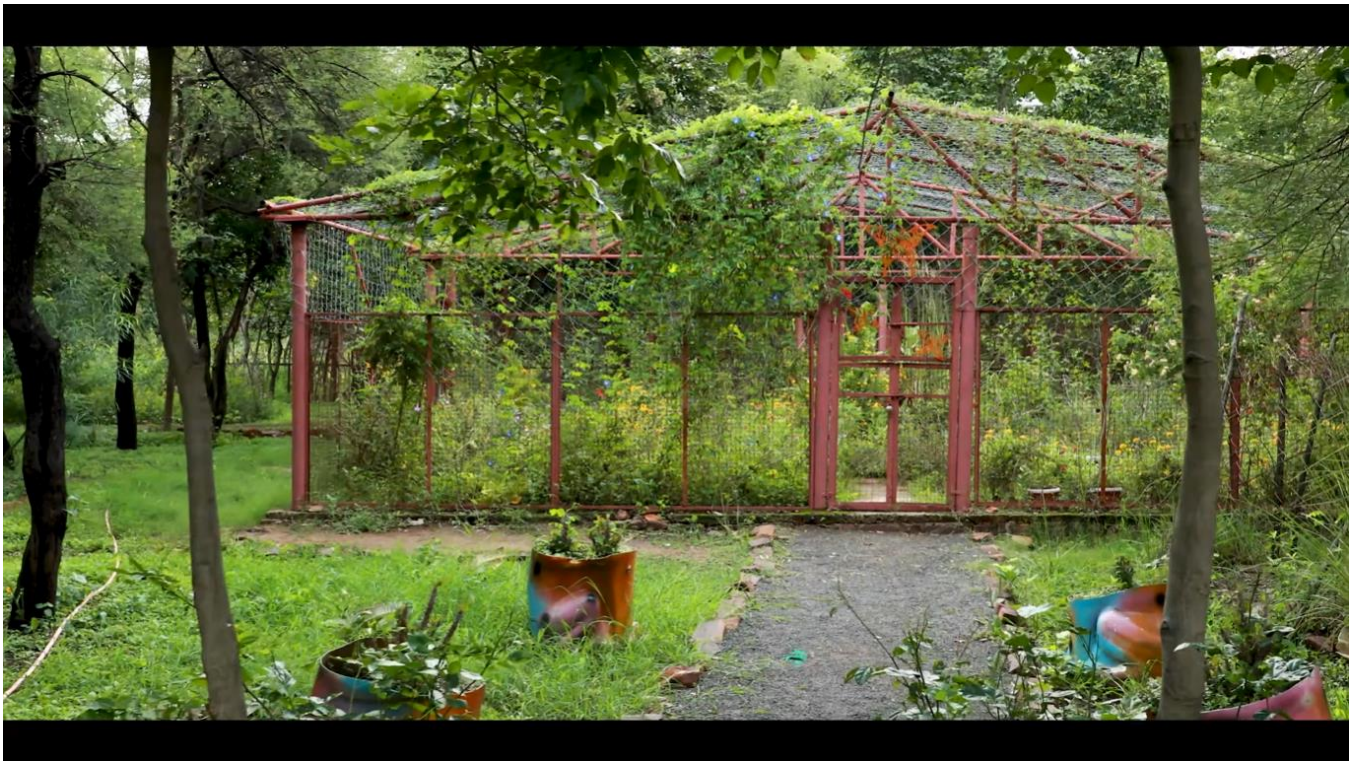

Figure 10: Butterfly Park at VVNP

3.1.1 Survey Design

The tourism zone of VVNP was surveyed for the diversity of butterflies. The total length of the tourism zone trail is around 5 kms which was divided into transects of 500m. Every alternate 500m trails was surveyed for butterfly diversity following periodic/systematic random sampling method. The survey method followed was Pollard's walk. Three replications each were taken at the selected transects on three continuous days.

3.1.2 Butterfly Field Survey Method (Pollard's Walk)

The butterfly sampling was done using the 'Pollard's walk', a type of transect walk primarily used for butterfly surveys, where the observers record butterflies within a 2.5-meter band on both sides of a transect while walking at a slow and steady pace and 5 meters ahead of the walk. The observations were recorded in the datasheet provided which entailed the details of the butterfly species, their count, activity pattern, and remarks on the host plant species.

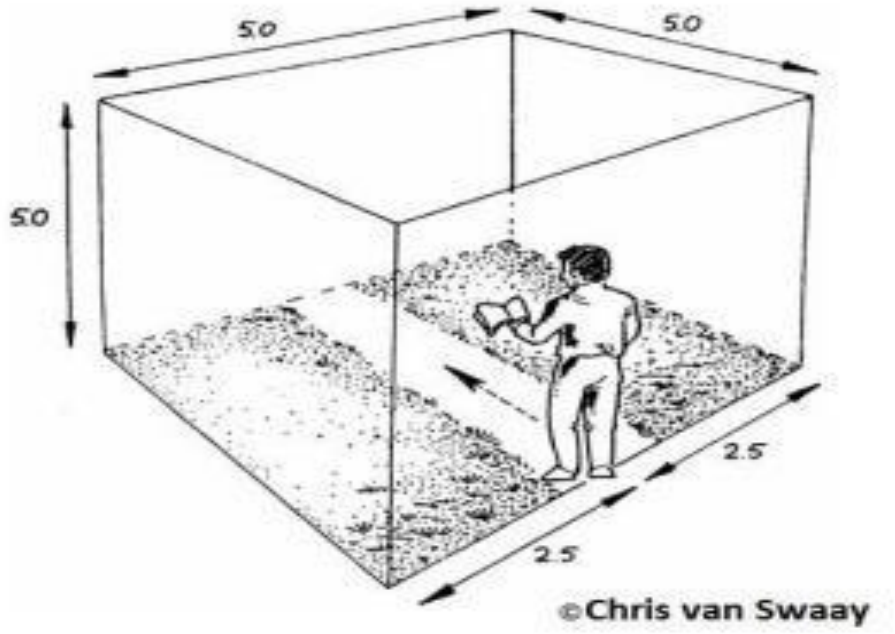

Figure 11: Pollard's Walk

Pollard Walk surveys employ fixed travel routes during counting. More rigorous statistical analysis of Pollard Walk transect data is possible because counts are conducted in a much more uniform manner with respect to area covered and time spent. Moreover, fixity of extent and location of transects allows subsequent or concurrent study of multiple factors (*e.g.,* floral and faunal studies on the same transect). Definite extent and permanent location also make frequent replication possible. This uniform delimitation of parameters, which allows confident longitudinal monitoring, is one of the most important features of transect sampling.

3.2 Establishment of Host and Nectar Plant Nursery for Butterfly Conservatory

3.3.1 Baseline survey of Host Plants

The butterfly park has been surveyed for the checklist of host and nectar plants during Feb 2022. Out of 54 species, 12 species of trees, 7 shrub species, 29 species of herbs, 3 grass species and 3 climber species. We recorded following species acting as host and nectar plant for butterflies:

Table 3: List of plant species in the butterfly park

S.No,	Common Name	Scientific Name	Remark (Tree/Shrub/Herb /Climber/Grass)
1.	Dhak	*Butea monosperma*	T
2.	Papadi	*Pongamia pinnata*	T (Dominate sp.)
3.	Babul	*Acacia nilotica*	T
4.	Shisham	*Dalbergia sissoo*	T
5.	Ber	*Ziziphus mauritiana*	T
6.	Dudhi	*Wrghtia tinctoria*	T
7.	Mahua	*Madhuca indica*	T
8.	Jamun	*Syzygium cumini*	T
9.	Amaltas	*Cassia fistula*	T
10.	Siris	*Albezia lebbeck*	T
11.	Date Palm	*Pheonix sylvestris*	T
12.	Guava		T
13.	Karaunda	*Carissa sp.*	S
14.	Kiss me not plant	*Euphorbia milli*	H
15.	Kaner Pink	*Nerium oleander*	S
16.	Kaner Yellow		S
17.	Sadabahar		H
18.	Sannai	*Crotolaria sp.*	H
19.	Hathisundi	*Heliotropium sp.*	H
20.	Butterfly Weed	*Asclepias sp.*	H
21.		*Argeratum sp.*	H
22.		*Vernonia sp.*	H
23.		*Euphorbia hirta*	H
24.	Patharchata	*Kalanchoe sp.*	H
25.	Coat Button plant	*Tridax precumbin*	H
26.	Marsh Glory	*Ipomea aquatica*	H
27.	Mexican Blue Bell	*Ruellia sp.*	H
28.	Lipstick tree	*Bixa orellana*	S
29.	Day Lily	*Hemerocallis sp.*	H
30.	Spider Lily	*Crinum asiasticum*	H
31.	Canna	*Canna indica*	H
32.	Egyptian Star cluster	*Pentas lanceolata*	H
33.	Fire Bush	*Hamelia sp.*	H

34.	Ixora	*Ixora sp.*	S
35.	Rangoon Creeper	*Combretum indicum*	C
36.	Marigold	*Tagetes erecta*	H
37.	Sunflower	*Helianthus annus*	H
38.	Wedelia	*Sphagneticola trilobola*	H
39.	Aak	*Calotropis procera*	H
40.	Butterfly pea	*Clitoria ternatea*	C
41.	Chandani	*Tabernaemontana divaricata*	H
42.	Lantana	*Lantana camara*	S
43.	Trailing Lantana	*Lantana montevidensis*	H
44.	Water Lily	*Nymphaea sp.*	H
45.	Oxalis	*Oxalis corniculata*	H
46.	Crab eye creeper	*Abrus precatorius*	C
47.	Chitrak	*Plumbago zeylanica*	S
48.	Bathuwa	*Chenopodium album*	H
49.	Kanchara	*Commelina sp.*	H
50.	Bhui-amla	*Phyllanthus niruri*	H
51.	Sida	*Sida sp.*	H
52.	Dhub Grass	*Cynodon dyctolon*	G
53.	Khas	*Vetiveria zizanioides*	G
54.	Crow foot grass	*Dactyloctenium sindicum*	G

3.3.2 Establishing conservatory for Butterflies

Identification of host plant species and dependent butterfly species

A list of commonly found butterflies and their host plants has been identified. A total of 95 species and family groups has been identified for the butterfly park at Van Vihar National Park. These plant species was targeted for collection and planted in Butterfly conservatory for enrichment of host plant availability.

S. No.	Plant Species	Family	Dependent Butterfly Species
1	*Albizzia sp.*	Fabaceae	Zebra Blue, C.Nawab, T.S.G Yellow
2	*Annona sp.*	Annonaceae	Tailed jay
3	*Ardisia solanacea*	Primulaceae	Plum Judy
4	*Argemone mexicana*	Papaveraceae	Painted Lady
5	*Aristolochiasp.*	Aristolochiaceae	Common Rose, Crimson Rose
6	*Asclepias curassavica*	Apocynaceae	Blue Tiger
7	*Axonopus compressus*	Poaceae	Common Four ring
8	*Bamboo*	Poaceae	Grass sp, Bushbrown, Fourring, Yellows, Darts, Swifts
9	*Barteria Cristata(Vajradanti)*	Acanthaceae	Danaid Eggfly, Peacock pansy, Grey, yellow, blue, chocolate, lemon
10	*Bauhinia racemosa*	Leguminosae	Common Emigrant
11	*Blepharis Sp.*	Acanthaceae	Flat , Zebra blue, Lineblue, Sailer
12	*Bothriochloa sp. Grass*	Poaceae	Grass sp, Bushbrown, Fourring, Yellows, Darts, Swifts
13	*Butea monosperma*	Fabaceae	C.emigrant,cerulean ,R pierrot, forget me not
14	*Cadaba fruiticosa*	Capparaceae	C. gull , crimson tip ,orange tip
15	*Caesalpinia pulcherrima*	Leguminosae	Common Grass Yellow
16	*Calotropis sp.*	Apocynaceae	Plain tiger, Stripped tiger, Blue tigers, grass jewel
17	*Capparis sp.*	Capparaceae	Common Gull, Psyche, Yellow Orange Tip, Pioneer, C. Gull , salmon arab
18	*Careya Arborea*	Lecythisaceae	Grey count
19	*Carrissa Spinaram*	Apocynaceae	Common Crow
20	*Caryota urens*	Arecaceae	Palmfly, Redeye, Palm bob
21	*Cascabela thevetia*	Apocynaceae	Common Crow
22	*Cassia fistula*	Fabaceae	Ciliate blue, Silverline, Sailor, Emigrant, Grass Yellow
23	*Cenchrus Grass*	Poaceae	Grass sp, Bushbrown, Fourring, Yellows, Darts, Swifts
24	*Chloris Grass*	Poaceae	Grass sp, Bushbrown, Fourring, Yellows, Darts, Swifts
25	*Chloroxylon swietenia*	Rutaceae	Lime , C B Peacock
26	*Chrysopogon Grass*	Poaceae	Grass sp, Bushbrown, Fourring, Yellows, Darts, Swifts
27	*Cinnamomum tamala*	Lauraceae	C mime
28	*Citrus Sp.*		Lime, Lemon pansy, Lime Blue

29	*Clerodendrum indicum*	Lamiaceae	Common Silverline
30	*Coffee*	Rubiaceae	Commander
31	*Crateva religiosa*	Capparaceae	Albatross, Orange tip, Psyche
32	*Cryptolepis dubia*	Apocynaceae	Plain tiger
33	*Cymbopogon sp. Grass*	Poaceae	Grass sp, Bushbrown, Fourring, Yellows, Darts, Swifts
34	*Dalbergia sp.*	Fabaceae	Flat , Zebra blue, Lineblue, Sailer, Common Emigrant, Rajah
35	*Delonix regia*	Fabaceae	Grass yellows, Common Nawab
36	*Desmodium oojeinense*	Leguminosae	Forget-Me-Not
37	*Dichanthium sp. Grass*	Poaceae	Grass sp, Bushbrown, Fourring, Yellows, Darts, Swifts
38	*Digitariasp. Sp. Grass*	Poaceae	Grass sp, Bushbrown, Fourring, Yellows, Darts, Swifts
39	*Diospyros melanoxylon* Roxb.	Ebenaceae	Baronet
40	*Euphorbiaceae sp. Grass*	Poaceae	common sergeant
41	*Ficus sp.*	Moraceae	Common map, Silver-Streak Blue
42	*Flacourtia Indica*	Salicaceae	Common Leopard
43	*Gram Plant*		Gram Blue
44	*Guava Plant*		Silverline
45	*Gymnosphoria Sp.*	Celastraceae	Common Leopard
46	*Helicteres isora* L.	Malvaceae	Common Nawab
47	*Heliotropium Sp.*	Boraginaceae	Plain tiger, Stripped tiger, Blue tigers, grass jewel
48	*Hygrophila auriculata* (Schumach.) Heine	Acanthaceae	Grey Pansy, Yellow Pansy
49	*Ichnocarpus Frutescens*	Apocynaceae	Crows
50	*Ixora*	Rubiaceae	Commander
51	*Jasminum multiflorum* (Burm.f.) Andrews	Oleaceae	Pioneer
52	*Justicia sp.*	Acanthaceae	Danaid Eggfly, Peacock pansy, Grey, yellow, blue, chocolate, lemon
53	*Kalanchoe sp.*	Crassulaceae	Pierrot
54	*Laburnum*	Fabaceae	C.emigrant,cerulean ,R pierrot, forget me not
55	*Leguminous Sp.*		Forget-Me-Not
56	*Litsea glutinosa*	Lauraceae	Common Mime, C wanderer
57	*Lotus corniculatus* L.	Leguminosae	Indian Cupid
58	*Maerua oblongifolia*	Capparaceae	Common Gull
59	*Magnolia grandiflora*	Magnoliaceae	Common jay
60	*Mahua*	Sapotaceae	Baronet
61	*Mango*	Anacardiaceae	Boron, Monkey Puzzle, Baronet
62	*Melilotus indicus*	Leguminosae	Pea Blue
63	*Michelia champaka*	Magnoliaceae	Common jay
64	*Miliusa tomentosa*	Annonaceae	Spot sword tail
65	*Mimosa pudica L.*	Leguminosae	Hedge blue, Cupid, Pansy ciliate, Blue Pansy, Yellow Pansy
66	*Morus alba L.*	Moraceae	Common Baron

67	*Murraya koenigii*	Rutaceae	Crimson rose
68	*Pancicum sp. Grass*	Poaceae	Grass sp, Bushbrown, Fourring, Yellows, Darts, Swifts
69	*Passion Flower*	Passifloroidae	Tawny caster
70	*Pea Family*		Sunbeam
71	*Peltophorum pterocarpum*	Leguminosae	Common Hedge Blue
72	*Pennisetum sp. Grass*	Poaceae	Grass sp, Bushbrown, Fourring, Yellows, Darts, Swifts
73	*Phragmites karka*	Poaceae	Rice Swift
74	*Pithecellobium dulce*	Leguminosae	Common Nawab
75	*Polyelthia longifelia*	Annonaceae	Tailed jay, common jay , spotted sword tail
76	*Pongamia pinnata*	Leguminosae	Pea Blue, Awls
77	*Portulaca sp.*	Portulacaceae	Danaid Eggfly
78	*Ricinus communis*	Euphorbiaceae	Common Castor, Angled Castor
79	*Ruellia tuberosa*	Acanthaceae	Grassblue, Blue Pansy
80	*Saccharum sp. Grass*	Poaceae	Grass sp, Bushbrown, Fourring, Yellows, Darts, Swifts
81	*Salvador persica*	Salcadoraceae	Salmon arab
82	*Saraca indica*	Fabaceae	Ciliate blue
83	*Schleichera oleosa*	Sapindaceae	Forget-Me-Not
84	*Senna tora*	Leguminosae	Common Grass Yellow
85	*Setaria barbata*	Poaceae	Grass sp, Bushbrown, Fourring, Yellows, Darts, Swifts, Common Evening Brown
86	*Sorghum sp. Grass*	Poaceae	Grass sp, Bushbrown, Fourring, Yellows, Darts, Swifts
87	*Sporobolus sp. Grass*	Poaceae	Grass sp, Bushbrown, Fourring, Yellows, Darts, Swifts
88	*Tamarindus indica* L.	Leguminosae	Black Rajah
89	*Tephrosia sp.*	Leguminosae	Dark Grass Blue, Forget-Me-Not
90	*Termanalia sp.*	Combretaceae	Large oak blue. Ciliate Blue, Tinset, Awl
91	*Themada sp. Grass*	Poaceae	Grass sp, Bushbrown, Fourring, Yellows, Darts, Swifts
92	*Thunbergia*	Acanthaceae	Danaid Eggfly, Peacock pansy, Grey, yellow, blue, chocolate, lemon
93	*Vigna unguiculata*	Leguminosae	Pea Blue
94	*Water Spider Lily*	Alliaceae	Commander
95	*Ziziphus Sp.*	Rhamnaceae	Sailer, Pierrot, Silverline, Red flash and other flash

Out of these 150+ saplings were planted before fencing the Butterfly park and majority were browsed and uprooted by herbivores and langurs. Field staff Shri Ashish Namdev, Deputy Ranger arranged fencing and protection for the butterfly garden. The species includes following

a) Bel *Agle marmelos*

b) Ber *Ziziphus marautiana*

c) Hathi-sundi *Heliotropium indicum*

d) Mahua *Madhuca indica*

e) Kusum *Schleichera oleosa*

f) Ashok *Polyelthia longifelia*

g) Kari Patta *Murraya Koenigii*

Marking shape of butterfly conservatory

As the park is already designated as Butterfly Park but dominated with Paapdi tree (*Pongamia pinnata).* As part of enrichment and establishment of the butterfly conservatory, we need to clear few of the trees stocks and open the area. We have then marked the butterfly shaped conservatory using lime powder and got approval by Director Mr. H.C. Gupta and Deputy Director Mr. A.K. Jain.

Two shapes have been designed, one is full fledge butterfly with both wings open and other one closed wing feeding on flower nectar.

Figure 12: Closed winged butterfly feeding on nectar of flower

Figure 13: Full fledge open winged butterfly

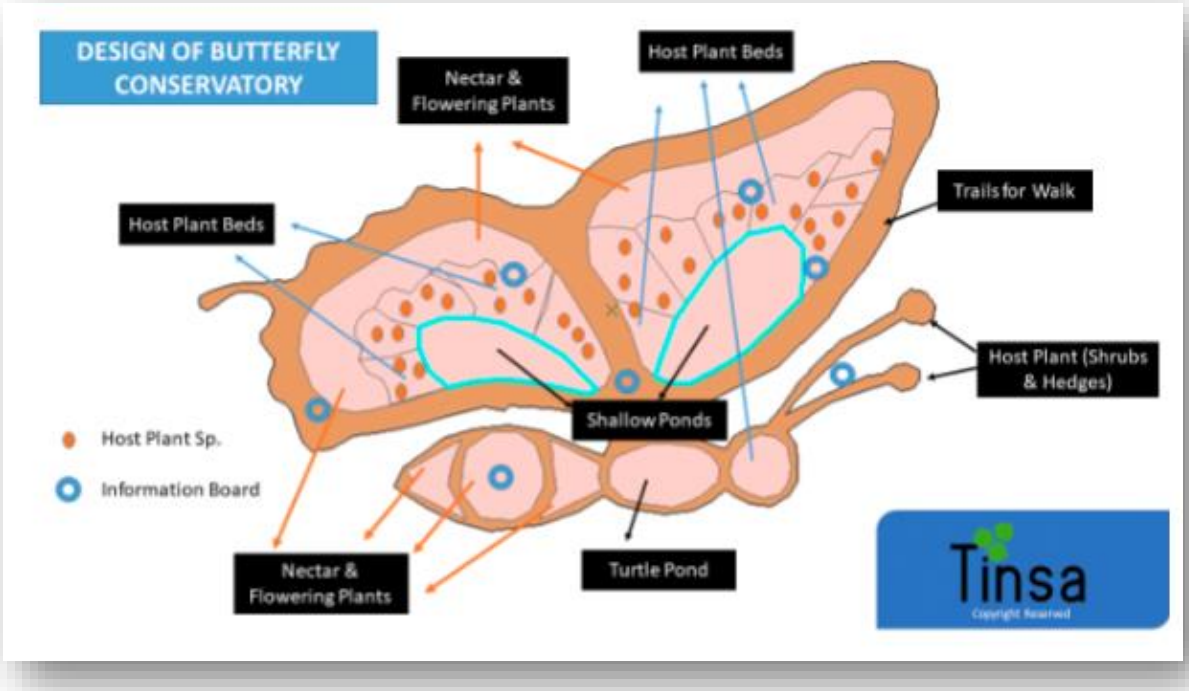

Figure 14: Reference butterfly shaped conservatory design

Framing shape using locally available boulders

The approved design were given shape using locally available boulders by Deputy Ranger and his team. Once the shape area will be raised this will give a better visualization.

Figure 15: Butterfly conservatory shaped using local boulders

Figure 16: Butterfly conservatory shaped using local boulders

Figure 17: Beautification using waste materials

Plantation of host and nectar plants

The list of host and nectar plants were shared with Deputy Ranger Mr. Namdev. He surveyed many nursery and were able to find more than 40 species of host and nectar plants in forest nursery, Ahamedpur, Bhopal and privates nurseries of Bhopal. The wild species are difficult to find so we are also establishing a nursery where we will collect wild seeds from VVNP and Ratapani WLS and grow them.

Figure 18: Plantation of Host and Nectar Plants

3.3.3 Monitoring Breeding records

After plantation of host and nectar plants morning surveys were conducted in first week of May 2022 and we recorded many of the species are breeding including Common lime, Tawny Coster, Plain Tiger, Red Pierrot, Common Castor, etc.

One can also see large number of butterflies flying across all parts of Butterfly conservatory.

Figure 19: Monitoring breeding records with Entomologist Mr. Shubham Chapekar and Deputy Ranger Mr. Namdev

3.3.4 Development of Information Boards for Interpretation Centre

An information centre need to be established in the butterfly conservatory and butterfly focused bi-lingual (hindi and english) has been developed.

Figure 20: Awareness Materials for Butterfly Information Centre

RESULTS

4.1 Baseline survey

The six-day butterfly surveys (14-20 February 2022) results resulted in 41 species of butterflies from the tourism zone which is extended into 5 km of transect. These 41 butterfly species belong to five families of butterflies i.e. Papilionidae, Nymphalidae, Pieridae, Lycaenidae, and Hesperidae. Maximum number of species i.e. 17 were observed from Nymphalidae family followed by Lycaenidae (12). Only one species from Hesperidae was observed.

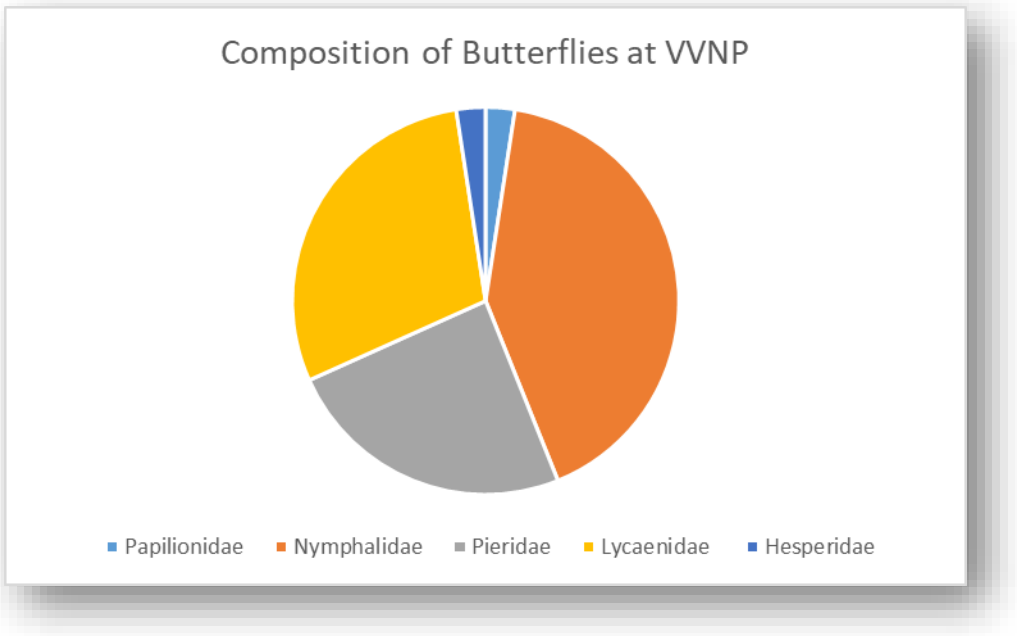

Figure 21: Composition of Butterflies at VVNP

Table 4: List of Butterflies Observed during the survey

Sr. No.	Order	Family	Common Name	Scientific Name	Habitat
1	Lepidoptera	Papilionidae	Lime Butterfly	*Papilio demole*	Mix Vegetation
2		Nymphalidae	Striped Tiger Butterfly	*Danaus genutia*	Mix Vegetation
3			Plain Tiger Butterfly	*Danaus chrysippus*	Mix Vegetation
4			Common Sailor	*Neptis hylas*	Mix Vegetation
5			Blue Tiger	*Tirumala limniace*	Mix Vegetation
6			Common Crow	*Euploea core*	Mix Vegetation
7			Tawny Coster	*Acraea terpsicore*	Mix Vegetation
8			Peacock Pansy	*Junonia almana*	Mix Vegetation
9			Blue Pansy	*Junonia orithya*	Open
10			Grey Pansy	*Junonia atlites*	Open
11			Chocolate Pansy	*Junonia iphita*	Open
12			Common Bush Brown	*Mycalesis perseus*	Mix Vegetation
13			Ring sp.	*Ypthima sp.*	Grassland
14			Commander	*Moduza procris*	Mix Vegetation
15			Evening Brown	*Melanitis leda*	Mix Vegetation
16			Common Wanderer	*Pareronia valeria*	Mix Vegetation
17			Red Baronet	*Euthalia nais*	Mix Vegetation/Wetland
18			Great Egg fly	*Hypolimnas bolina*	Mix Vegetation
19		Pieridae	Common Gull	*Cepora nerissa*	Mix Vegetation
20			Pioneer	*Belenois aurota*	Mix Vegetation
21			Lemon Emigrant	*Catopsilia pomona*	Mix Vegetation
22			Mottled Emigrant	*Catopsilia pyranthe*	Mix Vegetation
23			Psyche	*Leptosia nina*	Mix Vegetation
24			Spotless Grass Yellow	*Eurema laeta*	Mix Vegetation
25			Small Grass Yellow	*Eurema brigitta*	Mix Vegetation

26			Three Spotted Grass Yellow	*Eurema blanda*	Mix Vegetation/Open
27			Common Grass Yellow	*Eurema hecabe*	Mix Vegetation/Open
28			Common Jezebel	*Delias eucharis*	Mix Vegetation/Open
29			Grass Jewel	*Freyeria trochylus*	Open
30			Guava Blue	*Deudorix isocrates*	Open
31			Zebra Blue	*Leptotes plinius*	Open
32			Dingy Line blue	*Petrelaea dana*	Open
33			Common Pierrot	*Castalius rosimon*	Open
34			Spotted Pierrot	*Tarucus callinara*	Open
35		Lycaenidae	Dark Cerulean	*Jamides bochus*	Open
36			Lesser Grass Blue	*Zizina otis*	Open
37			Pea Blue	*Lampides boeticus*	Open
38			Striped Pierrot	*Tarucus nara*	Open
39			Common Cerulean	*Jamides celeno*	Mix Vegetation
40			Common Lineblue	*Prosotas nora*	Mix Vegetation
41		Hesperidae	Swift Sp.	*Pelopidas sp.*	Open

4.2 Establishment of Butterfly Park

Two butterfly shaped conservatory for Butterflies has been established in existing butterfly park of Van Vihar National Park, along with enrichment in term of host and nectar plants, development of shallow mud-puddling ponds, fencing the park etc.

Figure 22: Plantations and establishment of Butterfly conservatory

Figure 23: Development of Mud-puddling ponds

Figure 24: Development of Dragonfly Pond

DISCUSSION AND CONCLUSION

Butterflies are one of the best choices to understand the impact of climate change, habitat degradation, land use change, and other drivers of habitat loss due to the relative ease and popularity of monitoring butterflies. Butterflies are also used as bio-indicators in ecological and environmental studies assuming butterflies faces comparable pressures from various drivers of biodiversity loss. Therefore, it is safe to establish that, continuous monitoring of butterflies can help us protect and conserve biodiversity of a region.

The results of the present study give us an insight into the status of diversity of butterflies of Van Vihar National Park and Zoo. The study shows increase in the number of diversity from 24 (as per official records) to 41 species recorded during the survey. However, the results should be considered as an underestimation of true butterfly diversity of VVNP because the data is only from one season survey and the data was collected only from the tourism zone. The upcoming surveys in different seasons will give us a better understanding of spatio-temporal distribution of the butterfly community at VVNP. However, this study still is able to guide us in the right direction in conserving the butterfly population. A baseline butterfly diversity data has been established which can be utilized by researchers as well as forest managers. The population structure and composition gives us information about the distribution, dispersal, dominance, rarity of various butterfly species.

It is also indicated by the results that both mixed vegetation and open scrub lands are preferred by the consortium of the butterflies in the study region. It is also reported in literature that Habitat determinants within the park could be the key factor for local species richness (Nielsen et al., 2013) This could suggest that diverse habitat be sustained and management strategies be directed towards the same.

Importance of continuous habitat-level monitoring survey for butterfly conservation has been highlighted in studies by other authors (Kitahara et al., 2022). It has been confirmed that the effectiveness of continuous habitat-level monitoring survey in identifying species of conservation concern on a local scale. Thus, it has been recommended continuous monitoring surveys at a local (habitat) level in order to prevent the rapid progression of extinction of local populations (Han et al., 2021). Seasonal and long term monitoring of butterfly diversity at Van Vihar National Park and Zoo is recommended. The results of this data will guide us in

understanding the health of the ecosystem present at VVNP. The park administration can take a cue from the results of the diversity of the butterfly about the health of the habitat and ecosystem and accordingly can take prompt action.

With development and enrichment of Butterfly park a large number of butterflies can be seen in the Butterfly park including large flocks of Plain tiger, Blue tigers, Striped Tigers, Common Emigrants, Lime Butterflies, Lemon Pansy, Grass Yellows, Common crows and mixed flocks of Gram blues, Line blues, Zebra blue, Forget me not etc. This has resulted in large no. of visitors visiting Butterfly park.

This study suggests that VVNP has a great potential to provide habitat to a diverse group of insects including butterflies. A greater diversity of butterfly can attract a number of visitors which includes wildlife enthusiasts, researchers, hobbyists, photographers etc. This scenario provides us with a great opportunity to create awareness among the visitors about the importance of butterflies and their role in our food chain and ecosystem. The butterfly park of the VVNP can be established as a platform for the citizens of the Bhopal city to learn, observe, appreciate and cherish the beauty and importance of the presence of butterflies and nature.

RECOMMENDATIONS

- This study is underestimated in terms that it is restricted to tourism zone only and detailed study in National Park area can enrich the list of butterflies and host plants.
- Second, the study is limited to pre-summer season and multi-season surveys can give a better understand of ecology and diversity of butterflies in Van Vihar National Park.
- Citizen Science based butterfly surveys can be planned for each month at least in Tourism zone to promote awareness among local people as well as regular data collection.
- Enrichment of host and nectar plants and development of nursery within Van Vihar National Park
- Development of Butterfly Interpretation Centre and appointment of a regular Nature Educator specialized in Butterflies and Entomology.
- A batch of trained volunteers were introduced to the VVNP Management and these volunteers can be utilized to promote conservation awareness to visitors.

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Appendix I: Butterfly Diversity of Van Vihar National Park & Zoo, Bhopal

Common Lime

Papilio demoleus

Striped Tiger

Danaus genutia

Plain Tiger

Danaus chrysippus

Blue Tiger

Tirumala limniace

Common Sailor

Neptis hylas

Great Eggfly

Hypolimnas bolina

Common Crow

Euploea core

Tawny Coster

Acraea terpsicore

Peacock Pansy

Junonia almana

Blue Pansy

Junonia orithya

Grey Pansy

Junonia atlites

Chocolate Pansy

Junonia iphita

Common Bush Brown

Mycalesis perseus

Ring Sp.

Ypthima sp.

Commander

Moduza procris

Common Evening Brown

Melanitis leda

Common Wanderer

Pareronia valeria

Baronet

Euthalia nais

Common Gull

Cepora nerissa

Pioneer

Belenois aurota

Lemon Emigrant

Catopsilia pomona

Mottled Emigrant

Catopsilia pyranthe

Psyche

Leptosia nina

Spotless Grass Yellow

Eurema laeta

Small Grass Yellow

Eurema brigitta

Three Spotted Grass Yellow

Eurema blanda

Common Grass Yellow

Eurema hecabe

Common Jazebel

Delias eucharis

Grass Jewel

Freyeria trochylus

Guava Blue

Deudorix isocrates

Zebra Blue

Leptotes plinius

Dingy Lineblue

Petrelaea dana

Common Pierrot

Castalius rosimon

Spotted Pierrot

Tarucus callinara

Dark Cerulean

Jamides bochus

Lesser grass jewel

Zizina otis

Pea blue

Lampides boeticus

Striped Pierrot

Tarucus nara

Common Cerulean

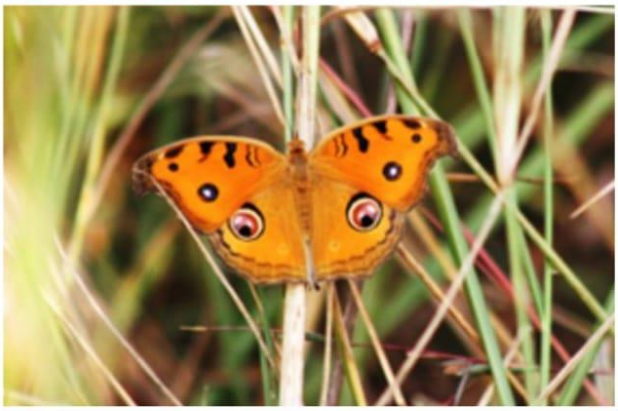
Jamides celeno

Common Lineblue

Prosotas nora

Swift Sp.

Pelopidas sp.



VAN VIHAR
NATIONAL PARK & ZOO

Tinsa